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3.3 Icelandic cod (Division Va)

3.3.1 Groundfish survey design

Icelandic Groundfish Survey (IceGFS) started in 1985. The area of investigation covers the Icelandic shelf down to the 500 m depth contour. 600 stations were considered a reasonable effort to reach an acceptable level of coefficient of variation of cod indices. In order to work the 600 stations within a reasonable time limit, 5 commercial, standardised, stern trawlers are leased.

The allocation of trawling stations is based on the stratified random sampling theory. The stratification scheme is based on pre-estimated cod density patterns derived from commercial as well as research vessel catch data, which were summarised by statistical squares. The statistical square basis allows flexibility in post-stratifications with respect to different species.

Based on biological and hydrographical considerations, the survey area was divided into two areas, a northern and a southern area for design purposes.

The allocation of statistical squares to strata is based on the estimated density of cod in each square. Information on cod density was derived from three different sources: The trawler captains and their advisors graded each square with respect to their experience of fishing in March. Commercial fisheries data yielded additional information on cod density, as did results from previous research surveys.

Ten strata were constructed from the statistical squares, 4 in the southern area and 6 in the northern one. Statistical squares in each strata are not necessarily adjacent, which allows more possibilities in constructing homogeneous strata with regard to fish density.

Stations were divided between strata in direct proportion to the product of the area of each stratum and its estimated cod density. Finally, the trawl stations of a stratum were allocated to each square within the stratum in direct proportion to the area of the square.

Stations within each statistical square were divided equally between fishermen and project members from the Marine Research Institute (MRI). Project members selected random positions for their stations. Fishermen were asked to fix their stations in each square in accordance with their knowledge and experience of fishing and fishing grounds. Trawling is done both day and night, and sampling is distributed uniformly over the 24 hours.

This sampling method may be classified as "semi-random stratified" since only half of the stations are randomly selected.

In 1996 the Groundfish Survey design was analysed and revised with the aim to reduce the total survey cost but keeping about the same level of accuracy. Stations which have only be taken occasionally during the survey period since the beginning of the survey in 1985 and other stations with low or zero catches especially in the southeastern area were thrown out. Recalculation of the survey indices resulted in minor differences to the previous estimates. Accordingly the number of stations was reduced to 540 (instead of the 600 originally) in 1996 and the survey was carried out using 4 trawlers instead of 5 which had been used previously.

3.3.2 Trends in landings and fisheries

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.

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).

Since 1988 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. Effort on cod in 1994 decreased compared to 1993 . This trend has continued since then and a marked reduction in effort against cod has taken place in the most recent years (Table 3.3.2) 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 (Figure 3.3.1).

Due to an increase of the fishable stock biomass the quota for the 1996/1997 fishing year was set at 186 000 t. Landings in 1996 increased accordingly to 182 000 t. For 1997/1998 fishing year the quota was set at 218 000 t. Landings in 1997 amounted to 204 000 t. This lead to a slight increase in effort by the trawler fleet, but the effort of the gillnet fleet and especially the longliners continued to decline.

Trends in fishing mortality by fleet (Figure 3.3.2.) show the same picture for the most recent years. There has been a sharp decline in the fishing mortality of the gillnet and the trawler fleets since 1993. The fishing mortalities of the longliners and the handliners have also shown a slight decrease. The fishing mortality of the trawlers increased in 1996, which can be explained by increased catch rate for this fleet especially in 1996.

3.3.3 Catch in numbers at age

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.

3.3.4 Mean weight at age

3.3.4.1 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. 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.

3.3.4.2 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.

3.3.4.3 Mean weight at age in the spawning stock

For years up to 1997, 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.

3.3.5 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 has been a marked increase in the proportion of mature fish at age during the period 1992–1997 (Figure 3.3.3). The maturity at age data are given in Table 3.3.7.

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.

3.3.6 Stock Assessment

3.3.6.1 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 1992–1997.

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 3.3.8).

The same method was applied for the gillnet fleet. Logbooks for this fleet have been analysed for the years 1992–1997 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 are based on the gillnet fishery in the south and west areas during January-May. These indices have been added to the assessment (Table 3.3.9).

The Icelandic groundfish survey data (Palsson *et al.*, 1989) are used as part of the assessment. 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 each of the three areas separately, age groups 3 to 14 and for the years 1985–1997.

To use the latest information available in the XSA, the 1998 survey abundance indices were moved back in time of approximately three months i.e. to December 1997 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 3.3.10 by fleet, area and age group.

3.3.6.2 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.

3.3.6.3 Estimates of fishing mortality

Tuning fleets used and the relevant tuning indices are given in Tables 3.3.8.-3.3.10. 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 3.3.11.

The resulting fishing mortalities from the final XSA are given in Table 3.3.12 and in Figure 3.3.7.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 (see Table 3.3.15). Present fishing mortality is at the Fmed level.

3.3.6.4 Stock and recruitment estimates

The resulting stock size in numbers and spawning stock biomasses from the final VPA are given in Tables 3.3.13–14. In the stock in numbers table, the recruitment in the most recent years (year classes 1994–1997 as 3-year-olds in 1997-2000) was estimated using RCT3 as described in Section 3.3.8.3.

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 3.3.15 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.

3.3.7 *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 3.3.8.5 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 3.3.16 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 3.3.3. 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. Such data for cod were available to the present meeting, consisting of catches at age in numbers by *metier*, i.e. gear, area and season for each of the years 1992–1997. The resulting data were used to disaggregate fishing mortality by metier. For each fleet the fishing mortality vector was separated into an overall fishing mortality. (Figure 3.3.2.)

3.3.8 Prediction of catch and biomass

3.3.8.1 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.

Table 3.3.17 gives the size of the estimated capelin stock each year. For both sets of weight data, the mean weight at age for most of the important ages is found to be significantly correlated with the weight of the same year class the year before and the capelin biomass at the beginning of the year. This holds for ages 4-8 in the catches and ages 5-8 in the spawning stock at spawning time. Thus, these regressions are used to predict the mean weights at age for these age groups for the years 1998-2000. The preliminary estimate of 1998 capelin biomass is about the 1997 level. For 1999 onwards, the average capelin biomass is used. For ages 3 and 9–14 in both data sets and age 4 in the SSB, the average over the years 1995–1997 is used.

In the most recent period maturity at age has been at high levels compared to the years prior to 1992 (Figure 3.3.3.). Only in 1996 did maturity at age decline. For the short-term predictions the average for the years 1992–1997 has been used for the years 1998-2000.

The exploitation pattern used for the short-term predictions was taken as the average of the years 1995–1997 from the VPA.

3.3.8.2 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.

Mean weight and maturity at age have been predicted as the average over the years 1976–1997.

The average exploitation pattern over 1985–1990 has been used as input.

3.3.8.3 Recruitment

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 3.3.18. As an input to the RCT3 program age groups 1-4 from the survey were chosen.

The size of the year classes 1994–1997 has been estimated using RCT3, with the output as given in Table 3.3.19. The revised recruitment estimates are then discounted with natural and fishing mortalities for use in the predictions.

3.3.8.4 Short term prediction results

Input to the projections is given in Table 3.3.20. Results from projections up to the year 2000 with different fishing mortalities are given in Table 3.3.21.

Landings in 1998 are expected to be 230 000 t due an increase in the quota established. This will however mean a further decrease in fishing mortality to F=0.42 compared to F=0.48 in 1997.

Continuing fishing in 1999 at the 1997 level of fishing mortality (F=0.48) will lead to an further increase in SSB in the short term.

The average size of the incoming year classes (1988–1995) is 137 million individuals. The yield-per-recruit computations indicate that the maximum obtainable yield per recruit is just under 1.8 kg. These two numbers indicate that the average yield from these year classes cannot be expected to exceed 246 000 t.

3.3.8.5 Long-term prediction results and biological reference points

The yield-per-recruit curve based on the 1985–1990 exploitation pattern along with biological reference points is given in Figure 3.3.5 (Tables 3.3.22-23).

The biological reference values for F_{max} and $F_{0.1}$ are 0.37 and 0.20 respectively. Yield per recruit at the F_{max}- level is around 1.8 kg.

A plot of the spawning stock biomass and recruitment is given in Figure 3.3.6. When using the period 1955–1994, 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. The estimated B_{pa} for this stock is 300 000t. The time series shows that the five poorest year classes ever have been generated in years when the spawning stock was lower than 300 000 t. Corresponding fishing mortality F_{pa}=0.4. The expected fishing mortality in 1998 is F=0.42. The lowest observed spawning stock size of 200 000 t has been set as a B_{lim}.

3.3.9 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=0.44 in 1996. In 1997 it increased to F=0.48 which is at the F_{med} level.

In spite of poor recruitment in recent years the spawning stock has shown the first signs of recovery from the historical low levels in most recent years. This is a result of the recent catch restrictions combined with an increase in maturity at age.

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 management scheme 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. According to this management strategy for the 1998/1999 fishing year the catch will be 250 000 t which corresponds to F=0.44.

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.

3.3.10 Comments on the assessment

There has been a considerable decline in fishing mortality on this stock in the most recent period. 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. Variations in this biological parameter are indicated by the trends apparent in Figure 3.3.3.

It is clear that the stock has been heavily overfished for a long time but now show the first signs of recovery which is expected to continue under the newly adopted management scheme.

Table 3.3.1 Nominal catch (tonnes) of Cod in Division Va, by countries, 1984-1997 as officially reported to ICES.

Country	1984	1985	1986	1987	1988	1989	1990
Belgium	254	207	226	597	365	309	260
Faroe Islands	2,041	2,203	2,554	1,848	1,966	2,012	1,782
Iceland	281,481	322,810	365,852	389,808	375,741	353,985	333,348
Norway	90	46	1	4	4	3	-
UK (Engl. and Wales)	2	1	-	-	-	-	-
Total	283,868	325,267	368,633	392,257	378,076	356,309	335,390
WG estimate	-	-	-	-	-	-	-

Country	1991	1992	1993	1994	1995	1996	1997 [1]
Belgium	548	222	145	136	-	-	-
Faroe Islands	1,323	883	664	754	739	599	
Iceland	306,697	266,662	251,170	177,919	168,685	181,052	200,600
Norway	-	-	-	-	4	7	
UK (Engl. and Wales)	-	-	+	-	-	-	-
Total	308,568	267,767	251,979	178,809	169,428	181,656	200,600
WG estimate	-	-	-	-	-	-	203,546 [2]

1) Provisional.
2) Additional landings by Iceland of 2311 t, Faroes of 628 t and Norway of 7 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 1991-1997 (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	60580	71202	30	851	114
1996	66867	67057	29	997	134
1997	81202	74159	32	1095	147

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

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

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

Marine Research Institute Sat May 2 12:26:37 1998
Virtual Population Analysis : Catch in numbers, millions
Final-VPA

Age	1978	1979	1980	1981	1982	1983	1984
3	5.999	7.186	4.348	2.118	3.285	3.554	6.750
4	16.287	28.427	28.530	13.297	20.812	10.910	31.553
5	43.931	13.772	32.500	39.195	24.462	24.305	19.420
6	17.626	34.443	15.119	23.247	28.351	18.944	15.326
7	8.729	14.130	27.090	12.710	14.012	17.382	8.082
8	4.119	4.426	7.847	26.455	7.666	8.381	7.336
9	0.978	1.432	2.228	4.804	11.517	2.054	2.680
10	0.348	0.350	0.646	1.677	1.912	2.733	0.512
11	0.119	0.168	0.246	0.582	0.327	0.514	0.538
12	0.048	0.043	0.099	0.228	0.094	0.215	0.195
13	0.015	0.024	0.025	0.053	0.043	0.064	0.090
14	0.027	0.004	0.004	0.068	0.011	0.037	0.036
Juvenile	66.317	66.657	74.804	79.027	73.043	58.426	65.651
Adult	31.909	37.748	43.878	45.407	39.449	30.667	26.867
Sum 3- 3	5.999	7.186	4.348	2.118	3.285	3.554	6.750
Sum 4-14	92.227	97.219	114.334	122.316	109.207	85.539	85.768
Total	98.226	104.405	118.682	124.434	112.492	89.093	92.518

Age	1985	1986	1987	1988	1989	1990	1991
3	6.457	20.642	11.002	6.713	2.605	5.785	8.554
4	24.552	20.330	62.130	39.323	27.983	12.313	25.131
5	35.392	26.644	27.192	55.895	50.059	27.179	15.491
6	18.267	30.839	15.127	18.663	31.455	44.534	21.514
7	8.711	11.413	15.695	6.399	6.010	17.037	25.038
8	4.201	4.441	4.159	5.877	1.915	2.573	6.364
9	2.264	1.771	1.463	1.345	0.881	0.609	0.903
10	1.063	0.805	0.592	0.455	0.225	0.322	0.243
11	0.217	0.392	0.253	0.305	0.107	0.118	0.125
12	0.233	0.103	0.142	0.157	0.086	0.050	0.063
13	0.102	0.076	0.046	0.114	0.038	0.015	0.011
14	0.038	0.040	0.058	0.025	0.005	0.020	0.012
Juvenile	69.001	80.654	107.928	103.170	82.565	65.114	60.283
Adult	32.496	36.842	29.931	32.101	38.804	45.441	43.166
Sum 3- 3	6.457	20.642	11.002	6.713	2.605	5.785	8.554
Sum 4-14	95.040	96.854	126.857	128.558	118.764	104.770	94.895
Total	101.497	117.496	137.859	135.271	121.369	110.555	103.449

Age	1992	1993	1994	1995	1996	1997
3	12.217	20.500	6.160	10.770	5.360	1.723
4	21.708	33.078	24.142	9.103	14.896	16.454
5	26.524	15.195	19.666	16.829	7.377	17.311
6	11.413	13.281	6.968	13.066	12.315	6.716
7	10.073	3.583	4.393	4.115	9.436	7.385
8	8.304	2.785	1.257	1.596	2.158	5.963
9	2.006	2.707	0.599	0.313	0.837	1.148
10	0.257	1.181	0.508	0.184	0.208	0.493
11	0.046	0.180	0.283	0.156	0.076	0.126
12	0.032	0.034	0.049	0.141	0.065	0.028
13	0.012	0.011	0.018	0.029	0.055	0.037
14	0.008	0.013	0.006	0.008	0.005	0.021
Juvenile	48.743	45.914	26.361	21.953	31.824	21.980
Adult	43.857	46.634	37.688	34.357	20.964	35.425
Sum 3- 3	12.217	20.500	6.160	10.770	5.360	1.723
Sum 4-14	80.383	72.048	57.889	45.540	47.428	55.682
Total	92.600	92.548	64.049	56.310	52.788	57.405

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).

Marine Research Institute Sat May 2 12:26:36 1998
Virtual Population Analysis : Weight at age in the catches, in grams
Final-VPA

Age	1978	1979	1980	1981	1982	1983	1984
3	1289	1408	1392	1180	1006	1095	1288
4	1833	1956	1862	1651	1550	1599	1725
5	2929	2642	2733	2260	2246	2275	2596
6	3955	3999	3768	3293	3104	3021	3581
7	5726	5548	5259	4483	4258	4096	4371
8	6806	6754	6981	5821	5386	5481	5798
9	9041	8299	8037	7739	6682	7049	7456
10	10865	9312	10731	9422	9141	8128	9851
11	13068	13130	12301	11374	11963	11009	11052
12	11982	13418	17281	12784	14226	13972	14338
13	19062	13540	14893	12514	17287	15882	15273
14	21284	20072	19069	19069	16590	18498	16660

Age	1985	1986	1987	1988	1989	1990	1991
3	1407	1459	1316	1438	1186	1290	1309
4	1971	1961	1956	1805	1813	1704	1899
5	2576	2844	2686	2576	2590	2383	2475
6	3650	3593	3894	3519	3915	3034	3159
7	4976	4635	4716	4930	5210	4624	3792
8	6372	6155	6257	6001	6892	6521	5680
9	8207	7503	7368	7144	8035	8888	7242
10	10320	9084	9243	8822	9831	10592	9804
11	12197	10356	10697	9977	11986	10993	9754
12	14683	15283	10622	11732	10003	14570	14344
13	16175	14540	15894	14156	12611	15732	14172
14	19050	15017	12592	13042	16045	17290	20200

Age	1992	1993	1994	1995	1996	1997	1998
3	1289	1392	1443	1348	1457	1484	1430
4	1768	1887	2063	1959	1930	1877	1967
5	2469	2772	2562	2920	3132	2878	2766
6	3292	3762	3659	3625	4141	4028	3910
7	4394	4930	5117	5176	4922	5402	5354
8	5582	6054	6262	6416	6009	6386	6602
9	6830	7450	7719	7916	7406	7344	7555
10	8127	8641	8896	10273	9772	8537	9527
11	12679	10901	10847	11022	10539	10797	10786
12	13410	12517	12874	11407	13503	11533	12148
13	15715	14742	14742	13098	13689	10428	12405
14	11267	16874	17470	15182	16194	12788	14751

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).

Marine Research Institute Sat May 2 12:26:36 1998
Virtual Population Analysis : Weight at age in the catches, in grams
Final-VPA

Age	1978	1979	1980	1981	1982	1983	1984
3	1289	1408	1392	1180	1006	1095	1288
4	1833	1956	1862	1651	1550	1599	1725
5	2929	2642	2733	2260	2246	2275	2596
6	3955	3999	3768	3293	3104	3021	3581
7	5726	5548	5259	4483	4258	4096	4371
8	6806	6754	6981	5821	5386	5481	5798
9	9041	8299	8037	7739	6682	7049	7456
10	10865	9312	10731	9422	9141	8128	9851
11	13068	13130	12301	11374	11963	11009	11052
12	11982	13418	17281	12784	14226	13972	14338
13	19062	13540	14893	12514	17287	15882	15273
14	21284	20072	19069	19069	16590	18498	16660

Age	1985	1986	1987	1988	1989	1990	1991
3	1407	1459	1316	1438	1186	1290	1309
4	1971	1961	1956	1805	1813	1704	1899
5	2576	2844	2686	2576	2590	2383	2475
6	3650	3593	3894	3519	3915	3034	3159
7	4976	4635	4716	4930	5210	4624	3792
8	6372	6155	6257	6001	6892	6521	5680
9	8207	7503	7368	7144	8035	8888	7242
10	10320	9084	9243	8822	9831	10592	9804
11	12197	10356	10697	9977	11986	10993	9754
12	14683	15283	10622	11732	10003	14570	14344
13	16175	14540	15894	14156	12611	15732	14172
14	19050	15017	12592	13042	16045	17290	20200

Age	1992	1993	1994	1995	1996	1997	1998
3	1289	1392	1443	1348	1457	1484	1430
4	1768	1887	2063	1959	1930	1877	1967
5	2469	2772	2562	2920	3132	2878	2766
6	3292	3762	3659	3625	4141	4028	3910
7	4394	4930	5117	5176	4922	5402	5354
8	5582	6054	6262	6416	6009	6386	6602
9	6830	7450	7719	7916	7406	7344	7555
10	8127	8641	8896	10273	9772	8537	9527
11	12679	10901	10847	11022	10539	10797	10786
12	13410	12517	12874	11407	13503	11533	12148
13	15715	14742	14742	13098	13689	10428	12405
14	11267	16874	17470	15182	16194	12788	14751

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

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Marine Research Institute Sat May 2 12:26:36 1998
Virtual Population Analysis : Weight at age in the SSB, in grams
Final-VPA
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Age	1978	1979	1980	1981	1982	1983	1984
3	1031	1141	1333	967	996	891	1002
4	1671	1647	1680	1513	1626	1472	1479
5	2863	2532	2708	2101	2095	2139	2257
6	3920	4027	3875	3225	3006	2918	3476
7	5976	5664	5446	4520	4339	4130	4480
8	6946	6951	7106	5851	5571	5553	5887
9	9204	8234	8120	7661	6801	7007	7660
10	10833	9500	10737	9084	9259	7770	9920
11	12920	12921	12628	10833	11550	10817	11035
12	12863	13028	17528	12401	13445	13176	14531
13	19104	13308	15939	11724	17138	14175	15378
14	21183	18930	25212	14326	16554	18543	16394

Age	1985	1986	1987	1988	1989	1990	1991
3	1131	1182	1289	1218	1012	813	1122
4	1597	1762	1811	1604	1542	1330	1776
5	2285	2681	2735	2499	2423	2132	2233
6	3524	3562	4202	3566	3743	3187	3044
7	5010	4824	5110	5161	5298	4691	3891
8	6195	6457	6497	6238	6910	6627	5897
9	7800	7843	7802	7302	7725	8915	7657
10	9225	9419	10220	8647	9397	10362	10573
11	11336	10674	11197	10184	11953	12093	11230
12	13277	13660	10620	11504	9529	15453	14340
13	15325	13812	15893	14159	12195	15337	14172
14	18932	18479	16514	10952	14270	17257	20200

Age	1992	1993	1994	1995	1996	1997	1998
3	876	1037	1193	1066	1264	1221	1184
4	1389	1570	1748	1826	1627	1613	1689
5	2174	2518	2382	2735	2600	2595	2524
6	3185	3611	3684	3497	3829	3807	3809
7	4481	4872	5175	4741	4605	5434	5215
8	5587	6150	6210	6126	5792	6440	6720
9	6775	7538	7676	7582	7550	7629	7587
10	8225	8840	8814	9887	9433	8606	9309
11	11702	11088	10842	10829	11293	10486	10869
12	13474	12002	12595	11307	12984	11774	12022
13	15436	14402	14402	13098	13821	10943	12621
14	11267	18383	17470	15182	16194	15225	15534

Table 3.3.7. Cod at Iceland. Division Va. Sexual maturity at age.

Marine Research Institute Sat May 2 12:26:36 1998
Virtual Population Analysis : Sexual maturity at age in the stock
Final-VPA

Age	1978	1979	1980	1981	1982	1983	1984
3	0.049	0.000	0.056	0.000	0.023	0.000	0.000
4	0.050	0.019	0.023	0.029	0.051	0.087	0.043
5	0.185	0.189	0.165	0.085	0.129	0.167	0.189
6	0.443	0.531	0.478	0.289	0.226	0.338	0.416
7	0.877	0.793	0.807	0.659	0.544	0.515	0.656
8	0.962	0.929	0.915	0.890	0.849	0.717	0.782
9	0.982	0.982	0.979	0.952	0.956	0.857	0.858
10	1.000	0.919	0.977	0.962	0.967	0.979	0.949
11	1.000	1.000	1.000	0.988	1.000	0.985	0.969
12	1.000	1.000	0.964	1.000	1.000	1.000	0.948
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Age	1985	1986	1987	1988	1989	1990	1991
3	0.027	0.005	0.020	0.039	0.000	0.000	0.000
4	0.058	0.054	0.046	0.020	0.048	0.075	0.063
5	0.202	0.244	0.238	0.206	0.226	0.303	0.214
6	0.548	0.543	0.585	0.477	0.550	0.633	0.543
7	0.774	0.762	0.808	0.690	0.820	0.819	0.781
8	0.903	0.891	0.942	0.831	0.858	0.912	0.887
9	0.938	0.981	0.952	0.929	0.887	0.953	0.945
10	1.000	0.962	1.000	0.946	0.991	0.986	0.842
11	1.000	0.988	0.979	0.974	1.000	1.000	1.000
12	1.000	1.000	1.000	0.821	0.903	1.000	1.000
13	1.000	1.000	1.000	1.000	0.859	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Age	1992	1993	1994	1995	1996	1997	1998
3	0.072	0.078	0.096	0.043	0.078	0.073	0.074
4	0.225	0.246	0.281	0.394	0.097	0.305	0.265
5	0.562	0.470	0.570	0.729	0.512	0.502	0.557
6	0.706	0.714	0.796	0.849	0.742	0.740	0.768
7	0.906	0.939	0.895	0.853	0.862	0.880	0.886
8	0.961	0.984	0.919	0.954	0.911	0.922	0.938
9	0.977	0.973	1.000	1.000	0.841	0.971	0.957
10	1.000	0.968	0.852	1.000	1.000	0.932	0.950
11	1.000	1.000	0.985	1.000	1.000	1.000	0.997
12	1.000	1.000	1.000	1.000	0.986	0.913	0.962
13	1.000	1.000	1.000	1.000	0.971	1.000	0.994
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 3.3.8. Cod at Iceland. Division Va. Bottom trawl CPUE (GLM) indices 1992-1997 used in XSA tuning.

TRAWL-JUN-DEC-N

Year/Age	4	5	6	7	8
1992	867	1058	461	353	139
1993	1343	620	473	185	82
1994	2703	1466	302	139	36
1995	946	1883	1492	205	127
1996	1868	1231	1386	646	112
1997	3663	2134	454	447	272

TRAWL-JAN-MAY-N

Year/Age	4	5	6	7	8
1992	579	1219	813	465	203
1993	1602	993	815	128	54
1994	1334	1705	623	426	63
1995	47	2339	1637	327	187
1996	2357	871	1589	854	154
1997	1631	1977	804	716	561

TRAWL-JAN-MAY-S

Year/Age	6	7	8	9
1992	470	530	693	113
1993	375	62	106	97
1994	507	192	37	16
1995	1126	463	72	0
1996	718	596	105	24
1997	526	474	310	60

Table 3.3.9. Cod at Iceland. Division Va. Gillnet CPUE (GLM) indices 1992-1997 used in XSA tuning.

GILLNET-JAN-MAY-S

Year/Age	6	7	8	9
1992	145	366	683	216
1993	188	165	211	290
1994	245	296	135	64
1995	418	422	214	64
1996	483	509	232	116
1997	399	968	708	171

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

IceGFS. N.
1984 1997
1 1 0.99 1
3 8

1	55261	48059	13027	6211	1990	868
1	22540	18404	17203	4864	1388	375
1	77227	15257	7551	7364	1453	345
1	92490	49378	5573	2906	2306	265
1	60113	46566	18693	1665	545	311
1	8272	15722	18464	6501	456	137
1	22262	8102	8772	9355	1242	107
1	13601	9542	2499	2303	1347	144
1	31684	9441	5124	1100	672	318
1	18211	13369	2675	1550	263	168
1	4301	11353	7088	1330	417	53
1	19228	6083	6923	6599	1160	227
1	48173	23365	5898	5422	3004	171
1	13959	48786	20710	5656	2806	1010

IceGFS. a3 on a3. N
1985 1997
1 1 0.17 0.25
3 3

1	31297
1	84656
1	99294
1	68604
1	17511
1	19408
1	15633
1	30540
1	26030
1	5556
1	17477
1	37466
1	11969

IceGFS. a2 on a3. N.
1986 1997
1 1 0.17 0.25
3 3

1	39301
1	52943
1	25874
1	5820
1	14921
1	11786
1	14473
1	16407
1	2237
1	10539
1	28480
1	3869

Table 3.3.10b Ctd. Cod at Iceland. Division Va. Icelandic Groundfish survey indices used in XSA tuning.

IceGFS. SE
1984 1997
1 1 0.99 1
3 8

1	233	561	470	524	373	345
1	452	686	1171	608	294	138
1	772	404	391	842	286	105
1	4670	3153	519	333	385	62
1	1914	4474	3858	619	274	238
1	85	419	1673	1762	265	83
1	113	114	324	1104	396	89
1	349	511	309	763	1087	203
1	1148	391	361	146	163	117
1	1098	1189	356	321	79	57
1	350	1943	2084	619	300	70
1	792	460	1056	1654	502	141
1	1139	860	358	582	561	50
1	488	3397	1605	624	615	437

IceGFS. SW.
1984 1997
1 1 0.99 1
3 8

1	1723	4444	2588	1911	813	417
1	1413	2203	2968	1310	535	232
1	4003	1266	1190	1656	410	104
1	3929	5935	1144	860	873	102
1	5857	9371	5845	812	296	224
1	1702	6149	8867	4150	409	113
1	3044	2560	4625	7491	1556	193
1	1088	2019	1016	1702	2172	387
1	4112	1935	1664	420	359	255
1	4366	3533	851	573	114	66
1	1298	4397	3538	866	355	22
1	3829	1958	3133	3764	804	181
1	3785	3024	1181	1655	1554	126
1	911	5132	3131	1182	895	537

IceGFS. a3 on a3. SW
1985 1997
1 1 0.17 0.25
3 3

1	534
1	2667
1	2351
1	920
1	818
1	820
1	823
1	936
1	2340
1	795
1	2033
1	2608
1	712

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

Lowestoft VPA Version 3.1

2/05/1998 14:54

Extended Survivors Analysis

"ICELANDIC COD (Div. Va); data from 1970-97(4/98)"

CPUE data from file codvates.dat

Catch data for 14 years. 1984 to 1997. Ages 3 to 14.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
IceGFS. N.	1984	1997	3	8	0.99	1
IceGFS. a3 on a3. N	1985	1997	3	3	0.17	0.25
IceGFS. a2 on a3. N.	1986	1997	3	3	0.17	0.25
IceGFS. SE	1984	1997	3	8	0.99	1
IceGFS. SW.	1984	1997	3	8	0.99	1
IceGFS. a3 on a3. SW	1985	1997	3	3	0.17	0.25
TRAWL-JUN-DEC-N	1992	1997	4	8	0.58	1
TRAWL-JAN-MAY-N	1992	1997	4	8	0	0.58
TRAWL-JAN-MAY-S	1992	1997	6	9	0	0.58
GILLNET-JAN-MAY-S	1992	1997	6	9	0	0.58

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 5

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

Catchability independent of age for ages >= 11

Terminal population estimation :

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

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

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

Prior weighting not applied

Tuning converged after 31 iterations

1

Regression weights	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
3	0.045	0.035	0.049	0.096	0.077	0.147	0.089	0.074	0.029	0.022
4	0.218	0.264	0.23	0.31	0.373	0.308	0.259	0.184	0.139	0.115
5	0.505	0.136	0.444	0.505	0.633	0.49	0.304	0.289	0.222	0.237
6	0.838	0.6	0.638	0.776	0.894	0.776	0.437	0.34	0.356	0.324
7	0.955	0.726	0.786	0.948	1.11	0.808	0.642	0.502	0.441	0.376
8	1.4	0.878	0.817	0.787	1.023	1.161	0.76	0.511	0.541	0.559
9	1.119	0.819	0.79	0.78	0.618	1.235	0.858	0.425	0.556	0.628
10	0.983	0.547	0.835	0.884	0.529	0.953	0.818	0.713	0.562	0.767
11	1.035	0.655	0.629	0.965	0.398	0.909	0.629	0.645	0.744	0.817
12	0.899	0.98	0.75	0.846	0.71	0.582	0.678	0.76	0.617	0.688
13	2.335	0.564	0.438	0.357	0.264	0.569	0.715	1.21	0.782	0.901
14	1.33	0.693	0.668	0.77	0.479	0.763	0.715	0.837	0.684	0.805

1

XSA population numbers (Thousands)

YEAR	AGE 3	4	5	6	7	8	9	10	11	12
1988	1.70E+05	2.22E+05	1.56E+05	3.63E+04	1.15E+04	8.62E+03	2.21E+03	8.04E+02	5.23E+02	2.92E+02
1989	8.39E+04	1.33E+05	1.46E+05	7.70E+04	1.29E+04	3.62E+03	1.74E+03	5.90E+02	2.46E+02	1.52E+02
1990	1.34E+05	6.64E+04	8.39E+04	1.04E+05	3.46E+04	5.09E+03	1.23E+03	6.28E+02	2.79E+02	1.05E+02
1991	1.03E+05	1.04E+05	4.32E+04	4.41E+04	4.52E+04	1.29E+04	1.84E+03	4.58E+02	2.23E+02	1.22E+02
1992	1.82E+05	7.70E+04	6.25E+04	2.13E+04	1.66E+04	1.43E+04	4.81E+03	6.91E+02	1.55E+02	6.96E+01
1993	1.66E+05	1.38E+05	4.34E+04	2.72E+04	7.15E+03	4.48E+03	4.22E+03	2.12E+03	3.33E+02	8.51E+01
1994	8.01E+04	1.17E+05	8.30E+04	2.18E+04	1.02E+04	2.61E+03	1.15E+03	1.00E+03	6.70E+02	1.10E+02
1995	1.67E+05	6.00E+04	7.40E+04	5.01E+04	1.15E+04	4.41E+03	9.99E+02	3.99E+02	3.63E+02	2.93E+02
1996	2.10E+05	1.27E+05	4.09E+04	4.54E+04	2.92E+04	5.71E+03	2.17E+03	5.35E+02	1.60E+02	1.56E+02
1997	8.59E+04	1.67E+05	9.06E+04	2.68E+04	2.60E+04	1.54E+04	2.72E+03	1.02E+03	2.49E+02	6.22E+01

Estimated population abundance at 1st Jan 1998

0.00E+00	5.61E+04	1.40E+05	6.12E+04	1.54E+04	1.47E+04	7.25E+03	1.17E+03	3.86E+02	8.99E+01

Taper weighted geometric mean of the VPA populations:

1.45E+05	1.19E+05	7.39E+04	3.99E+04	1.82E+04	6.87E+03	2.28E+03	8.43E+02	3.42E+02	1.51E+02

Standard error of the weighted Log(VPA populations) :

0.432	0.4263	0.4293	0.4915	0.561	0.5847	0.5528	0.5469	0.59	0.6638

YEAR	AGE 13	14
1988	1.39E+02	3.76E+01
1989	9.74E+01	1.11E+01
1990	4.67E+01	4.54E+01
1991	4.05E+01	2.47E+01
1992	4.28E+01	2.32E+01
1993	2.80E+01	2.69E+01
1994	3.89E+01	1.30E+01
1995	4.57E+01	1.56E+01
1996	1.12E+02	1.12E+01
1997	6.89E+01	4.20E+01

Estimated population abundance at 1st Jan 1998

2.56E+01 2.29E+01

Taper weighted geometric mean of the VPA populations:

6.97E+01 2.91E+01

Standard error of the weighted Log(VPA populations) :

0.6779 0.7949

1

Log catchability residuals.

Fleet : IceGFS. N.

Age	1984	1985	1986	1987
3	0.91	-0.02	0.38	0.72
4	0.59	0.23	-0.06	0.37
5	0.4	0.3	0.27	-0.2
6	0.51	0.16	0.32	0.27
7	0.44	0.18	0.33	0.62
8	0.75	0.16	0.38	0.28
9	No data for this fleet at this age			

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
3	0.79	-0.49	0.05	-0.14	0.12	-0.27	-1.05	-0.3	0.35	0
4	0.38	-0.15	-0.15	-0.36	0	-0.3	-0.35	-0.38	0.17	0.61
5	0.26	-0.06	0.06	-0.47	0.01	-0.42	-0.28	-0.2	0.16	0.64
6	-0.4	-0.02	0.07	-0.33	-0.22	-0.24	-0.51	0.16	0.08	0.62
7	0.05	-0.47	-0.4	-0.42	0.04	-0.35	-0.42	0.35	0.31	0.29
8	0.67	0.2	-0.45	-1.11	-0.19	0.48	-0.54	0.15	-0.37	0.44
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	-1.6782	-1.6535	-1.9463	-2.4051
S.E(Log q)	0.3341	0.3421	0.3795	0.5303

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	0.56	2.71	6.16	0.8	14	0.23	-1.59
4	0.65	2.63	5.06	0.86	14	0.18	-1.53

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	0.75	1.451	4.06	0.78	14	0.24	-1.68
6	0.85	0.807	3	0.75	14	0.3	-1.65
7	0.89	0.586	2.83	0.74	14	0.35	-1.95
8	0.93	0.271	2.88	0.59	14	0.51	-2.41

Fleet : IceGFS. a3 on a3. N

Age	1984	1985	1986	1987
3	99.99	0.25	0.41	0.74
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	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
3	0.88	0.22	-0.14	-0.09	0.01	-0.04	-0.87	-0.46	0.06	-0.19
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	0.63	2.029	5.49	0.77	13	0.25	-1.74

Fleet : IceGFS. a2 on a3. N.

Age	1984	1985	1986	1987
3	99.99	99.99	0.31	0.78
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	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
3	0.58	-0.21	0.27	0.3	-0.06	0.17	-1.11	-0.3	0.46	-0.64
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	0.54	2.973	6.81	0.83	12	0.22	-2.41
1							

Fleet : IceGFS. SE

Age	1984	1985	1986	1987
3	-0.9	-0.28	-0.57	1.38
4	-0.87	-0.07	-0.7	0.61
5	-0.57	-0.04	-0.34	-0.22
6	-0.27	-0.22	-0.15	-0.19
7	-0.13	-0.27	-0.19	-0.07
8	0.46	-0.21	-0.18	-0.54
9	No data for this fleet at this age			

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
3	1	-1.42	-1.58	-0.15	0.46	0.57	0.1	0.17	0.26	0.3
4	1.03	-0.79	-1.42	-0.29	-0.2	0.27	0.87	0.03	-0.14	0.93
5	1.03	-0.11	-0.89	-0.21	-0.3	-0.09	0.84	0.26	-0.29	0.43
6	0.32	0.37	-0.36	0.27	-0.54	-0.11	0.43	0.48	-0.45	0.12
7	0.46	0.09	-0.44	0.46	-0.27	-0.45	0.36	0.61	-0.27	-0.12
8	1.04	0.34	0	-0.13	-0.55	0.03	0.38	0.3	-0.96	0.23
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	-4.028	-3.3549	-3.0491	-3.0393
S.E(Log q)	0.5283	0.3636	0.3749	0.5129

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.59	1.186	7.96	0.47	14	0.48	-5.25
4	0.52	1.945	7.98	0.63	14	0.34	-4.52

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	0.66	1.383	6.44	0.64	14	0.34	-4.03
6	1.01	-0.029	3.3	0.64	14	0.39	-3.35
7	1.1	-0.44	2.34	0.65	14	0.43	-3.05
8	1.18	-0.549	1.98	0.49	14	0.63	-3.04
1							

Fleet : IceGFS. SW.

Age	1984	1985	1986	1987
3	-0.36	-0.6	-0.38	-0.25
4	-0.18	-0.28	-0.94	-0.13
5	-0.02	-0.26	-0.38	-0.59
6	0.18	-0.29	-0.32	-0.09
7	0.05	-0.26	-0.43	0.16
8	0.36	0.03	-0.47	-0.33
9	No data for this fleet at this age			

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
3	0.66	0.12	0.25	-0.47	0.27	0.5	-0.05	0.28	0	-0.54
4	0.39	0.52	0.31	-0.3	0.03	-0.02	0.31	0.1	-0.26	-0.03
5	0.29	0.41	0.62	-0.17	0.08	-0.37	0.22	0.2	-0.25	-0.06
6	-0.26	0.39	0.71	0.23	-0.33	-0.38	-0.08	0.46	-0.25	-0.09
7	-0.05	-0.07	0.34	0.57	-0.07	-0.68	-0.07	0.49	0.16	-0.34
8	0.7	0.36	0.49	0.23	-0.06	-0.11	-1.07	0.27	-0.32	0.15
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	-2.8736	-2.5105	-2.4582	-2.7541
S.E(Log q)	0.3402	0.3544	0.3668	0.4722

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	0.85	0.577	4.96	0.63	14	0.35	-3.79
4	1.04	-0.129	2.83	0.59	14	0.38	-3.14

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	0.69	2.047	5.42	0.83	14	0.21	-2.87
6	0.67	2.864	5.18	0.89	14	0.18	-2.51
7	0.75	1.818	4.3	0.85	14	0.25	-2.46
8	0.77	1.226	4.16	0.75	14	0.35	-2.75
1							

Fleet : IceGFS. a3 on a3. SW

Age	1984	1985	1986	1987
3	99.99	-0.83	-0.06	-0.01
4	No data for this fleet at this age			
5	No data for this fleet at this age			
6	No data for this fleet at this age			
7	No data for this fleet at this age			
8	No data for this fleet at this age			
9	No data for this fleet at this age			

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
3	-0.44	0.14	-0.31	-0.05	-0.49	0.54	0.17	0.37	0.39	-0.02
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	1.03	-0.093	4.53	0.57	13	0.41	-4.73
1							

Fleet : TRAWL-JUN-DEC-N

Age	1988	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	-0.2	-0.39	0.43	-0.01	-0.11	0.27
5	99.99	99.99	99.99	99.99	0.01	-0.27	-0.2	0.15	0.27	0.03
6	99.99	99.99	99.99	99.99	0.33	0.02	-0.47	0.22	0.26	-0.36
7	99.99	99.99	99.99	99.99	0.46	0.43	-0.35	-0.18	-0.02	-0.32
8	99.99	99.99	99.99	99.99	-0.36	0.38	-0.21	0.33	-0.03	-0.12
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	-3.4379	-3.3108	-3.2932	-3.3206
S.E(Log q)	0.2049	0.3384	0.3603	0.297

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	0.87	0.374	4.83	0.69	6	0.29	-3.84

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	1.07	-0.212	2.91	0.7	6	0.24	-3.44
6	0.69	1.103	5.48	0.77	6	0.23	-3.31
7	1.22	-0.568	1.91	0.63	6	0.47	-3.29
8	1.22	-0.95	2.12	0.82	6	0.37	-3.32
1							

Fleet : TRAWL-JAN-MAY-N

Age	1988	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	0.08	0.5	0.47	-2.23	0.92	0.27
5	99.99	99.99	99.99	99.99	-0.08	0.05	-0.11	0.31	-0.1	-0.07
6	99.99	99.99	99.99	99.99	0.27	0	-0.14	-0.03	0.04	-0.12
7	99.99	99.99	99.99	99.99	0.12	-0.4	0.4	-0.02	-0.01	-0.09
8	99.99	99.99	99.99	99.99	-0.45	-0.57	0.02	0.52	0.07	0.38
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	-3.6292	-3.2356	-3.343	-3.4777
S.E(Log q)	0.1644	0.1467	0.2616	0.4331

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	0.3	2.545	9.55	0.77	6	0.24	-4.81

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	0.96	0.152	3.9	0.82	6	0.18	-3.63
6	1.05	-0.222	2.91	0.85	6	0.17	-3.24
7	0.94	0.29	3.74	0.84	6	0.27	-3.34
8	1.01	-0.038	3.41	0.72	6	0.49	-3.48
1							

Fleet : TRAWL-JAN-MAY-S

Age	1988	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	99.99	99.99	99.99	99.99	0.24	-0.26	0.17	0.11	-0.23	-0.03
7	99.99	99.99	99.99	99.99	0.56	-0.82	-0.1	0.63	-0.07	-0.2
8	99.99	99.99	99.99	99.99	0.89	0.21	-0.41	-0.33	-0.2	-0.11
9	99.99	99.99	99.99	99.99	0.23	0.37	-0.23	99.99	-0.54	0.17

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

Age	6	7	8	9
Mean Log q	-3.7555	-3.6467	-3.5833	-3.7568
S.E(Log q)	0.2108	0.5345	0.4779	0.3758

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
6	1.28	-0.814	1.93	0.69	6	0.28	-3.76
7	0.8	0.517	4.82	0.64	6	0.47	-3.65
8	0.71	1.543	5.1	0.88	6	0.3	-3.58
9	0.68	1.735	5.07	0.91	5	0.21	-3.76
1							

Fleet : GILLNET-JAN-MAY-S

Age	1988	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	99.99	99.99	99.99	99.99	-0.23	-0.24	0.15	-0.17	0.08	0.4
7	99.99	99.99	99.99	99.99	-0.06	-0.1	0.08	0.28	-0.48	0.27
8	99.99	99.99	99.99	99.99	0.09	0.11	0.1	-0.03	-0.2	-0.07
9	99.99	99.99	99.99	99.99	-0.28	0.31	0	0.02	-0.12	0.06

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

Age	6	7	8	9
Mean Log q	-4.4614	-3.3941	-2.7984	-2.5968
S.E(Log q)	0.2586	0.2844	0.123	0.1938

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
6	1.09	-0.228	3.95	0.64	6	0.31	-4.46
7	1.17	-0.572	2.36	0.75	6	0.36	-3.39
8	1.04	-0.421	2.57	0.97	6	0.14	-2.8
9	1.01	-0.058	2.55	0.92	6	0.22	-2.6
1							

Terminal year survivor and F summaries :

Age 3 Catchability dependent on age and year class strength

Year class = 1994

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	68500	0.542	0	0	1	0.1	0.023
IceGFS. a3 on a3. N	56996	0.483	0	0	1	0.126	0.027
IceGFS. a2 on a3. N.	36094	0.573	0	0	1	0.089	0.042
IceGFS. SE	92552	0.864	0	0	1	0.039	0.017
IceGFS. SW.	40127	0.414	0	0	1	0.171	0.038
IceGFS. a3 on a3. SW	67426	0.393	0	0	1	0.19	0.023
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
P shrinkage mean	118776	0.43				0.165	0.013
F shrinkage mean	23609	0.5				0.12	0.064

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
56080	0.17	0.19	8	1.079	0.022

Age 4 Catchability dependent on age and year class strength

Year class = 1993

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	206729	0.303	0.12	0.4	2	0.177	0.07
IceGFS. a3 on a3. N	129535	0.483	0	0	1	0.068	0.109
IceGFS. a2 on a3. N.	192904	0.573	0	0	1	0.049	0.074
IceGFS. SE	230475	0.577	0.336	0.58	2	0.049	0.063
IceGFS. SW.	119630	0.272	0.014	0.05	2	0.218	0.117
IceGFS. a3 on a3. SW	179317	0.393	0	0	1	0.103	0.08
TRAWL-JUN-DEC-N	159251	0.329	0	0	1	0.151	0.089
TRAWL-JAN-MAY-N	160123	1.229	0	0	1	0.011	0.089
TRAWL-JAN-MAY-S	1	0	0	0	0	0	0
GILLNET-JAN-MAY-S	1	0	0	0	0	0	0
P shrinkage mean	73878	0.43				0.1	0.184
F shrinkage mean	69360	0.5				0.074	0.194

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
140031	0.13	0.12	13	0.907	0.115

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

Year class = 1992

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	80251	0.229	0.241	1.05	3	0.195	0.178
IceGFS. a3 on a3. N	36776	0.484	0	0	1	0.039	0.355
IceGFS. a2 on a3. N.	43446	0.574	0	0	1	0.027	0.308
IceGFS. SE	74254	0.4	0.17	0.43	3	0.065	0.191
IceGFS. SW.	55938	0.217	0.146	0.67	3	0.215	0.247
IceGFS. a3 on a3. SW	85074	0.393	0	0	1	0.058	0.169
TRAWL-JUN-DEC-N	56864	0.222	0.073	0.33	2	0.213	0.243
TRAWL-JAN-MAY-N	57198	0.292	0.215	0.74	2	0.13	0.242
TRAWL-JAN-MAY-S	1	0	0	0	0	0	0
GILLNET-JAN-MAY-S	1	0	0	0	0	0	0
F shrinkage mean	49847	0.5				0.057	0.273

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
61214	0.1	0.07	17	0.712	0.237

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

Year class = 1991

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	17323	0.196	0.305	1.56	4	0.16	0.301
IceGFS. a3 on a3. N	6639	0.485	0	0	1	0.019	0.65
IceGFS. a2 on a3. N.	5237	0.576	0	0	1	0.014	0.77
IceGFS. SE	16084	0.279	0.097	0.35	4	0.086	0.321
IceGFS. SW.	14554	0.19	0.072	0.38	4	0.166	0.349
IceGFS. a3 on a3. SW	18891	0.395	0	0	1	0.029	0.279
TRAWL-JUN-DEC-N	15635	0.192	0.187	0.97	3	0.167	0.328
TRAWL-JAN-MAY-N	13546	0.211	0.217	1.03	3	0.152	0.371
TRAWL-JAN-MAY-S	15440	0.3	0	0	1	0.083	0.332
GILLNET-JAN-MAY-S	23725	0.3	0	0	1	0.083	0.228
F shrinkage mean	13144	0.5				0.041	0.38

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
15409	0.08	0.07	24	0.924	0.324

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

Year class = 1990

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	14669	0.185	0.123	0.66	5	0.144	0.375
IceGFS. a3 on a3. N	14025	0.489	0	0	1	0.01	0.39
IceGFS. a2 on a3. N.	17319	0.58	0	0	1	0.007	0.326
IceGFS. SE	12996	0.236	0.17	0.72	5	0.101	0.415
IceGFS. SW.	14071	0.18	0.154	0.86	5	0.149	0.389
IceGFS. a3 on a3. SW	25074	0.397	0	0	1	0.016	0.236
TRAWL-JUN-DEC-N	15858	0.18	0.163	0.9	4	0.15	0.352
TRAWL-JAN-MAY-N	15394	0.178	0.094	0.53	4	0.176	0.361
TRAWL-JAN-MAY-S	11693	0.27	0.017	0.06	2	0.076	0.452
GILLNET-JAN-MAY-S	17589	0.218	0.094	0.43	2	0.129	0.322
F shrinkage mean	9493	0.5				0.041	0.533

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
14659	0.07	0.05	31	0.685	0.376

1

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

Year class = 1989

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	8171	0.185	0.124	0.67	6	0.121	0.507
IceGFS. a3 on a3. N	7281	0.495	0	0	1	0.007	0.554
IceGFS. a2 on a3. N.	6760	0.587	0	0	1	0.005	0.587
IceGFS. SE	8705	0.226	0.161	0.71	6	0.094	0.482
IceGFS. SW.	8925	0.18	0.061	0.34	6	0.131	0.473
IceGFS. a3 on a3. SW	4438	0.402	0	0	1	0.011	0.796
TRAWL-JUN-DEC-N	6585	0.171	0.081	0.48	5	0.173	0.599
TRAWL-JAN-MAY-N	7617	0.173	0.091	0.52	5	0.154	0.536
TRAWL-JAN-MAY-S	7228	0.252	0.074	0.29	3	0.08	0.558
GILLNET-JAN-MAY-S	5829	0.184	0.124	0.68	3	0.171	0.655
F shrinkage mean	6431	0.5				0.052	0.609

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7255	0.07	0.04	38	0.575	0.559

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

Year class = 1988

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	1007	0.2	0.156	0.78	6	0.089	0.709
IceGFS. a3 on a3. N	1084	0.503	0	0	1	0.004	0.672
IceGFS. a2 on a3. N.	1601	0.597	0	0	1	0.003	0.5
IceGFS. SE	1196	0.236	0.304	1.28	6	0.073	0.625
IceGFS. SW.	1145	0.195	0.158	0.81	6	0.097	0.646
IceGFS. a3 on a3. SW	1135	0.409	0	0	1	0.006	0.65
TRAWL-JUN-DEC-N	1010	0.182	0.076	0.42	5	0.133	0.707
TRAWL-JAN-MAY-N	1169	0.181	0.039	0.22	5	0.118	0.636
TRAWL-JAN-MAY-S	1372	0.245	0.122	0.5	4	0.129	0.564
GILLNET-JAN-MAY-S	1231	0.172	0.093	0.54	4	0.265	0.612
F shrinkage mean	1213	0.5				0.083	0.619

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1174	0.08	0.05	40	0.556	0.628

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

Year class = 1987

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F

IceGFS. N.	332	0.23	0.107	0.47	6	0.072	0.851
IceGFS. a3 on a3. N	336	0.516	0	0	1	0.002	0.845
IceGFS. a2 on a3. N.	506	0.612	0	0	1	0.002	0.632
IceGFS. SE	468	0.261	0.128	0.49	6	0.064	0.669
IceGFS. SW.	394	0.224	0.106	0.47	6	0.08	0.757
IceGFS. a3 on a3. SW	282	0.419	0	0	1	0.004	0.948
TRAWL-JUN-DEC-N	439	0.214	0.157	0.74	4	0.113	0.701
TRAWL-JAN-MAY-N	531	0.202	0.127	0.63	4	0.1	0.61
TRAWL-JAN-MAY-S	256	0.262	0.086	0.33	4	0.124	1.009
GILLNET-JAN-MAY-S	360	0.179	0.049	0.28	4	0.263	0.806
F shrinkage mean	436	0.5				0.175	0.705

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
386	0.11	0.04	38	0.395	0.767

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

Year class = 1986

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	60	0.245	0.058	0.24	6	0.059	1.06
IceGFS. a3 on a3. N	112	0.533	0	0	1	0.002	0.701
IceGFS. a2 on a3. N.	73	0.633	0	0	1	0.001	0.94
IceGFS. SE	79	0.277	0.209	0.75	6	0.053	0.89
IceGFS. SW.	47	0.238	0.189	0.79	6	0.066	1.238
IceGFS. a3 on a3. SW	104	0.433	0	0	1	0.003	0.739
TRAWL-JUN-DEC-N	88	0.242	0.198	0.82	3	0.09	0.832
TRAWL-JAN-MAY-N	80	0.235	0.184	0.78	3	0.074	0.885
TRAWL-JAN-MAY-S	67	0.31	0.263	0.85	3	0.045	0.998
GILLNET-JAN-MAY-S	92	0.194	0.046	0.24	4	0.269	0.806
F shrinkage mean	117	0.5				0.339	0.679

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
90	0.18	0.06	35	0.341	0.817

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

Year class = 1985

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	31	0.266	0.138	0.52	6	0.02	0.603
IceGFS. a3 on a3. N	62	0.557	0	0	1	0.001	0.344
IceGFS. a2 on a3. N.	46	0.661	0	0	1	0	0.442
IceGFS. SE	24	0.3	0.127	0.42	6	0.018	0.721
IceGFS. SW.	27	0.259	0.118	0.46	6	0.023	0.659
IceGFS. a3 on a3. SW	16	0.453	0	0	1	0.001	0.932
TRAWL-JUN-DEC-N	38	0.276	0.032	0.12	2	0.031	0.51
TRAWL-JAN-MAY-N	20	0.298	0.345	1.16	2	0.021	0.829
TRAWL-JAN-MAY-S	23	0.343	0.149	0.44	3	0.062	0.752
GILLNET-JAN-MAY-S	26	0.226	0.036	0.16	3	0.132	0.678
F shrinkage mean	25	0.5				0.69	0.692

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
26	0.35	0.03	32	0.073	0.688

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

Year class = 1984

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	21	0.236	0.124	0.52	6	0.011	0.965
IceGFS. a3 on a3. N	48	0.59	0	0	1	0	0.529
IceGFS. a2 on a3. N.	50	0.7	0	0	1	0	0.511
IceGFS. SE	20	0.279	0.228	0.82	6	0.009	0.972
IceGFS. SW.	30	0.231	0.145	0.63	6	0.012	0.75
IceGFS. a3 on a3. SW	23	0.48	0	0	1	0.001	0.909
TRAWL-JUN-DEC-N	16	0.329	0	0	1	0.011	1.13
TRAWL-JAN-MAY-N	15	0.479	0	0	1	0.005	1.188
TRAWL-JAN-MAY-S	37	0.354	0.2	0.56	2	0.023	0.651

GILLNET-JAN-MAY-S	29	0.238	0.096	0.4	2	0.048	0.76
F shrinkage mean	22	0.5				0.881	0.912

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
23	0.44	0.04	28	0.088	0.901

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

Year class = 1983

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	10	0.247	0.242	0.98	6	0.01	1.07
IceGFS. a3 on a3. N	23	0.635	0	0	1	0	0.602
IceGFS. a2 on a3. N.	21	0.753	0	0	1	0	0.646
IceGFS. SE	14	0.281	0.174	0.62	6	0.009	0.85
IceGFS. SW.	20	0.241	0.075	0.31	6	0.011	0.677
IceGFS. a3 on a3. SW	14	0.516	0	0	1	0	0.841
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	19	0.422	0	0	1	0.014	0.683
GILLNET-JAN-MAY-S	12	0.307	0	0	1	0.026	0.969
F shrinkage mean	15	0.5				0.929	0.801

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
15	0.46	0.03	24	0.06	0.805

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

Marine Research Institute Sat May 2 12:26:37 1998
Virtual Population Analysis : Fishing mortality
Final-VPA

Age	1978	1979	1980	1981	1982	1983	1984
3	0.030	0.033	0.034	0.016	0.027	0.017	0.055
4	0.169	0.195	0.176	0.137	0.221	0.120	0.211
5	0.351	0.211	0.358	0.388	0.400	0.433	0.323
6	0.333	0.513	0.378	0.470	0.541	0.622	0.539
7	0.494	0.487	0.442	0.635	0.581	0.767	0.598
8	0.660	0.503	0.554	0.839	1.046	0.852	0.900
9	0.505	0.507	0.514	0.802	1.187	0.930	0.746
10	0.530	0.339	0.453	0.950	0.910	1.082	0.634
11	0.343	0.531	0.425	0.982	0.479	0.671	0.639
12	0.719	0.200	0.700	0.904	0.404	0.678	0.587
13	0.806	1.020	0.171	1.076	0.417	0.533	0.685
14	0.580	0.519	0.453	0.943	0.679	0.779	0.658
W.Av 5-10	0.372	0.403	0.404	0.529	0.582	0.609	0.479
Ave 5-10	0.479	0.427	0.450	0.681	0.777	0.781	0.623

Age	1985	1986	1987	1988	1989	1990	1991
3	0.051	0.070	0.045	0.045	0.035	0.049	0.096
4	0.288	0.222	0.309	0.222	0.266	0.231	0.312
5	0.388	0.581	0.519	0.506	0.485	0.446	0.507
6	0.572	0.697	0.785	0.838	0.601	0.640	0.778
7	0.683	0.883	0.976	0.953	0.727	0.785	0.949
8	0.731	0.936	0.994	1.393	0.875	0.816	0.786
9	0.802	0.806	0.975	1.112	0.820	0.787	0.779
10	0.770	0.764	0.707	0.987	0.546	0.836	0.872
11	0.613	0.740	0.582	1.032	0.665	0.625	0.965
12	0.641	0.672	0.665	0.905	0.975	0.772	0.830
13	0.711	0.445	0.739	2.334	0.576	0.438	0.378
14	0.707	0.685	0.734	1.274	0.716	0.692	0.765
W.Av 5-10	0.486	0.689	0.697	0.629	0.544	0.597	0.752
Ave 5-10	0.658	0.778	0.826	0.965	0.676	0.719	0.779

Age	1992	1993	1994	1995	1996	1997	1994-1997
3	0.078	0.147	0.089	0.074	0.029	0.022	0.053
4	0.374	0.309	0.259	0.184	0.139	0.115	0.174
5	0.633	0.490	0.304	0.289	0.223	0.237	0.263
6	0.893	0.775	0.437	0.341	0.356	0.324	0.365
7	1.109	0.807	0.642	0.503	0.442	0.376	0.491
8	1.024	1.157	0.759	0.512	0.542	0.559	0.593
9	0.619	1.230	0.857	0.427	0.558	0.628	0.617
10	0.531	0.948	0.817	0.713	0.564	0.767	0.715
11	0.392	0.905	0.626	0.646	0.744	0.817	0.708
12	0.714	0.566	0.676	0.751	0.619	0.688	0.684
13	0.361	0.577	0.676	1.178	0.762	0.901	0.879
14	0.523	0.845	0.730	0.743	0.649	0.760	0.721
W.Av 5-10	0.790	0.682	0.377	0.334	0.345	0.314	0.343
Ave 5-10	0.801	0.901	0.636	0.464	0.447	0.482	0.507

Table 3.3.13. Cod at Iceland. Stock in numbers (millions).

Marine Research Institute Sat May 2 12:26:37 1998
Virtual Population Analysis : Stock in numbers, millions
Final-VPA

Age	1978	1979	1980	1981	1982	1983	1984
3	221.657	245.521	144.033	143.274	133.575	226.323	139.004
4	114.957	176.061	194.528	113.998	115.390	106.396	182.088
5	162.909	79.448	118.551	133.569	81.350	75.742	77.274
6	68.303	93.925	52.650	67.877	74.178	44.652	40.214
7	24.515	40.087	83.048	29.534	34.736	35.350	19.620
8	9.306	12.250	20.159	50.702	12.818	15.903	13.437
9	2.700	3.939	6.065	9.481	17.940	3.687	5.554
10	0.925	1.335	1.942	2.970	3.480	4.482	1.191
11	0.450	0.446	0.778	1.011	0.940	1.147	1.244
12	0.102	0.261	0.214	0.417	0.310	0.476	0.480
13	0.030	0.041	0.175	0.087	0.138	0.170	0.198
14	0.067	0.011	0.012	0.121	0.024	0.075	0.081
Juvenile	491.742	526.238	477.619	450.104	383.309	444.542	405.963
Adult	114.180	127.086	144.537	102.936	91.570	69.860	74.422
Sum 3- 3	221.658	245.521	144.033	143.274	133.575	226.323	139.004
Sum 4-14	384.264	407.804	478.123	409.766	341.304	288.079	341.382
Total	605.922	653.324	622.155	553.040	474.879	514.402	480.385

Age	1985	1986	1987	1988	1989	1990	1991
3	144.027	335.802	277.535	168.303	82.982	132.161	102.572
4	107.715	112.091	256.306	217.295	131.736	65.588	102.982
5	120.678	66.117	73.476	154.009	142.515	82.689	42.619
6	45.817	67.037	30.293	35.803	76.021	102.823	43.330
7	19.203	21.166	27.345	11.312	12.684	34.108	44.378
8	8.835	7.941	7.168	8.435	3.570	5.021	12.732
9	4.471	3.484	2.551	2.172	1.714	1.218	1.817
10	2.156	1.642	1.273	0.788	0.585	0.618	0.454
11	0.517	0.817	0.627	0.514	0.240	0.277	0.219
12	0.537	0.230	0.319	0.287	0.150	0.101	0.122
13	0.219	0.232	0.096	0.134	0.095	0.046	0.038
14	0.082	0.088	0.122	0.038	0.011	0.044	0.024
Juvenile	361.265	531.439	607.935	515.893	345.069	311.790	248.125
Adult	92.993	85.208	69.175	83.198	107.235	112.905	103.164
Sum 3- 3	144.027	335.802	277.535	168.304	82.982	132.161	102.572
Sum 4-14	310.230	280.845	399.575	430.787	369.322	292.534	248.716
Total	454.257	616.646	677.110	599.090	452.304	424.695	351.288

Age	1992	1993	1994	1995	1996	1997	1998
3	180.518	164.639	79.639	166.400	209.634	100.000	165.000
4	76.264	136.774	116.322	59.647	126.520	166.794	80.092
5	61.731	42.952	82.253	73.522	40.637	90.161	121.725
6	21.017	26.830	21.550	49.668	45.066	26.631	58.241
7	16.288	7.047	10.121	11.395	28.928	25.838	15.770
8	14.064	4.399	2.575	4.360	5.643	15.223	14.524
9	4.749	4.138	1.132	0.987	2.140	2.688	7.126
10	0.682	2.095	0.990	0.393	0.527	1.003	1.174
11	0.155	0.329	0.664	0.358	0.158	0.246	0.381
12	0.068	0.086	0.109	0.291	0.154	0.061	0.089
13	0.043	0.027	0.040	0.045	0.112	0.068	0.025
14	0.021	0.025	0.013	0.017	0.011	0.043	0.023
Juvenile	266.590	230.220	154.184	207.829	365.246	231.842	269.427
Adult	109.012	159.119	161.226	159.254	94.284	196.913	192.743
Sum 3- 3	180.518	164.639	79.639	166.400	209.634	100.000	163.000
Sum 4-14	195.084	224.699	235.771	200.683	249.896	328.755	299.170
Total	375.602	389.339	315.410	367.083	459.530	428.755	462.170

Table 3.3.14. Cod at Iceland. Division Va. Spawning stock biomass (tonnes).

Marine Research Institute Sat May 2 12:26:37 1998
Virtual Population Analysis : SSB in 1000 x tons
Final-VPA

Age	1978	1979	1980	1981	1982	1983	1984
3	10.689	0.000	10.271	0.000	2.917	0.000	0.000
4	8.826	5.033	6.867	4.674	8.747	12.670	10.555
5	75.078	34.391	46.055	20.608	18.924	23.102	28.990
6	102.240	164.296	82.993	52.345	40.895	34.834	47.189
7	101.232	142.177	293.392	65.636	62.440	53.319	43.624
8	44.333	60.423	97.901	174.044	36.502	41.484	39.717
9	18.244	23.793	35.895	44.874	62.993	13.516	24.330
10	7.402	9.432	15.614	15.691	19.197	19.365	7.881
11	4.695	4.251	7.633	6.445	8.215	8.439	9.325
12	0.887	2.946	2.469	3.193	3.271	4.321	4.755
13	0.365	0.317	2.450	0.582	1.845	1.773	2.089
14	1.024	0.152	0.233	1.052	0.277	0.906	0.928
Total	375.015	447.212	601.773	389.143	266.223	213.730	219.383

Age	1985	1986	1987	1988	1989	1990	1991
3	4.166	1.877	6.780	7.576	0.000	0.000	0.000
4	9.011	9.747	19.210	6.371	8.842	5.970	10.362
5	48.125	35.625	40.001	66.522	65.818	45.488	17.084
6	71.050	100.354	56.146	45.209	124.589	163.251	54.106
7	54.565	52.823	73.969	26.624	39.710	92.340	89.271
8	34.163	28.873	27.025	22.623	13.735	20.204	44.930
9	21.231	17.355	11.319	8.246	7.557	6.764	8.625
10	13.102	9.834	8.835	3.828	3.993	4.032	2.537
11	4.166	5.759	4.949	2.965	1.991	2.369	1.478
12	5.000	2.165	2.348	1.672	0.771	1.030	1.117
13	2.271	2.463	1.020	0.595	0.719	0.548	0.431
14	1.051	1.115	1.346	0.213	0.103	0.516	0.326
Total	267.901	267.990	252.950	192.444	267.828	342.512	230.267

Age	1992	1993	1994	1995	1996	1997
3	10.759	12.510	8.611	7.210	19.612	8.463
4	21.195	47.534	51.876	39.492	18.525	76.456
5	61.316	42.823	98.506	129.781	48.694	105.346
6	34.515	52.313	52.816	126.820	109.602	64.840
7	41.176	22.534	34.890	36.175	92.259	101.803
8	45.925	15.271	10.035	19.381	22.354	67.345
9	22.261	16.056	5.493	5.808	9.905	14.039
10	4.145	10.846	4.790	2.633	3.617	5.307
11	1.435	2.251	5.008	2.711	1.189	1.660
12	0.624	0.749	0.945	2.187	1.393	0.452
13	0.537	0.285	0.396	0.322	0.998	0.459
14	0.179	0.290	0.148	0.168	0.129	0.433
Total	244.069	223.463	273.515	372.688	328.277	446.602

Table 3.3.15. Cod at Iceland. Division Va. Average fishing mortality of age groups 5-10, recruitment (at age3, in millions), spawning stock at spawning time ('000 tonnes).

Year	F5-10	Year class	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	0.4	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	214
1984	0.62	277	219
1985	0.66	168	268
1986	0.78	82	268
1987	0.83	131	252
1988	0.97	100	192
1989	0.68	180	268
1990	0.72	168	342
1991	0.78	79	230
1992	0.81	125	241
1993	0.93	195	218
1994	0.68	90	265
1995	0.52	157	365
1996	0.57	110	318

Table 3.3.16. Cod at Iceland . Division Va. Estimated mortality due to cannibalism.

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

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

Year	Total
1979	3177
1980	2210
1981	1442
1982	1128
1983	2182
1984	3579
1985	3688
1986	3987
1987	3727
1988	2990
1989	2677
1990	2146
1991	2454
1992	3050
1993	3185
1994	3119
1995	3700
1996	4243
1997	3669
1998	3669
Average	3001

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

Yearclass	VPA age3	'Surv4'	'Surv3'	'Surv2'	'Surv1'
1975	222	-11	-11	-11	-11
1976	245	-11	-11	-11	-11
1977	144	-11	-11	-11	-11
1978	143	-11	-11	-11	-11
1979	134	-11	-11	-11	-11
1980	226	-11	-11	-11	-11
1981	139	55261	-11	-11	-11
1982	144	22540	31297	-11	-11
1983	336	77227	84656	39301	-11
1984	276	92490	99294	52943	16492
1985	168	60113	68604	25874	13903
1986	83	8272	17511	5820	2605
1987	132	22262	19408	14921	1711
1988	102	13601	15633	11786	2048
1989	181	31684	30540	14473	3509
1990	165	18211	26030	16407	1712
1991	80	4301	5556	2237	223
1992	166	19228	17477	10539	1312
1993	210	48173	37466	28480	8920
1994	-11	13959	11969	3869	487
1995	-11	-11	28949	18566	2454
1996	-11	-11	-11	3570	530
1997	-11	-11	-11	-11	5299

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

Analysis by RCT3 ver3.1 of data from file :

Recnwwg.dat

Iceland Cod: VPA and groundfish survey data

Data for 4 surveys over 23 years : 1975 - 1997

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

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

Forecast/Hindcast variance correction used.

Yearclass = 1992

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	-.21	.24	.792	11	9.86	4.88	.286	.280
Surv3	.59	-1.01	.25	.800	10	9.77	4.73	.298	.257
Surv2	.56	-.37	.25	.810	9	9.26	4.84	.307	.243
Surv1	.42	1.65	.40	.565	8	7.18	4.64	.500	.091
					VPA Mean =		5.03	.422	.129

Yearclass = 1993

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	-.23	.24	.775	12	10.78	5.38	.289	.295
Surv3	.60	-1.09	.27	.744	11	10.53	5.22	.322	.237
Surv2	.57	-.40	.26	.779	10	10.26	5.44	.318	.243
Surv1	.45	1.46	.44	.484	9	9.10	5.54	.563	.078
					VPA Mean =		5.02	.408	.148

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	.51	-.16	.22	.794	13	9.54	4.74	.262	.327
Surv3	.61	-1.20	.27	.741	12	9.39	4.55	.323	.216
Surv2	.56	-.29	.24	.790	11	8.26	4.31	.311	.233
Surv1	.42	1.64	.39	.534	10	6.19	4.26	.508	.087
					VPA Mean =		5.04	.404	.138

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									
Surv3	.61	-1.17	.27	.739	12	10.27	5.09	.312	.309
Surv2	.55	-.24	.24	.787	11	9.83	5.19	.285	.370
Surv1	.42	1.66	.39	.535	10	7.81	4.96	.468	.138
					VPA Mean =		5.03	.407	.182

Table 3.3.19 (Cont'd)

Yearclass = 1996

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------				I	I-----------Prediction---------			I
Surv4									
Surv3									
Surv2	.55	-.18	.24	.785	11	8.18	4.29	.321	.496
Surv1	.42	1.69	.39	.536	10	6.27	4.32	.511	.196
					VPA Mean =		5.02	.408	.308

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									
Surv1	.42	1.73	.39	.540	10	8.58	5.30	.486	.414
					VPA Mean =		5.01	.408	.586

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1992	125	4.83	.15	.05	.13	167	5.12
1993	203	5.32	.16	.08	.24	211	5.35
1994	99	4.60	.15	.13	.70		
1995	163	5.10	.17	.05	.07		
1996	91	4.52	.23	.24	1.09		
1997	169	5.13	.31	.14	.20		

Table 3.3.20

The SAS System 12:30 Friday, May 8, 1998

Cod in the Iceland Grounds (Fishing Area Va)

Prediction with management option table: Input data

Year: 1998								
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	165000.00	0.2000	0.0740	0.0850	0.2500	1184.000	0.0430	1430.000
4	80092.000	0.2000	0.2650	0.1800	0.2500	1689.000	0.1510	1987.000
5	121725.00	0.2000	0.5570	0.2480	0.2500	2524.000	0.2590	2766.000
6	58241.000	0.2000	0.7680	0.2960	0.2500	3809.000	0.3530	3910.000
7	15770.000	0.2000	0.8860	0.3820	0.2500	5215.000	0.4570	5354.000
8	14524.000	0.2000	0.9380	0.4370	0.2500	6720.000	0.5580	6602.000
9	7126.000	0.2000	0.9570	0.4770	0.2500	7587.000	0.5580	7555.000
10	1174.000	0.2000	0.9500	0.4770	0.2500	9309.000	0.7070	9527.000
11	381.000	0.2000	0.9970	0.4770	0.2500	10869.000	0.8020	10786.000
12	89.000	0.2000	0.9620	0.4770	0.2500	12022.000	0.8020	12148.000
13	25.000	0.2000	0.9940	0.4770	0.2500	12621.000	0.8020	12405.000
14+	23.000	0.2000	1.0000	0.4770	0.2500	15534.000	0.8020	14721.000
Unit	Thousands	-	-	-	-	Grams	-	Grams

Year: 1999								
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	90000.000	0.2000	0.0740	0.0850	0.2500	1184.000	0.0430	1430.000
4	.	0.2000	0.2650	0.1800	0.2500	1689.000	0.1510	1897.000
5	.	0.2000	0.5570	0.2480	0.2500	2447.000	0.2590	2703.000
6	.	0.2000	0.7680	0.2960	0.2500	3615.000	0.3530	3701.000
7	.	0.2000	0.8860	0.3820	0.2500	5096.000	0.4570	5119.000
8	.	0.2000	0.9380	0.4370	0.2500	6462.000	0.5580	6619.000
9	.	0.2000	0.9570	0.4770	0.2500	7587.000	0.5580	7555.000
10	.	0.2000	0.9500	0.4770	0.2500	9309.000	0.7070	9527.000
11	.	0.2000	0.9970	0.4770	0.2500	10869.000	0.8020	10786.000
12	.	0.2000	0.9620	0.4770	0.2500	12022.000	0.8020	12148.000
13	.	0.2000	0.9940	0.4770	0.2500	12621.000	0.8020	12405.000
14+	.	0.2000	1.0000	0.4770	0.2500	15534.000	0.8020	14721.000
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	170000.00	0.2000	0.0740	0.0850	0.2500	1184.000	0.0430	1430.000
4	.	0.2000	0.2650	0.1800	0.2500	1689.000	0.1510	1897.000
5	.	0.2000	0.5570	0.2480	0.2500	2447.000	0.2590	2652.000
6	.	0.2000	0.7680	0.2960	0.2500	3549.000	0.3530	3654.000
7	.	0.2000	0.8860	0.3820	0.2500	4919.000	0.4570	4911.000
8	.	0.2000	0.9380	0.4370	0.2500	6379.000	0.5580	6428.000
9	.	0.2000	0.9570	0.4770	0.2500	7587.000	0.5580	7555.000
10	.	0.2000	0.9500	0.4770	0.2500	9309.000	0.7070	9527.000
11	.	0.2000	0.9970	0.4770	0.2500	10869.000	0.8020	10786.000
12	.	0.2000	0.9620	0.4770	0.2500	12022.000	0.8020	12148.000
13	.	0.2000	0.9940	0.4770	0.2500	12621.000	0.8020	12405.000
14+	.	0.2000	1.0000	0.4770	0.2500	15534.000	0.8020	14721.000
Unit	Thousands	-	-	-	-	Grams	-	Grams

Notes: Run name : MANSAS02
Date and time: 04MAY98:15:11

Table 3.3.21.

The SAS System 12:30 Friday, May 8, 1998
Cod in the Iceland Grounds (Fishing Area Va)

Prediction with management option table

Year: 1998					Year: 1999					Year: 2000	
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
0.8809	0.4246	1110429	528554	230000	0.0000	0.0000	1083961	634634	0	1403290	873400
.	.	.	.	.	0.1000	0.0482	.	625425	32128	1366698	829005
.	.	.	.	.	0.2000	0.0964	.	616396	63023	1331537	787365
.	.	.	.	.	0.3000	0.1446	.	607540	92740	1297744	748289
.	.	.	.	.	0.4000	0.1928	.	598855	121332	1265257	711598
.	.	.	.	.	0.5000	0.2410	.	590336	148848	1234018	677129
.	.	.	.	.	0.6000	0.2892	.	581980	175336	1203971	644729
.	.	.	.	.	0.7000	0.3374	.	573782	200841	1175066	614259
.	.	.	.	.	0.8000	0.3856	.	565740	225406	1147251	585587
.	.	.	.	.	0.9000	0.4338	.	557850	249072	1120479	558594
.	.	.	.	.	1.0000	0.4820	.	550107	271878	1094704	533169
.	.	.	.	.	1.1000	0.5302	.	542510	293860	1069885	509206
.	.	.	.	.	1.2000	0.5784	.	535054	315054	1045979	486612
.	.	.	.	.	1.3000	0.6266	.	527736	335494	1022948	465296
.	.	.	.	.	1.4000	0.6748	.	520554	355211	1000754	445176
.	.	.	.	.	1.5000	0.7230	.	513503	374237	979362	426175
.	.	.	.	.	1.6000	0.7712	.	506583	392598	958739	408221
.	.	.	.	.	1.7000	0.8194	.	499788	410325	938852	391249
.	.	.	.	.	1.8000	0.8676	.	493118	427442	919670	375197
.	.	.	.	.	1.9000	0.9158	.	486568	443976	901164	360007
.	.	.	.	.	2.0000	0.9640	.	480136	459949	883306	345625
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANSAS02
Date and time : 04MAY98:15:11
Computation of ref. F: Simple mean, age 5 - 10
Basis for 1998 : TAC constraints

Table 3.3.22.

The SAS System 12:30
Friday, May 8, 1998
Cod in the Iceland Grounds (Fishing Area 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	0.0325	0.0850	0.2500	1089.182	0.0600	1321.500
4	.	0.2000	0.1054	0.1800	0.2500	1618.636	0.3300	1841.091
5	.	0.2000	0.2991	0.2480	0.2500	2451.455	0.6100	2637.000
6	.	0.2000	0.5575	0.2960	0.2500	3608.000	0.8600	3634.591
7	.	0.2000	0.7795	0.3820	0.2500	4964.182	1.0500	4886.409
8	.	0.2000	0.9007	0.4370	0.2500	6303.273	1.1600	6238.000
9	.	0.2000	0.9496	0.4770	0.2500	7765.955	1.1600	7700.864
10	.	0.2000	0.9688	0.4770	0.2500	9480.136	1.1600	9499.000
11	.	0.2000	0.9949	0.4770	0.2500	11455.364	1.1600	11356.318
12	.	0.2000	0.9954	0.4770	0.2500	12949.682	1.1600	13195.727
13	.	0.2000	0.9987	0.4770	0.2500	14577.409	1.1600	14798.682
14	.	0.2000	1.0000	0.4770	0.2500	15734.556	1.1600	15597.391
Unit	Numbers	-	-	-	-	Grams	-	Grams

Notes: Run name : YLDSAS03
Date and time: 04MAY98:16:17

Table 3.3.23

The SAS System 12:30 Friday, May 8, 1998

Cod in the Iceland Grounds (Fishing Area Va)

Yield per recruit: Summary table

						1 January		Spawning time	
F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0.000	0.000	5.016	23433.651	2.443	18229.384	2.324	17340.326
0.0500	0.0500	0.131	810.505	4.574	19139.477	2.043	14124.288	1.904	13111.721
0.1000	0.1000	0.225	1274.546	4.232	16008.875	1.740	11162.110	1.591	10125.491
0.1500	0.1500	0.293	1535.993	3.962	13687.493	1.506	8991.808	1.354	7982.212
0.2000	0.2000	0.345	1679.105	3.746	11935.799	1.322	7376.504	1.171	6417.994
0.2500	0.2500	0.386	1753.274	3.568	10590.386	1.176	6154.939	1.027	5256.802
0.3000	0.3000	0.419	1787.477	3.421	9538.682	1.058	5216.293	0.912	4379.993
0.3500	0.3500	0.446	1798.721	3.296	8702.316	0.960	4483.636	0.819	3706.720
0.4000	0.4000	0.468	1796.985	3.189	8026.123	0.879	3902.996	0.742	3181.248
0.4500	0.4500	0.488	1788.115	3.096	7470.822	0.810	3436.087	0.678	2764.692
0.5000	0.5000	0.505	1775.527	3.014	7008.101	0.752	3055.435	0.624	2429.578
0.5500	0.5500	0.520	1761.205	2.942	6617.301	0.701	2741.090	0.577	2156.246
0.6000	0.6000	0.533	1746.288	2.877	6283.159	0.657	2478.392	0.537	1930.443
0.6500	0.6500	0.545	1731.418	2.818	5994.253	0.619	2256.437	0.503	1741.700
0.7000	0.7000	0.556	1716.947	2.765	5741.928	0.585	2067.015	0.472	1582.232
0.7500	0.7500	0.566	1703.051	2.717	5519.545	0.554	1903.874	0.445	1446.169
0.8000	0.8000	0.575	1689.813	2.672	5321.946	0.527	1762.193	0.421	1329.036
0.8500	0.8500	0.584	1677.254	2.631	5145.079	0.502	1638.216	0.399	1227.377
0.9000	0.9000	0.592	1665.366	2.593	4985.725	0.480	1528.982	0.380	1138.494
0.9500	0.9500	0.599	1654.123	2.557	4841.297	0.460	1432.134	0.362	1060.258
1.0000	1.0000	0.606	1643.490	2.524	4709.696	0.441	1345.778	0.346	990.968
1.0500	1.0500	0.613	1633.430	2.492	4589.204	0.424	1268.375	0.332	929.259
1.1000	1.1000	0.619	1623.904	2.463	4478.397	0.409	1198.665	0.318	874.016
1.1500	1.1500	0.625	1614.877	2.435	4376.092	0.394	1135.610	0.306	824.331
1.2000	1.2000	0.630	1606.312	2.409	4281.292	0.381	1078.345	0.295	779.448
1.2500	1.2500	0.635	1598.178	2.384	4193.153	0.369	1026.145	0.284	738.741
1.3000	1.3000	0.640	1590.443	2.361	4110.957	0.357	978.398	0.275	701.685
1.3500	1.3500	0.645	1583.080	2.338	4034.087	0.346	934.585	0.265	667.836
1.4000	1.4000	0.649	1576.063	2.317	3962.011	0.336	894.263	0.257	636.817
1.4500	1.4500	0.654	1569.369	2.297	3894.267	0.327	857.051	0.249	608.308
1.5000	1.5000	0.658	1562.976	2.277	3830.452	0.318	822.622	0.242	582.031
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YLDSAS03
Date and time : 04MAY98:16:17
Computation of ref. F: Simple mean, age 5 - 10
F-0.1 factor : 0.1978
F-max factor : 0.3651
F-0.1 reference F : 0.1978
F-max reference F : 0.3651
Recruitment : Single recruit

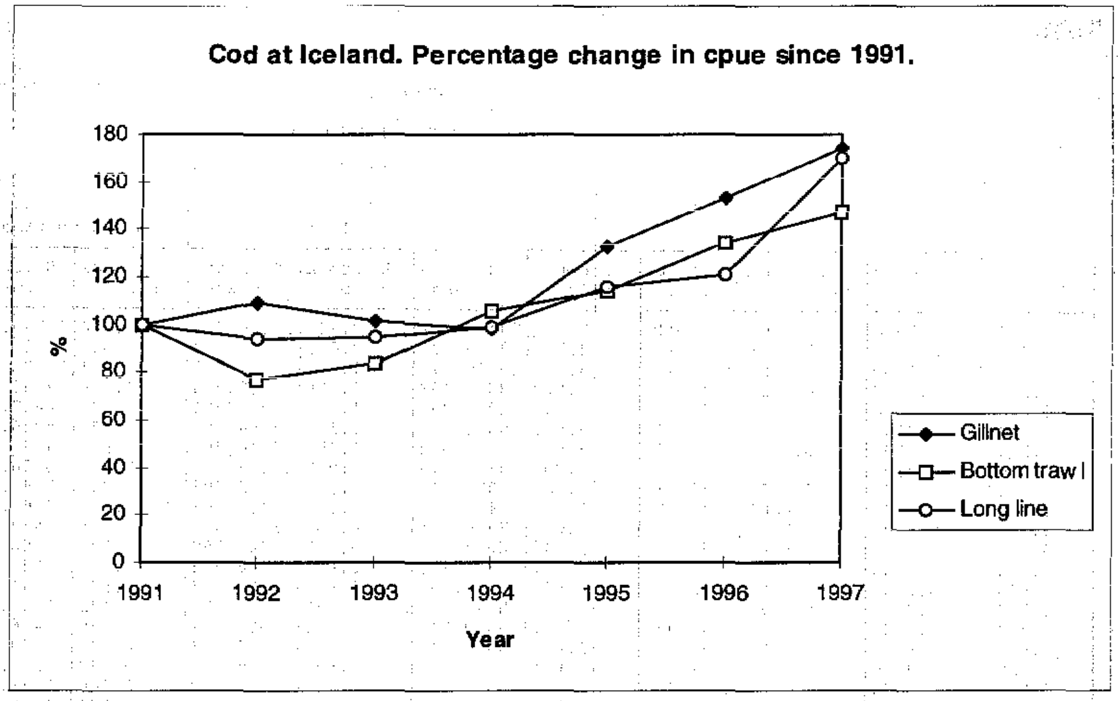

Figure 3.3.1. Cod at Iceland Division Va. Percentage changes in CPUE for the main gears since 1991.

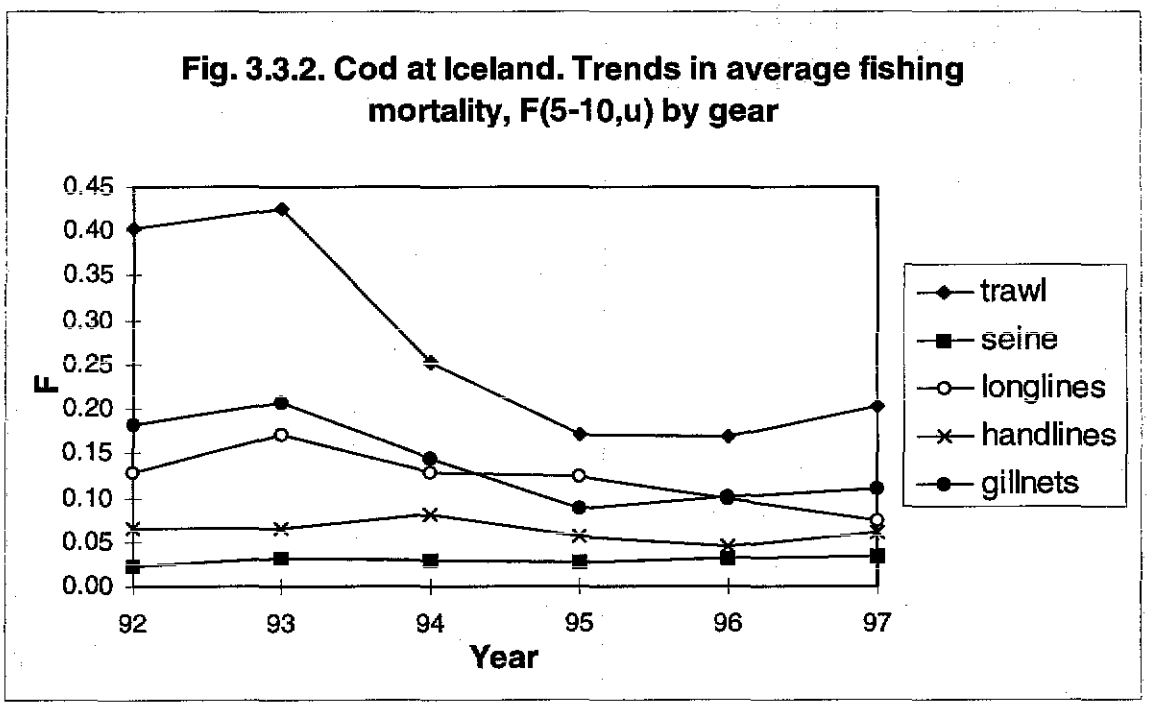

Figure. 3.3.2. Cod at Iceland. Division Va. Trends in average fishing mortality by gear.

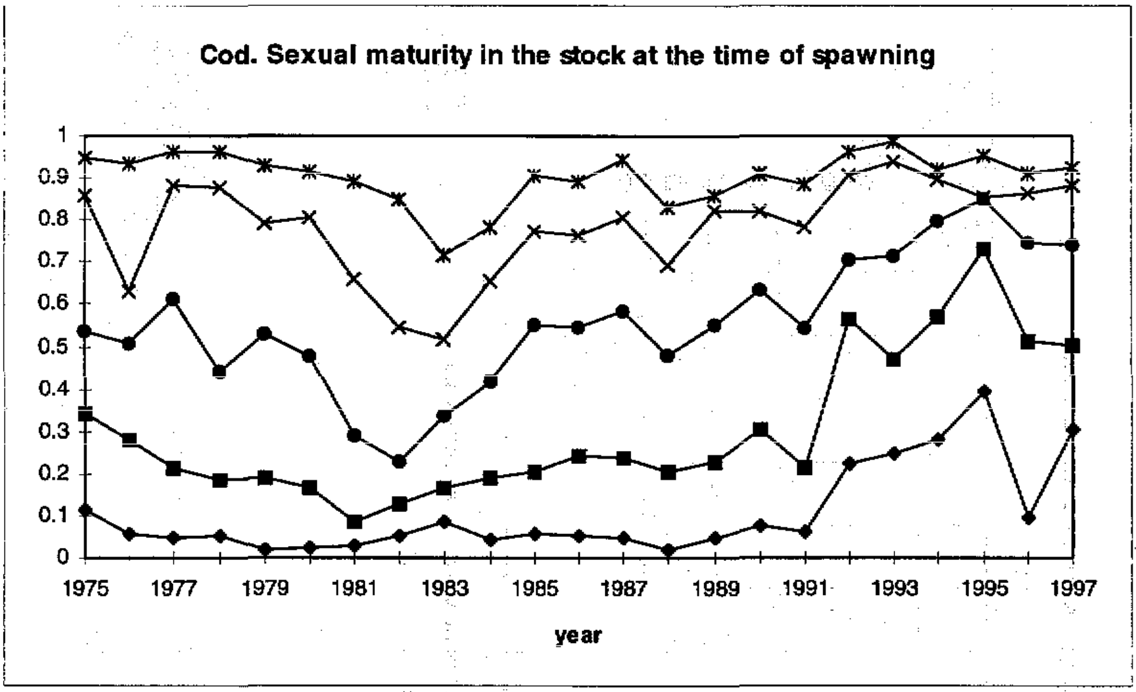

Figure 3.3.3. Cod at Iceland. Division Va. Propotion mature at the spawning time.

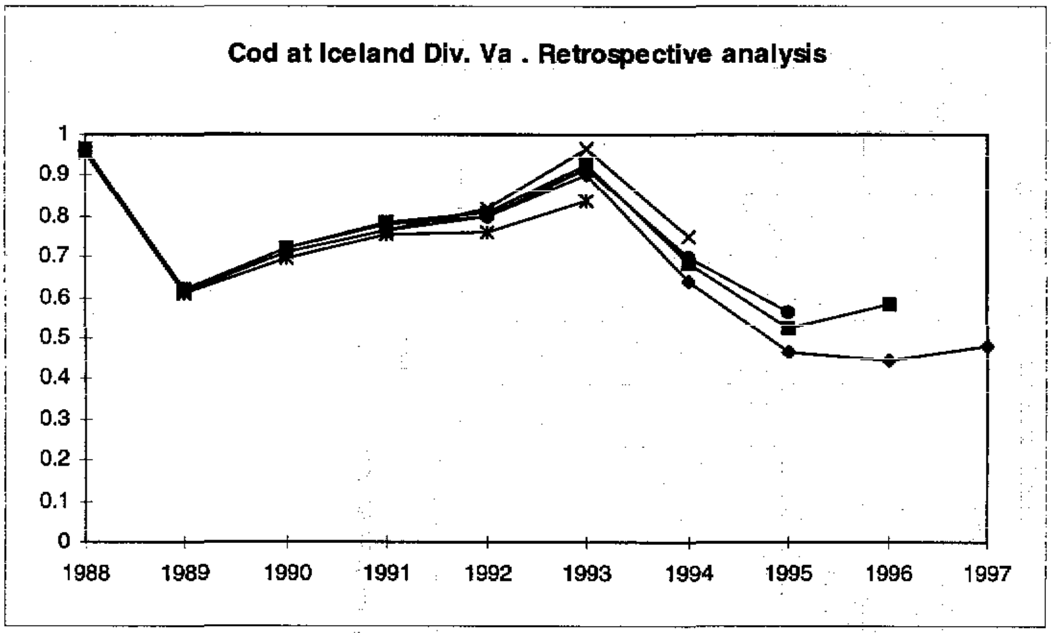

Figure 3.3.4. Cod at Iceland. Division Va. Retrospective analysis of the XSA.

Fish Stock Summary
Cod in the Iceland Grounds (Fishing Area Va)
4 – 5 – 1998

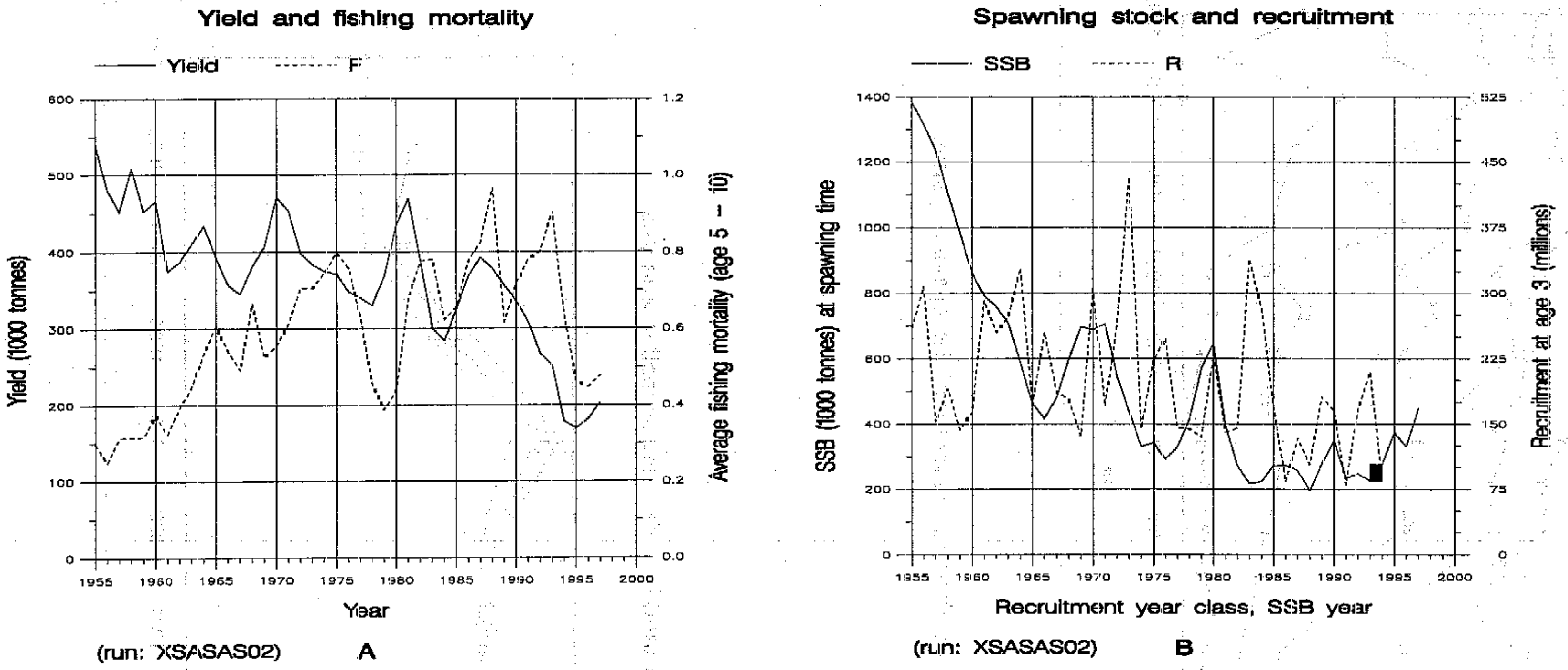

Figure 3.3.5.

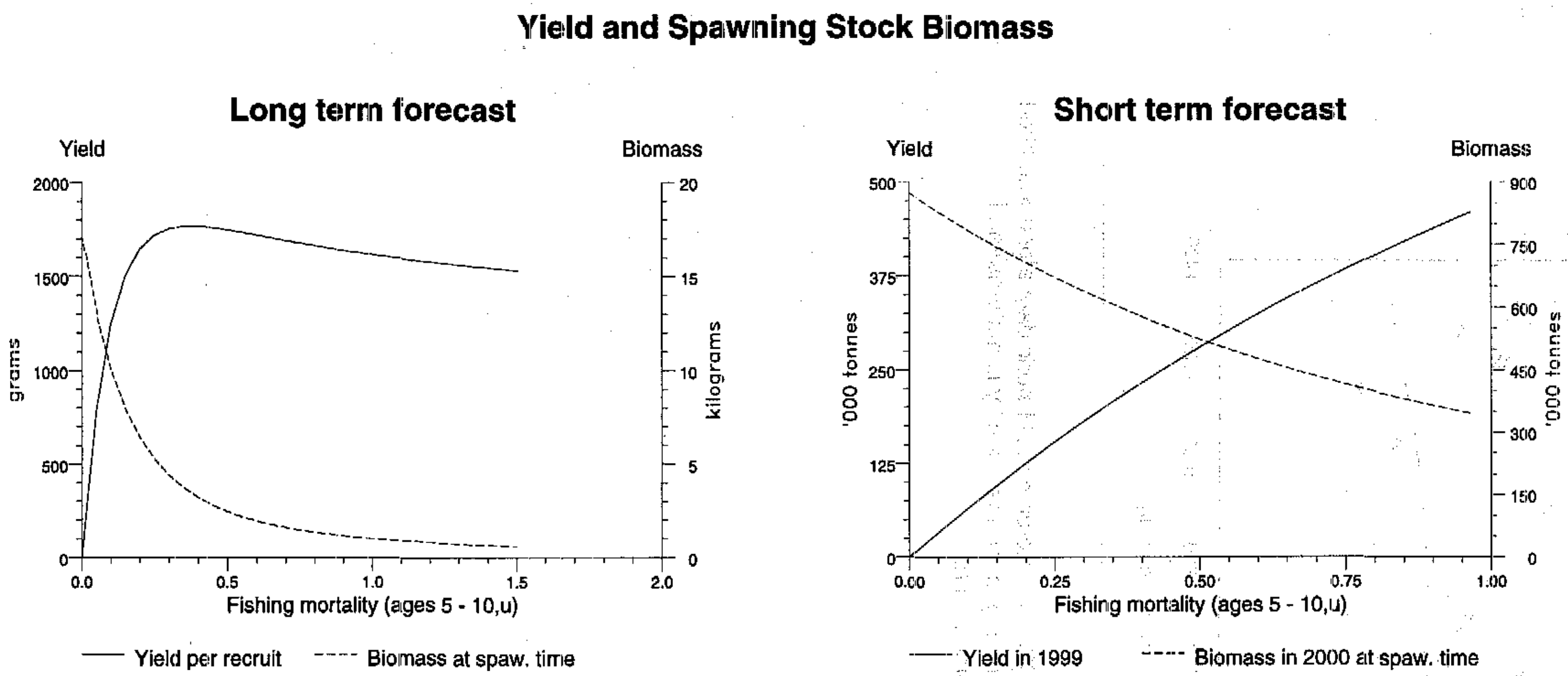

Figure 3.3.5 (cont'd).

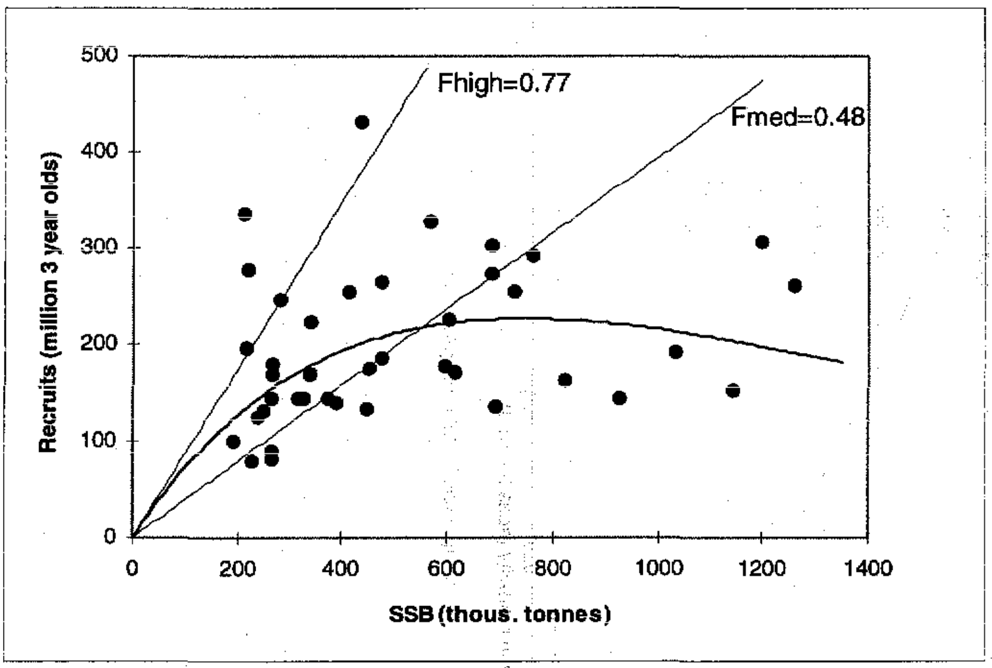

Figure 3.3.6. Cod at Iceland. Division Va. SSB and recruitment. Historic data along with fitted stock-recruitment curve Ricker curve, accounting for cannibalism by immatures) and replacement lines corresponding to Fmed and Fhigh.

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 1997). There were no O-group surveys in 1995 and 1996 but the survey series was continued in 1997 with the area coverage reduced to the Icelandic EEZ. The most recent Icelandic survey indicated a low number of O-group cod being present in the Dohrn-Bank area between Iceland and Greenland. However, the estimate of the 1997 year class is exceptional high. 90 % of the O-group cod were distributed in northern areas off Iceland (Tab. 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 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

[1]) Figure reflects Dohrn Bank area only 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. 11. Figure 5.1.1 and Table 5.1.1 indicated 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. Table 5.1.2 and 5.1.3 list the trawl parameters of the survey and the survey effort by year and stratum. 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

Tables 5.1.4 and 5.1.5 listed abundance and biomass indices by stratum, at West and East Greenland, respectively and then combined for the years 1982-97. Indices varied significantly between strata and years. Trends of the abundance and biomass estimates for West and East Greenland are 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 1997 survey results confirmed the severely depleted status of the stock. The depleted stock was again found to be mainly distributed off East Greenland. 1997 survey results indicated that 93 % of the stock abundance and 98 % of the biomass was found off East Greenland.

5.1.1.2 Age composition

Age disaggregated abundance indices for West, East Greenland and the total are listed in Tables 5.1.6–8, respectively. In 1997, the stock structure off West Greenland was found to be composed almost exclusively of the pre-recruiting age group 4 years (83 %). The age composition off East Greenland was found to be more diverse and comprised mainly mature cod at ages 4-6 years. However, the recruiting year classes were poor, so, there is no indication of recovery.

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 are listed in Tables 5.1.9–11, 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 1982-97. They revealed pronounced area and year effects. Age groups 2–10 years off East Greenland were found to be bigger than those off West Greenland. Driven by the high abundance of cod off West Greenland, weighted mean length and weight for the age groups 1-5 displayed a decrease during 1986-87 and remained at low levels until 1991. Since then, the weight at age at ages 3 to 8 years increased significantly and remained at that high level in 1997.

5.1.2 Trends in landings and fisheries

Officially reported catches are given in Tables 5.1.12 and 5.1.13 for West and East Greenland including inshore catches, respectively. Landings as used by the working group are listed in Table 5.1.14 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 catches 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) are 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. The reported catches declined from 828 t to 187 t in 1993-96, respectively. A total offshore catch amounting to 338 t was reported for 1997.

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 finfish 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. More recent information on finfish by-catch in the shrimp fishery off East Greenland was presented for 1997.

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. The summary of the assessment is given in Table 5.1.15.

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 are 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 target and limit reference points

Input parameters for the estimation of long term yield and spawning stock biomass per recruit are listed in Table 5.1.16 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 of 1.0 kg. F_{high} and the corresponding spawning stock biomass per recruit represent corrected values.

However, neither the determined Beverton & Holt nor the Ricker model fitted the observed recruitment-spawning stock biomass points well. The Beverton and 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. Fig. 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

Reliable information about the amount of by-catch and discard of cod in the shrimp fishery off East and West Greenland was not available. A recruitment model which explained 51 % of the variation in 3 years old recruits (Rätz *et al.*, 1998) based on VPA-results and the yield per recruit input data (Table 5.1.16) was used to perform long term simulations in order to estimate the adverse effect of fishing mortality of pre-recruits at ages 0-2 years. The recruitment model (Fig. 5.1.10) is formulated as a multiple linear regression based on significant SSB and water temperature effects (top of Fyllas Bank off West Greenland) as independent variables.

Allowing the recruitment estimate of the model to vary between ±124 % (standard error of the model) simulations for the stock development over 100 years were calculated using a high fishing mortality to rapidly collapse the SSB to 5 % of its initial weight. Subsequently to the stock collapse, no further fishing mortality was affective. The results of 100 iterations are shown in Figure 5.1.11. The mean stock projection indicated a very slowly recovery from the depleted status. The probability of the stock to recover to 1/3 of its initial size after the stock collapse increased from 0 after 20 years and amounted 40 % after 90 years. The simulations were reiterated with a 10 % reduction of the generated recruits caused by the by-catches in the shrimp fishery. It is shown in Figure 5.1.12 that this low pre-recruitment mortality has a significant adverse effect on the potential recovery. The mean of 100 stock projections showed a reduced slope and the probability of the SSB to recover to 1/3 of the initial value increased from 0 after 30 years. After 90 years, the probability of the stock recovery amounted to 10 % only. The working group considered the simulations hardly representative for stock recovery but interpreted its reduced probability due to the reduced recruitment to be representative of the adverse by-catch effect. The sensitivity of the potential stock recovery to slightly increased pre-recruitment mortality is demonstrated by the second run of simulations which resulted in a 80 % probability reduction.

5.1.7 Management considerations

The assessment of the offshore component of the cod stocks off Greenland revealed that overfishing 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 mortalities. 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 1996 assessment

This assessment of the offshore component of the cod stocks off Greenland 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 Specification of strata for the German groundfish survey off Greenland.

Stratum	geographic boundaries				depth	area
	south	north	east	west	(m)	(nm2)
1.1	64°15'N	67°00'N	50°00'W	57°00'W	1-200	6805
1.2	64°15'N	67°00'N	50°00'W	57°00'W	201-400	1881
2.1	62°30'N	64°15'N	50°00'W	55°00'W	1-200	2350
2.2	62°30'N	64°15'N	50°00'W	55°00'W	201-400	1018
3.1	60°45'N	62°30'N	48°00'W	53°00'W	1-200	1938
3.2	60°45'N	62°30'N	48°00'W	53°00'W	201-400	742
4.1	59°00'N	60°45'N	44°00'W	50°00'W	1-200	2568
4.2	59°00'N	60°45'N	44°00'W	50°00'W	201-400	971
5.1	59°00'N	63°00'N	40°00'W	44°00'W	1-200	2468
5.2	59°00'N	63°00'N	40°00'W	44°00'W	201-400	3126
6.1	63°00'N	66°00'N	35°00'W	41°00'W	1-200	1120
6.2	63°00'N	66°00'N	35°00'W	41°00'W	201-400	7795
7.1	64°45'N	67°00'N	29°00'W	35°00'W	1-200	92
7.2	64°45'N	67°00'N	29°00'W	35°00'W	201-400	4589
Sum						37463

Table 5.1.2 Trawl parameters of the survey.

Gear	140-feet bottom trawl
Horizontal net opening	22 m
Standard trawling speed	4.5 kn
Towing time	30 minutes
Coefficient of catchability	1.0

Table 5.1.3 Numbers of valid hauls by stratum and total, 1982-97.

Year	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2	7.1	7.2	Sum
1982	20	11	16	7	9	6	13	2	1	10	3	12	1	25	136
1983	26	11	25	11	17	5	18	4	3	19	10	36	0	18	203
1984	25	13	26	8	18	6	21	4	5	4	2	8	0	5	145
1985	10	8	26	10	17	5	21	4	5	21	14	50	0	28	219
1986	27	9	21	9	16	7	18	3	3	15	14	37	1	34	214
1987	25	11	21	4	18	3	21	3	19	16	13	40	0	18	212
1988	34	21	28	5	18	5	18	2	21	8	13	39	0	26	238
1989	26	14	30	9	8	3	25	3	17	18	12	29	0	11	205
1990	19	7	23	8	16	3	21	6	18	19	6	15	0	13	174
1991	19	11	23	7	12	6	14	5	8	11	10	28	0	16	170
1992	6	6	6	5	6	6	7	5	0	0	0	0	0	6	53
1993	9	6	9	6	10	8	7	0	9	6	6	18	0	14	108
1994	16	13	13	8	10	6	7	5	0	0	0	0	0	6	84
1995	0	0	3	0	10	7	10	5	8	6	6	17	0	12	84
1996	5	5	8	5	12	5	10	5	7	9	5	13	0	9	98
1997	5	6	5	5	6	5	8	5	5	5	4	8	0	8	75

Table 5.1.4 Cod off Greenland (offshore component). Abundance indices (1000) for West, East Greenland and total by stratum, 1982-97. Confidence intervals (CI) are given in per cent of the statified mean at 95% level of significance. () incorrect due to incomplete sampling.

YEAR	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2	7.1	7.2	WEST	EAST	TOTAL	CI
1982	5092	729	47957	1868	15114	3706	17790			468		6173		1449	92276	8090	100366	28
1983	431	467	16013	5170	14881	2326	10916			2228	1274	2276		2213	50204	7991	58195	25
1984	377	179	4714	171	5201	689	5353		4063			1750		790	16684	(6603)	(23286)	32
1985	19630	2428	13222	4395	10531	1638	7499		3564	373	3978	3348		1141	59343	12404	71747	33
1986	32438	1236	50908	229	37446	1321	22104			780	6950	6676		828	145682	15234	160915	32
1987	330944	1651	248002		154681		51114		18317	9832	6527	6081		878	786392	41635	828026	59
1988	92024	2423	338740	84935	47336	89	60946		7985	8085	2060	4375		1083	626493	23588	650080	48
1989	2497	920	27930	673	261502		65203		30906	38407	11600	9383		1436	358725	91732	450459	59
1990	965	513	4155	362	6014		10303	12213	4956	2524	4533	9041		4200	34525	25254	59777	43
1991	268	205	180	152	1027	611	1839	523	2343	1786	779	1958		3541	4805	10407	15213	29
1992	552	622	117	137	121	74	151	269						658	2043	(658)	(2700)	50
1993	566	457	176	127	80	31	0		1252	98	922	502		527	1437	3301	4738	36
1994	206	103	33	33	72	23	82	22						801	574	(801)	(1375)	36
1995					138	67	58	15	265	78	2933	3654		257	278	7187	7463	93
1996	152	126	76	38	121	0	298	0	290	0	260	382		515	811	1447	2257	38
1997	0	47	35	0	120	5	108	0	74	0		624		3456	315	4153	4469	75

Table 5.1.5 Cod off Greenland (offshore component). Biomass indices (tons) for West, East Greenland and total by stratum, 1982-97. Confidence intervals (CI) are given in per cent of the statified mean at 95% level of significance. () incorrect due to incomplete sampling.

YEAR	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2	7.1	7.2	WEST	EAST	TOTAL	CI
1982	2378	307	63684	2632	20319	8745	30426			1927		14563		7127	128491	23617	152107	25
1983	353	205	20215	7827	22806	9594	21374			6147	3512	11344		13154	82374	34157	116531	25
1984	824	234	7508	234	7218	1055	8493		10397			4110		5237	25566	(19744)	(45309)	34
1985	2528	251	12869	2351	10731	990	5952		7073	1356	9955	9437		5744	35672	33565	69236	39
1986	10641	484	26098	80	28510	1423	19483			2645	18631	16543		3366	86719	41185	127902	26
1987	283591	545	200632		116610		37210		10315	9054	9291	17616		5316	638588	51592	690181	63
1988	94175	1367	333848	77967	44593	93	55945		8750	18204	6162	16258		3572	607988	52946	660935	48
1989	727	228	25829	441	231239		75386		40614	127865	34957	31324		4786	333850	239546	573395	46
1990	224	114	3552	190	5778		13165	11388	9229	6813	12954	24408		12560	34431	65964	100395	34
1991	91	72	73	45	1208	589	2621	451	4236	5779	1263	7467		14006	5150	32751	37901	36
1992	135	195	23	36	21	14	81	102						1216	607	(1216)	(1823)	69
1993	135	88	49	33	44	10	0		862	60	1742	1076		1860	359	5600	5959	41
1994	27	33	6	23	23	11	4	13						2792	140	(2792)	(2930)	68
1995					26	13	11	7	93	185	1115	13750		382	57	15525	15581	155
1996	23	64	23	20	51	0	192	0	167	0	755	1004		1673	373	3599	3973	56
1997	0	40	24	0	107	4	110	0	57	0		1193		12473	284	13722	14007	90

Table 5.1.6 Cod off West Greenland (offshore component). Age disaggregate abundance indices (1000), 1982–1997. *) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (Anon., 1984).

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	2816	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

Table 5.1.7 Cod off East Greenland (offshore component). Age disaggregate abundance indices (1000), 1982–1997. *) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (Anon., 1984). () 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	6805
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

Table 5.1.8 Cod off Greenland (offshore component). Age disaggregate abundance indices (1000), 1982–1997. *) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (Anon., 1984). () 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	13590	2089	5569	180	1399	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

Table 5.1.9 Cod off West Greenland (offshore component). Weighted mean weight (g., by stratum abundance) at age 1–10 years, 1982, 1984–1997.

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						

Table 5.1.10 Cod off East Greenland (offshore component). Weighted mean weight (g., by stratum abundance) at age 1–10 years, 1982, 1984–1997. () 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		

Table 5.1.11 Cod off Greenland (offshore component). Weighted mean weight (g., by stratum abundance) at age 1–10 years, 1982, 1984–1997. () 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	1761	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		

Table 5.1.12 Nominal catch (tonnes) of Cod in NAFO Sub-area 1, 1984–1997 as officially reported to NAFO.

Country	1984	1985	1986	1987	1988	1989	1990
Faroe Islands	-	-	-	-	-	-	51
Germany	8.941	2.170	41	55	6.574	12.892	7.515
Greenland	24.457	12.651	6.549	12.284	52.135	92.152	58.816
Japan	13	54	11	33	10	-	-
Norway	5	1	2	1	7	2	948
UK	-	-	-	-	927	3780	1.631
Total	33.416	14.876	6.603	12.373	59.653	108.826	68.961
WG estimate	-	-	-	-	62.653 [2]	111.567 [3]	98.474 [4]

Country	1991	1992	1993	1994	1995	1996	1997 [1]
Faroe Islands	1	-	-	-	-	-	-
Germany	96	-	-	-	-	-	-
Greenland	20.238	5.723	1.924	2.115	1.710	948	1.186
Japan	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-
UK	-	-	-	-	-	-	-
Total	20.335	5.723	1.924	2.115	1.710	948	1.186
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 5.1.13 Nominal catch (tonnes) of cod in ICES Sub-area XIV, 1984–1997 as officially reported to ICES.

Country	1984	1985	1986	1987	1988	1989	1990
Faroe Islands	-	-	86	-	12	40	-
Germany	7.035	2.006	4.063	5.358	12.049	10.613	26.419
Greenland	1.051	106	606	1.550	345	3.715	4.442
Iceland	-	-	-	1	9	-	-
Norway	794	-	-	-	-	-	17
Russia						-	-
UK (Engl. and Wales)	-	-	-	-	-	1.158	2.365
UK (Scotland)	-	-	-	-	-	135	93
United Kingdom	-	-	-	-	-	-	-
Total	8.880	2.112	4.755	6.909	12.415	15.661	33.336
WG estimate	8.914 [1]	-	-	-	9.457 [2]	14.669 [3]	33.513 [4]

Country	1991	1992	1993	1994	1995	1996	1997 [6]
Faroe Islands	-	-	-	1	-	-	-
Germany	8.434	5.893	164	24	22	5	39
Greenland	6.677	1.283	241	73	29	5	
Iceland	-	22	-	-	1	-	-
Norway	828	1.032	122	43	+	1	15
Russia	-	126	-	-	-	-	-
UK (Engl. and Wales)	5.333	2.532	163	-	-	-	-
UK (Scotland)	528	463	46	-	-	-	-
United Kingdom	-	-	-	296	232	181	284
Total	21.800	11.351	736	437	284	192	338
WG estimate	21.818 [5]	-	-	-	-	-	-

[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 5.1.14 Cod off Greenland (offshore component). Catches (t) as used by the Working Group, inshore and offshore by gear (Horsted, 1994).

Year	inshore	offshore miscellaneus	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	11381	11381	17104
1993	1924	0	828	828	2752
1994	2115	0	469	469	2584
1995	1710	0	264	264	1974
1996	953	0	187	187	1140
1997	1186	0	338	338	1524

Table 5.1.15 Cod off Greenland (offshore component). Summary table of the 1996 assessment.

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Run title : Greenland cod - (offshore component) ,

At 6/05/1996 14:24
Table 17 Summary (with SOP correction)

Tab. 5.1.17 cont'd
Run title : Greenland cod - (offshore component) ,

At 6/05/1996 14:24
Table 16 Summary (without SOP correction)
```

0	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR5-8
0						
1955	153802	2882233	1817484	253266	.1393	.1088
1956	511983	2770848	1519495	315469	.2076	.1493
1957	104904	2143557	1331280	256298	.1925	.2100
1958	134529	2221787	1469227	304152	.2070	.2017
1959	463649	2157214	1042375	226234	.2170	.1891
1960	531662	2648678	1228850	238132	.1938	.1944
1961	226870	2653216	1083431	332117	.3065	.2571
1962	93567	2432916	1035904	441690	.4264	.4039
1963	409559	2414276	1020359	427594	.4191	.3694
1964	703359	2428299	887216	362209	.4083	.3873
1965	286689	2247323	716209	359005	.5013	.4115
1966	329962	2311440	715515	349320	.4882	.4025
1967	105573	2069749	828645	425934	.5140	.4139
1968	37493	1462524	775887	388086	.5002	.4396
1969	39073	893209	572007	210307	.3677	.3790
1970	22749	654431	466971	118297	.2533	.2190
1971	87980	558107	378343	138657	.3665	.3976
1972	4193	379199	248141	124495	.5017	.4732
1973	9181	228055	109533	62881	.5741	.4311
1974	6196	143004	88940	45781	.5147	.6703
1975	24604	104875	54787	47055	.8589	.9065
1976	154622	221732	30131	40867	1.3563	.8210
1977	16618	204073	20604	31807	1.5437	.7643
1978	20081	200477	37794	26063	.6896	.2672
1979	26788	225420	78818	20092	.2549	.2936
1980	71104	178154	94123	57584	.6118	.5017
1981	14247	172700	71075	40266	.5665	.4135
1982	56541	159912	57228	51847	.9060	.7513
1983	7705	123786	46589	44330	.9515	.9125
1984	13774	93449	35644	22363	.6274	.6862
1985	1990	59414	29874	8500	.2845	.2405
1986	10878	61114	32906	6038	.1835	.1590
1987	265710	249641	36166	10837	.2996	.0989
1988	85126	333759	56409	49096	.8704	.7919
1989	1408	329006	83625	85948	1.0278	.8285
1990	1621	167685	41003	100483	2.4506	1.3283
1991	635	54388	30227	22966	.7598	.6994
1992	248	25292	20732	11381	.5490	.8148
Arith. Mean	132544	1017498	478778	159407	.5813	.4734
0Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 5.1.16 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	NUMBER
3	0.815	0.001	0.154	0.2	1
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	

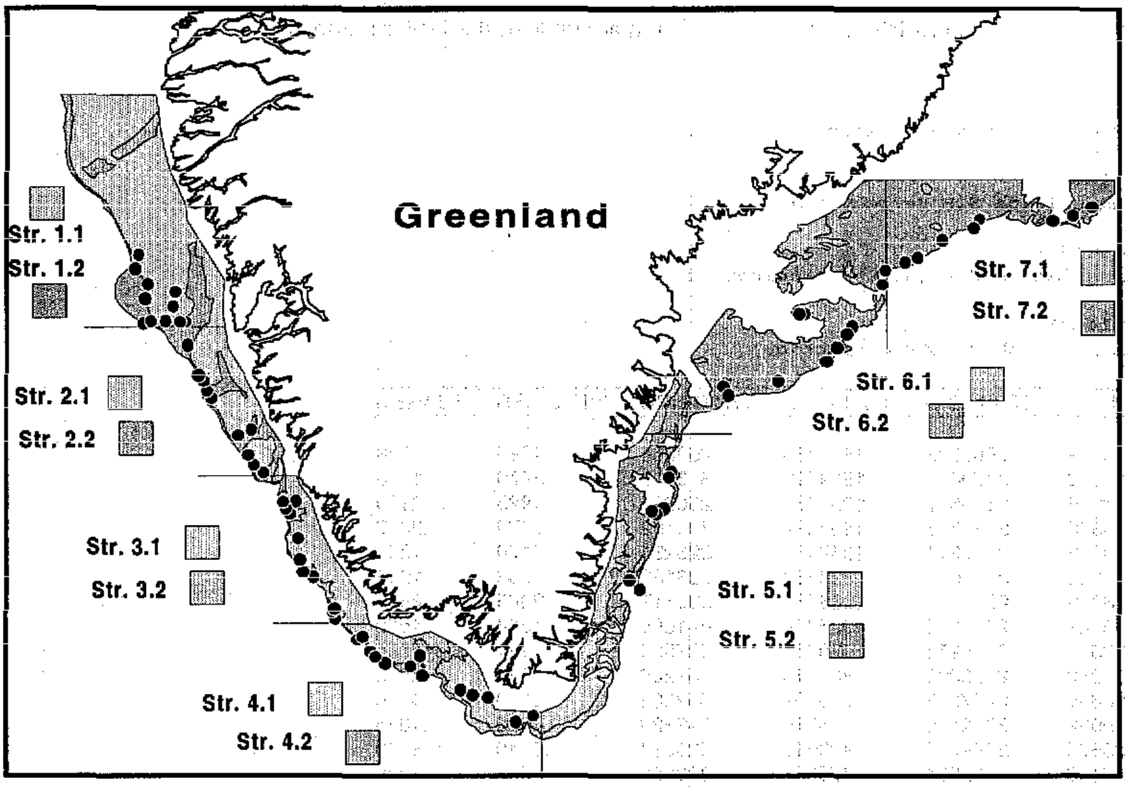


Figure 5.1.1 Cod off Greenland (offshore component). Survey area, stratification and position of hauls carried out in 1997.

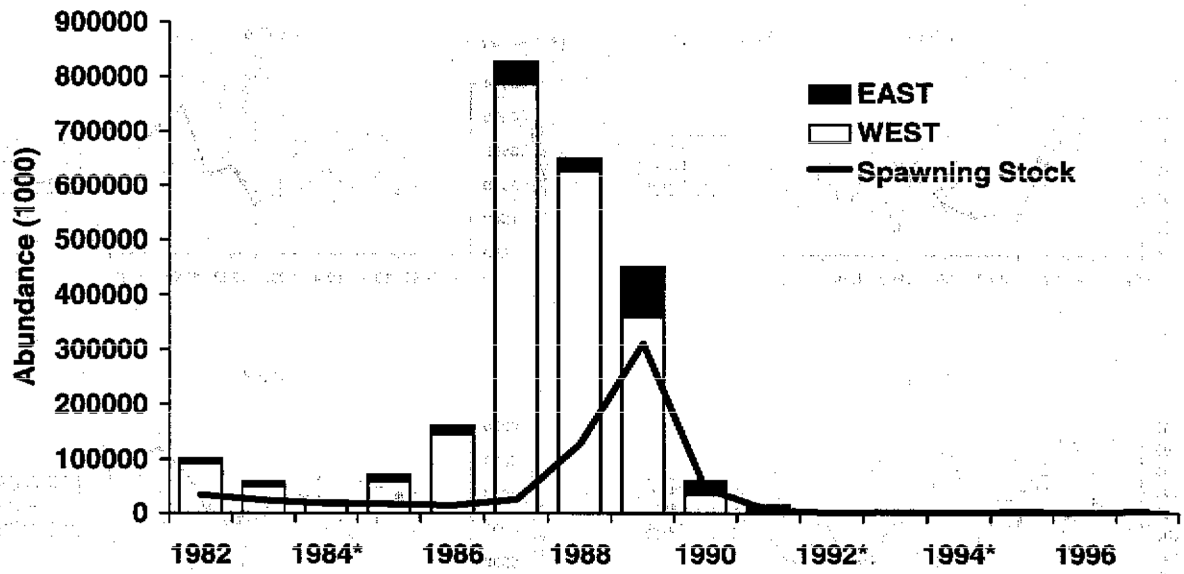


Figure 5.1.2 Cod off Greenland (offshore component). Aggregated survey abundance indices for West and East Greenland and spawning stock size, 1982-97. *) incomplete survey coverage.

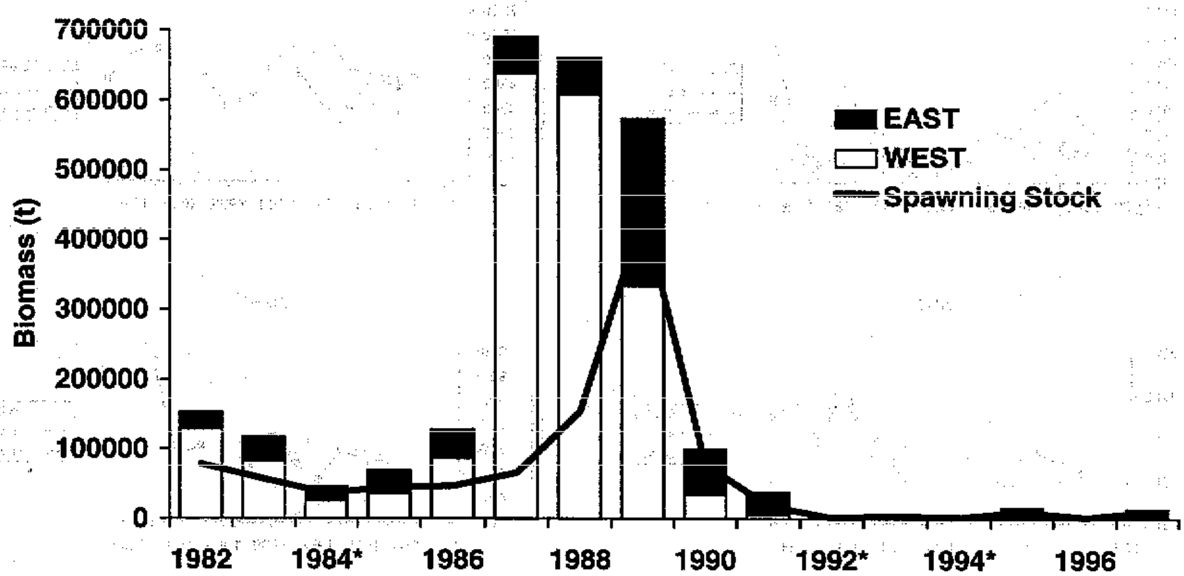


Figure 5.1.3 Cod off Greenland (offshore component). Aggregated survey biomass indices for West and East Greenland and spawning stock biomass, 1982-97. *) incomplete survey coverage.

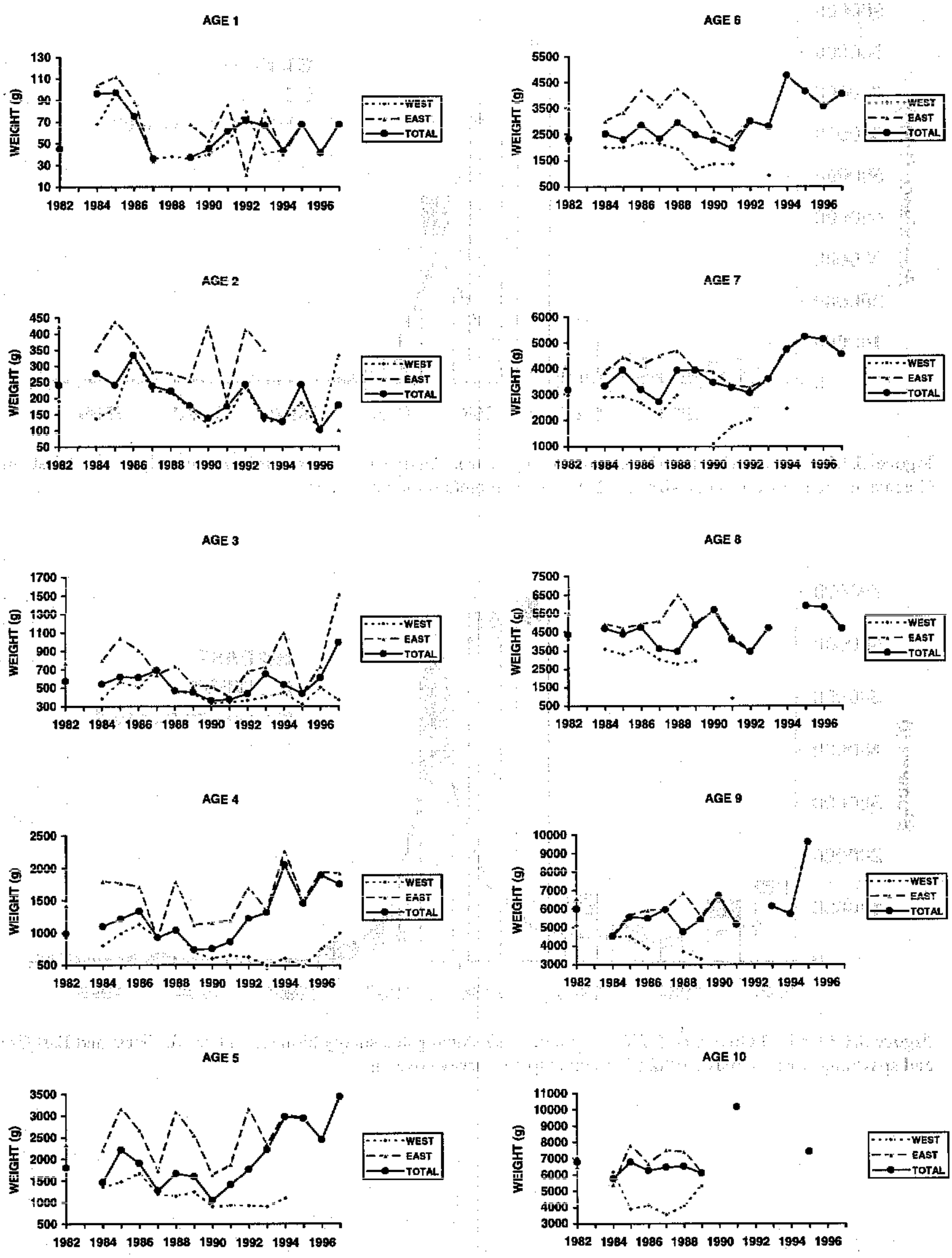


Figure 5.1.4 Cod off Greenland (offshore component). Weighted mean weight at age 1–10 years for West, East Greenland and total, 1982-97.

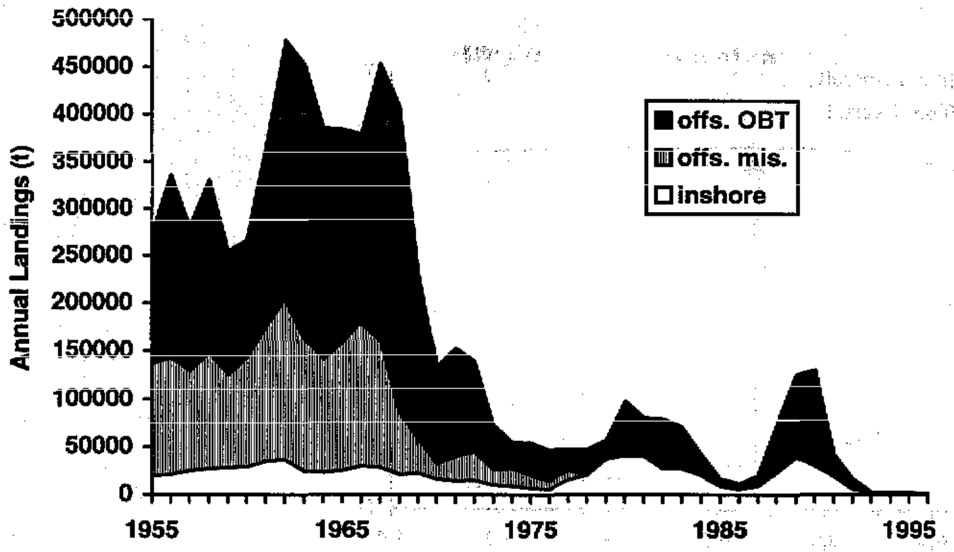


Figure 5.1.5 Cod off Greenland. Catches 1955-95 as used by the Working Group, inshore and offshore by gear (Horsted,1994).

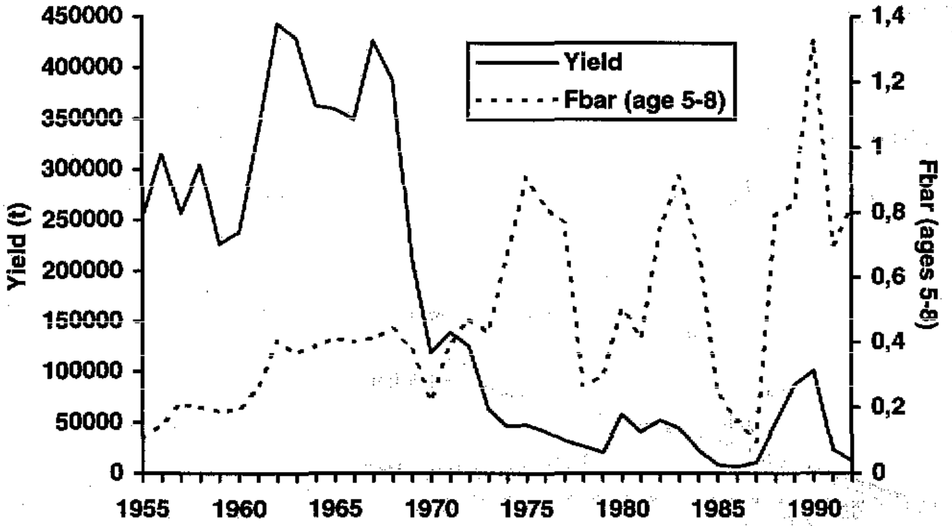


Figure 5.1.6 Greenland cod (offshore component). Trends in yield and fishing mortality.

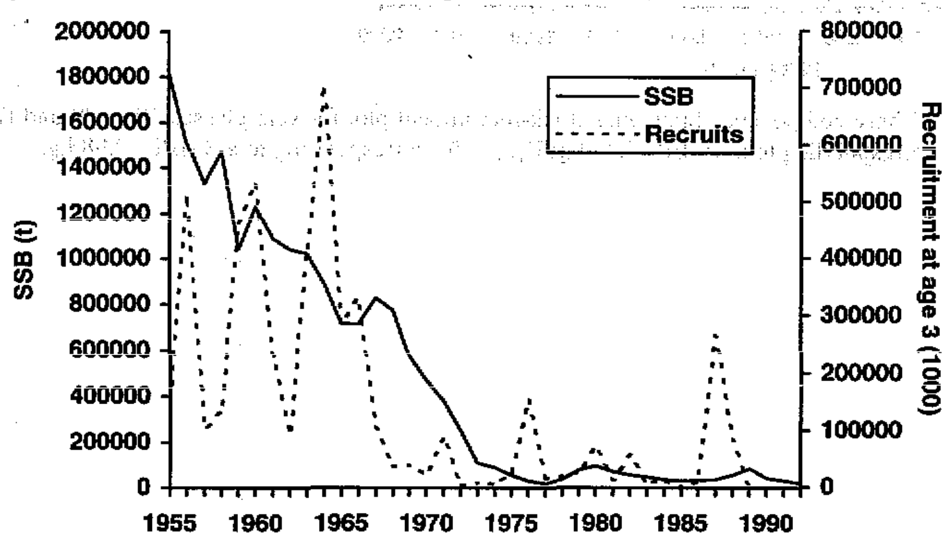


Figure 5.1.7 Greenland cod (offshore component). Trends in spawning stock biomass (SSB) and recruitment.

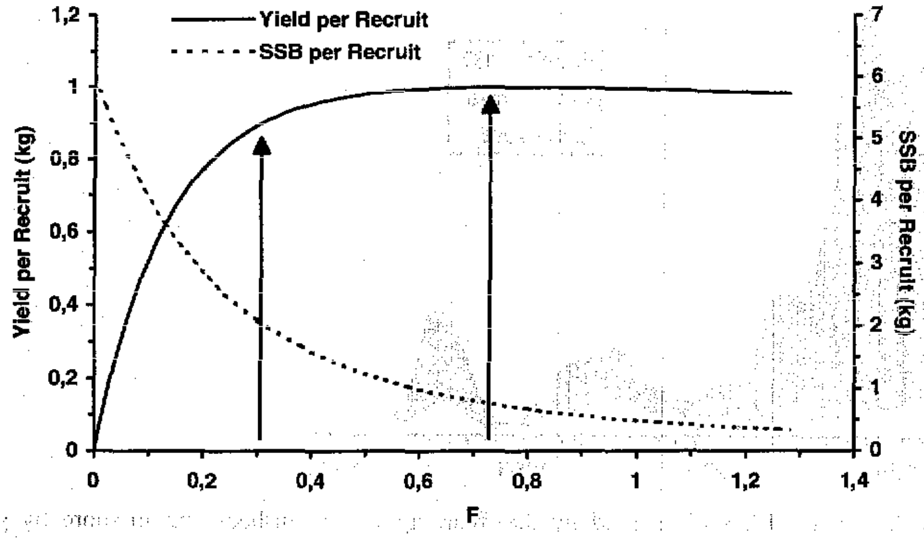


Figure 5.1.8 Greenland cod (offshore component). Long term yield and spawning stock biomass. $F_{0.1}$ reference age 5-8=0.297; F_{max} reference age 5-8=0.722.

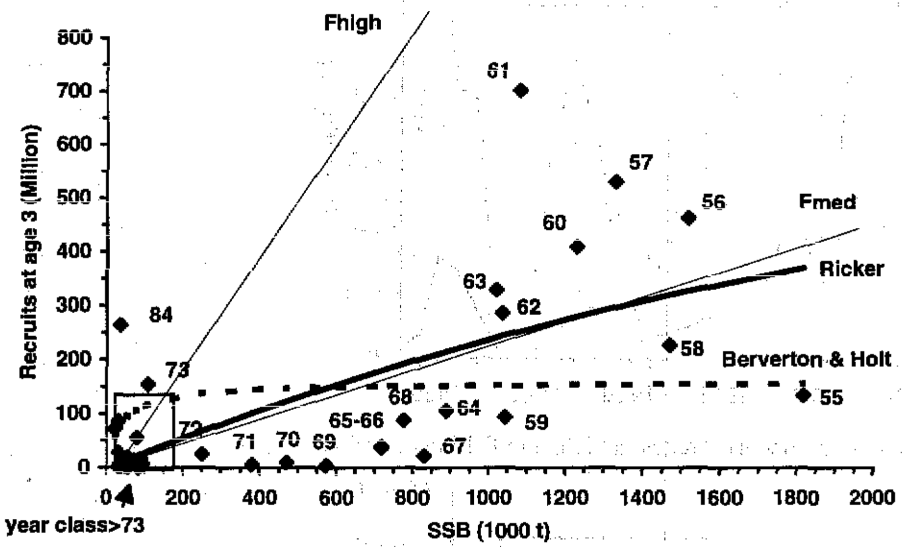


Figure 5.1.9 Greenland cod (offshore component). Spawning stock-recruitment plot for year classes 1955-89 and fitted recruitment curves. F_{med}=0.09 corresponding to a SSB/R=4.44 kg; F_{high}=0.59 corresponding to a SSB/R=0.98 kg.

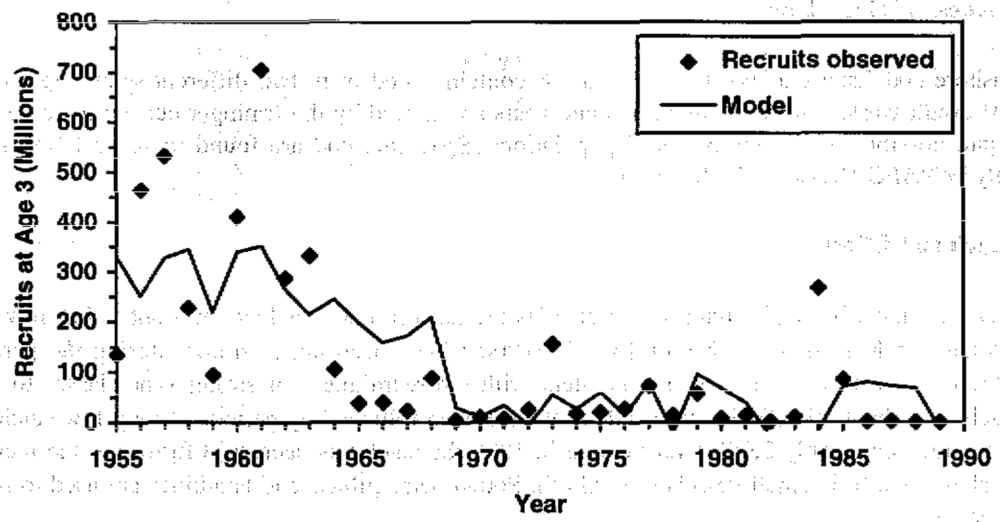


Figure 5.1.10 Greenland cod (offshore component). Recruitment model based on SSB and temperature (T) effects (Rätz et al., 1998). $f(x)=-99.485+87.24*T+0.185*SSB$, $n=35$, $r^2=0.51$,

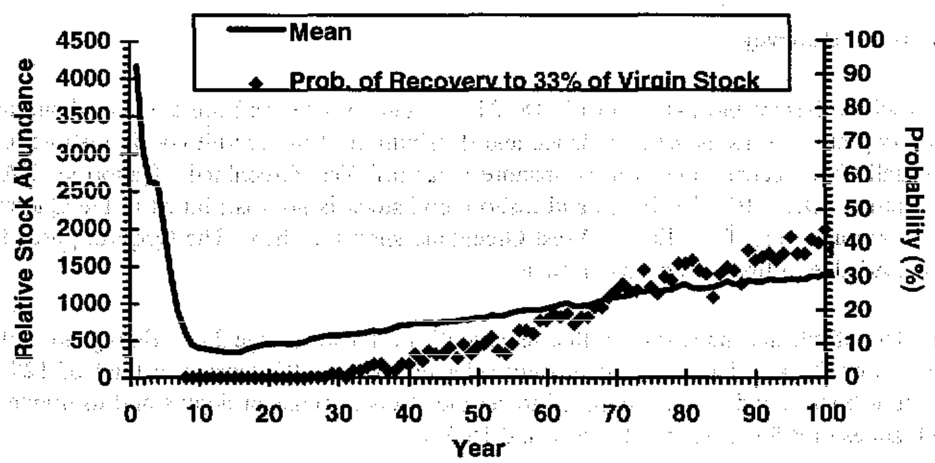


Figure 5.1.11 Greenland cod (offshore component). Recovery simulations (100 iterations) with no fishing mortality after stock collapse.

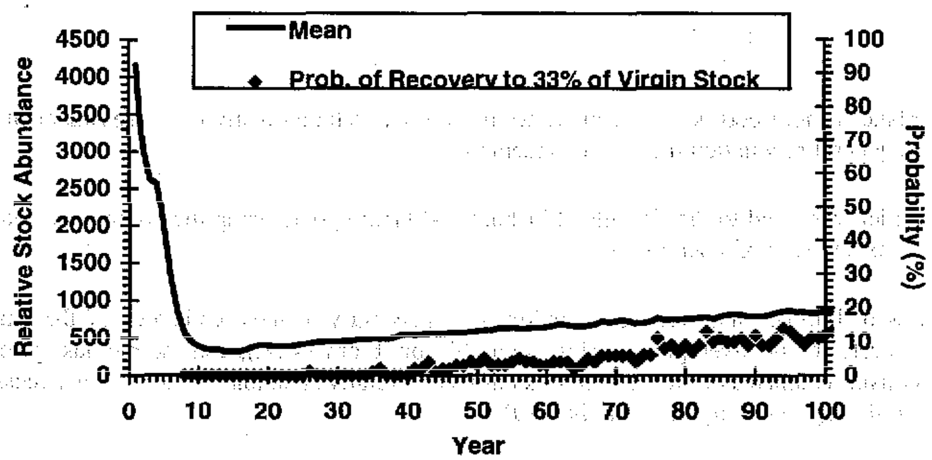


Figure 5.1.12 Greenland cod (offshore component). Recovery simulations (100 iterations) with no fishing mortality for age groups 3+ but 10 % reduced recruitment due to by-catches in the shrimp fishery after stock collapse.

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 cod 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 West Greenland, especially in NAFO Division 1B, 1C and 1D.

5.2.1 Trends in Catch and Effort

Historically, the inshore catches have been of limited importance as the inshore fisheries have accounted for only 5–10% of the total international catch. Annual catches of 15,000-20,000 t have been taken inshore during the period 1955–1973. Since then the catches have been varying consistent with the recruitment of strong year classes to the offshore fishery. High catches of about 50,000 t in 1980 and 1989 have been followed by periods of very low catches. In 1993–1995 the catches amounted to only 2,000 t yearly, and in 1996 the catch has decreased further to the record low. 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 408 t in 1997.

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 developed and used since 1985. The objective of the program is to asses 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. The Qaqortoq area has, however, not been covered since 1995 due to financial considerations.

Analysis of the selectivity of the fleet of gill-nets have shown, that selection is best towards age 2 cod (Hovgaard, 1992) whereas only the larger individuals of the age 1 cod are adequately selected. In the 1997-survey a total of 129 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, 1986 and 1987 year-class. After a moderate 1990 year-class the recruitment has been falling and ever since been below the 1985–1990 values.

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 tentative 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.

In order to predict the time-series of biomass and abundance index, it is necessary to have estimates of the annual catches and of the intrinsic growth rate (r), the average unexploited equilibrium biomass (K), and the biomass prior to the first recorded catch (B_1). To convert estimates of biomass to predictions of a relative abundance index, it is necessary to have an estimate of the constant of proportionality between them (q).

The model was fitted using Excel Solver to minimize 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

The minimization was done for 1994 to 1997 with the initial biomass estimated for 1993. In order to obtain stable results it was necessary to constrain the virgin biomass (K) to be higher than the assumed initial biomass. r was constrained to be between zero and one, while q was constrained to be higher than 0.001.

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 implies an F_{MSY} 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 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. All year-classes since 1991 are estimated to be very poor in the juvenile survey. Restrictive catch regulations for the fisheries should therefore be kept to enhance the recruitment prospects of the inshore stock.

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	7,427	835	730	-2.32	1924
1994	6,358	714	768	-2.11	2215
1995	5,045	567	600	-2.13	1710
1996	4,217	474	534	-2.07	948
1997	4,094	460	410	-2.30	1207
1998	3,701*				

*predicted

Table 5.2.2 Parameter values obtained form general production model.

Virgin Biomass	Rate of increase	q	Init. Biomass
12001	0.303	0.112	7,427 t

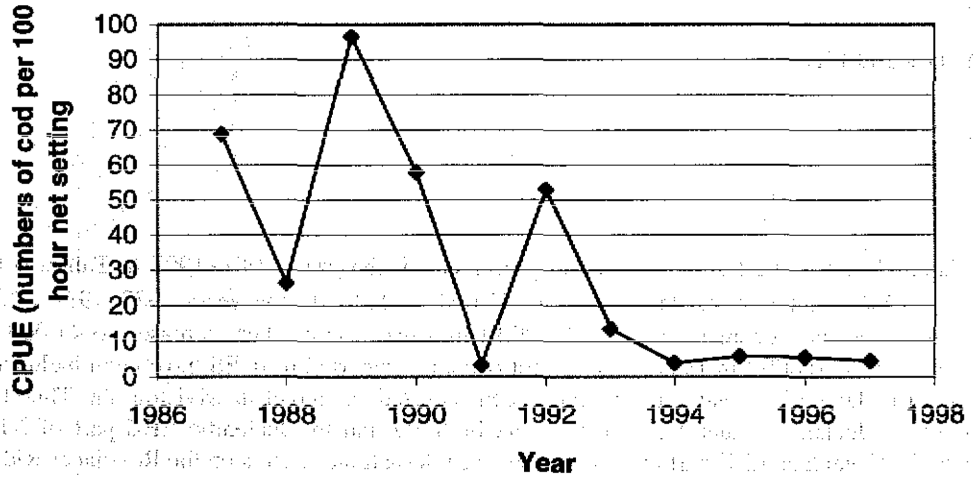


Figure 5.2.1 CPUE (number of age 2 cod caught per 100 hours net setting) in the Greenland young cod survey 1987–1997.

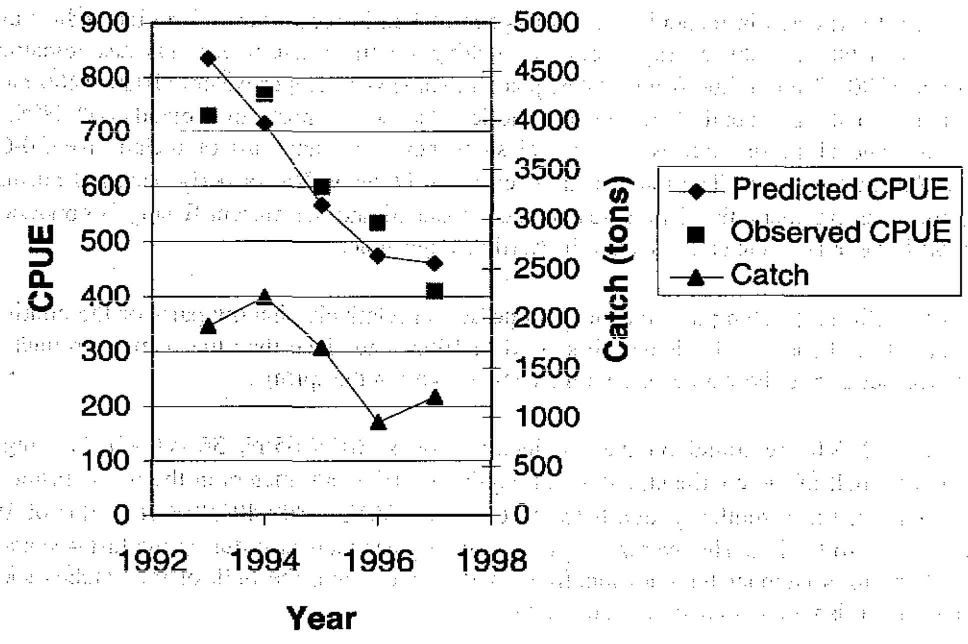


Figure 5.2.2 Greenland cod (inshore componenet) Observed and model-predicted CPUE rates

6 GREENLAND HALIBUT IN SUB-AREAS V AND XIV

6.1 Landings, Fisheries and Fleet

Tables 6.1.1–6.1.6

Landings

Total annual catches in Divisions Va, Vb and Sub-area XIV are presented for the years 1981–1997 in Tables 6.1.1–6.1.6. During the period 1982–1986, catches were stable at about 31 000-34 000 t. In the years 1987–1989 catches increased to about 62 000 t, followed by a decrease to about 35 000 t in 1992. The catches increased to 41 000 t in 1993, but have thereafter decreased to 30 000 t in 1997. 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 16 600 t in 1997. 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 5 000 t in 1997. Catches in division XIVb have increased from below 1 000 t in 1987–1991 to 8 500 t in 1997.

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.

The major fishing grounds in Icelandic waters are located west of Iceland (64°30-66°N, 27°-29°W), where approximately 75% of the annual trawl catch in Icelandic waters has been taken in recent years. The Icelandic trawlers moved to deeper waters around 1988, but the average depth of fishing on the western grounds has remained at approximately 900 meters since 1990. The longline fishery takes place in somewhat deeper waters (1000–1400 meters) west and south of the major trawl fishing grounds. Additional fisheries also occurs north of Iceland (67°-68°N, 19°-24°W, at approximately 500 m), and along the narrow continental slope north-east and east of Iceland (63°30-66°N, 11°–16°W, between 400 and 700 meter depth). The main fishing season in Division Va formerly occurred during the spawning season in spring, but in recent years, the fishing season has expanded and the present fishery is conducted in late winter to early summer, with the bulk of the catches taken in April through June.

The trawlers (single trawlers > 1 000 Hp) fishing in Division Vb operate on relatively shallow parts of the continental slope, mainly in summer. The gillnet fishery in Division Vb started in 1993, and since then the fishing grounds have expanded. This fishery is carried out during the whole year with a peak activity in the spring.

The fishing grounds in Division XIVb are found on the continental slopes (61°N-65°N, 36°-41°W).Trawling was formerly concentrated in a narrow belt of the continental slope at depths of 500–1000 meters in the north-easternmost area of XIVb, but has in 1997 moved to a southerly area between 61°40-62°30N, 40°00-40°30W at depths of 1000–1400 meters, where longliners are also fishing. The average depth of trawling has increased during the last 4 years. The main fishing season is from April to November for both longliners and trawlers with the bulk of the catches taken in July. Both freezer trawlers and fresh fish trawlers operate in the area.

Since 1996, a longline fishery has developed on new fishing grounds along the western slope of the Reykjanes Ridge (60°N-62°N, 27°-29°W), both inside and outside the 200 mile EEZ (XIVb and XII). The total catch in this area amounted to approximately 800 t in 1996 and 1 900 t in 1997.

Annual catches in 1997 are separated by gears in Table 6.1.6.

Bycatch

Recent report (WD No. 15), based on February 1998 measurements from a Greenlandic shrimp trawler operating in Denmark Strait (XIVb), indicate that Greenland halibut, mainly prerecruits below 40 cm, may constitute a significant bycatch. Measurements from February 1998 show that 0.48 kg and 0.81 individuals of Greenland halibut were caught per 1 kg shrimp. Applying these values to the reported shrimp catch in this area of 3754 t in 1997, gives an estimate of 3 million fish and 1800 t of Greenland halibut caught as bycatch in the Denmark Strait shrimp fishery. Bycatch in the southern shrimp fisheries in XIVb, based on a similar estimate, is insignificant.

6.2 Trends in Effort and CPUE

Commercial catch rates of Icelandic bottom trawlers have decreased for all fishing grounds since 1990 but seem to have stabilised in the last 3 years. For the years 1990–1997 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 1985–1997 (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 has been increasing steeply since 1991 and reached a maximum in 1997. 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 72% from 1985 to 1997. In the last two years the effort has decreased by 17% but the CPUE has remained the same.

For area XIVb, CPUE from logbooks in the years 1991–1996 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, remaining stable in 1997. However, the fishery in XIVb is new and catches have increased from a level of less than 500 tons annually before 1991 to more than 8000 tons in 1997. 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 in Numbers at Age and Sampling level

The data set comprising the age-length key for 1997 were from 2 different sources: approximately 120 samples (1346 otoliths) from the Icelandic trawl fleet and long line fleet operating in Icelandic water (Va-key), and 19 samples (458 otoliths) from the Norwegian long line fleet operating in Greenland waters (LLXIV-key). These keys were used to obtain catch in number for the length samples for each of the following fleets and areas:

Region	Gear	Landings	Nos. samples	Nos fish measured	Key
Va west	Trawl	11,341	320	12,800	Va
Va north & east	Trawl	1,733	36	1,420	Va
Va southeast	Trawl	2,079	50	1,993	Va
Va	Long line	1,476	125	5,012	Va
Vb	Trawl	2,703	-	2,879	Va
Vb	Gill net	2,156	-	1,816	Va
XIV	Trawl GER	4,037	-	94,440	Va
XIV	Trawl NOR	1,447	-	1,104	Va
XIV	Long line	1,022	25	4,253	LLXIV
XIV Reykjanes	Long line	1,970	42	1,666	LLXIV
	TOTAL	29,964	598	127,383	

The length-weight relationship used was $W = 0.01758 * L^{2.84387}$ for all fleets and area, except for the long line fleet in XIV, where $W=1.45*10^{-3}*L^{3.458}$ 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

Table 6.4.1

The mean weight at age in 1997 (Table 6.4.1) was derived from the weighted average of the above groups. Apart from 1994, 1996 and 1997 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

Table 6.5.1

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 from the Norwegian longline fishery in Division XIVb.

6.6 Stock Assessment

6.6.1 Tuning and estimates of fishing mortalities

Tables 6.6.1.1-6.6.1.4, Figures 6.6.1.1-6.6.1.2

Age-disaggregated CPUE values for age groups 7–12 over the period 1985–1997, obtained from the Icelandic trawling fleet operating in Division Va, were used in the tuning process. The initial tuning was performed with the same shrinkage level as used in the past two years (s.e. = 1.0). Since the retrospective analysis revealed a systematic trend showing an overestimation in terminal F-values (Figure 6.6.1.1A) a second run was applied with default shrinkage (s.e. = 0.5). Although the retrospective analysis also showed a similar systematic trend in overestimation of terminal F-values (Figure 6.6.1.1B), the latter run (s.e. = 0.5) was accepted by the WG, since the overestimation in the terminal F-values were less than in the former run (s.e. = 1.0). 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 A and B.

6.6.2 Spawning stock and recruitment

Figure 6.6.1.1

Spawning stock biomass is shown in Table 6.6.2.1 and Figure 6.6.1.2 D. The spawning stock was between 70 and 80 000 t between 1978–1983, and increased to a maximum of 123 000 t in 1988. Since then it has declined to a low of 67 500 t in 1997.

Estimates of recruitment at age 5 is shown in Table 6.6.2.2 and Figure 6.6.1.1 B. The long term average for the period 1975–1995 is 32 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, the numbers reaching a record low of 21 million fish in the 1987 year class. The size of the 1988 year class and onwards are also below average. Estimates of the more recent year classes of 1991 and 1992 are thought to be unreliable, since they are just entering the fisheries where VPA stock numbers are considered poorly calculated.

6.7 Prediction of Catch and Biomass

6.7.1 Input data

Tables 6.7.1.1-6.7.1.2

The input data for the short term prediction are given in Table 6.7.1.1. Mean weight at age is average from 1995-97 and the exploitation pattern is average fishing mortalities from 1995–1997 rescaled to the level of 1997. Maturity at age is the average of 1995–1997. Natural mortality was set to 0.15 and the proportions of F and M before spawning were set to 0. Year classes 1991–1993 were assumed to be equal to the average of the year classes 1986–1990. This is a reflection of the recruitment being below average since 1986 year class.

Since TAC for the Greenland EEZ was not reached in 1997 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 23 000 t was applied to 1998. This is based on the expectancy that the TAC constraint in Iceland will hold and on the assumption that the catch in other areas remain the same as in 1997.

The Y/R calculation uses the mean weight and maturity at age averaged for the period 1975–1997. The exploitation pattern is based on an average exploitation pattern over the period 1975–1997 rescaled to the level of 1997 (Table 6.7.1.2).

6.7.2 Biological reference points

From the stock recruitment plot given in Figure 6.7.2 F_{med} was estimated at 0.37, F_{high} at 0.59 and F_{low} at 0.12.

The following reference points were calculated by the WG:

Type	F-value
low	0.12
0.1	0.22
med	0.37
max	0.55
high	0.64
loss	0.89
MSY	0.96
crash	3.35

Type	SSB-level
loss	50
MSY	45

The SGPAFM suggested in their draft (ICES CM 1998/ACFM:10 Ref.D) that F_{pa} should be set at F_{med} and that B_{pa} set at 70 000 t, based on the lowest estimated biomass in recent years. The WG accepts the suggestion of using $F_{med} = 0.37 = F_{pa}$. The B_{pa} value that the SGPAFM proposed was the SSB in 1996 based on the 1997 assessment. Since the revised value of SSB in 1996, being 80 000 t based on the current assessment, is considered to be a better estimator, it is the recommendation of the WG to define B_{pa} = 80 000 t.

The working group did not reach a final conclusion for the definition of B_{lim} and F_{lim} but proposed a preliminary value for B_{lim} as B_{loss} = 50 000 t. This is the estimated SSB in the beginning of the 1975–1997 data series. Using this preliminary value of B_{lim}, the same value of Bpa as derived above can be obtained by using $B_{pa} = B_{lim}\, e^{1.645\sigma}$, where σ = 0.3.

6.7.3 Projections of catch and biomass

Table 6.7.3.1

At the beginning of 1998, the total stock is estimated to have declined to about 131 000 t, and the spawning stock to 63 000 t (Table 6.7.3.1). The catch prediction of 23 000 t in 1998 will result in an estimated fishing mortality of 0.37, which is approximately 20% less than F in 1996. Assuming an F in 1999 to be the same as in 1998, results in the stock remaining in a stable, although low, state in the beginning of 2000. A minimum of a 50% reduction in F in 1999, compared with the estimate of 1998, is needed to increase SSB to any extent above the 1998 level. This will result in F values of less than 0.19 and catches less than 12 000 t in 1999. This is equivalent to the reduction in F or yield in accordance with how close the estimate of biomass in 1998 is to B_{pa} and the proposed B_{lim}.

6.8 Management Considerations

Figure 6.8.1

The Greenland halibut stock biomass has been falling rapidly from a peak in 1987. Catches in the last 7 years have remained between 30 000-40 000 t, despite increase in F and effort over the period. The fishing mortality has been substantially above $F_{0.1}$ since 1986 and is currently above the level of F_{pa}. The SSB in 1997 and 1998 is also below the B_{pa}.

The stock recruitment relationship is highly negative (Figure 6.7.2), 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.

An equilibrium analysis (Cook 1997), gave an $F_{med} = 0.16$, this being based on the most recent year classes in the data series (Figure 6.8.1). This analysis supports our suggested F-level boundary in the coming years. The probability that the suggested F-levels will exceed F_{loss} are less than 1%. However, by fishing at the 1997 level ($F = 0.47$) there is a 30% probability of exceeding F_{loss}.

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 Faroe Islands. The regulation schemes of those states have previously resulted in catches well in excess of advised TAC's by ICES. Since there is no agreement in sight in the foreseeable future, it is expected that the catch will continue to be above the ICES TAC advise.

6.9 Comments on the Assessment

Improved sampling of catch data is needed. Information on age composition and maturity from the trawl fisheries in XIV and from both the gill net and trawl fisheries in Vb are lacking and information on maturity from the fisheries in Va are suspect.

Progress has been made in an attempt to quantify discrepancies and bias in age readings among Greenland halibut age readers in the last years and the work will continue (ICES 1997). The age reading on samples from the principal fleet, the Icelandic trawl fleet, have been performed by the same person since 1994, and are internally consistent. Samples from XIVb have been performed by different age readers each year, but are internally consistent.

Precision and standardisation in determination of maturity are badly needed.

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, it will not become of use in stock assessment in the near future. In the interim period it is recommended that available log book information from Division Vb be compiled and made available to strengthen the basis of the stock assessment.

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

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 1981-1997, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988
Denmark	-	-	-	-	-	-	6	+
Faroe Islands	767	1,532	1,146	2,502	1,052	853	1,096	1,378
France	8	27	236	489	845	52	19	25
Germany	3,007	2,581	1,142	936	863	858	565	637
Greenland	+	1	5	15	81	177	154	37
Iceland	15,457	28,300	28,360	30,080	29,231	31,044	44,780	49,040
Norway	-	-	2	2	3	+	2	1
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
Working Group estimate	-	-	-	-	-	-	-	-

Country	1989	1990	1991	1992	1993	1994	1995	1996 [1]	1997 [1]
Denmark	-	-	-	-	-	-	-	1	-
Faroe Islands	2,319	1,803	1,566	2,128	4,405	6,241	3,763	6,148	4,971
France	-	-	-	3	2	-	-	29	-
Germany	493	336	303	382	415	648	811	3,368	3,365
Greenland	11	40	66	437	288	867	533	1,162	991
Iceland	58,330	36,557	34,883	31,955	33,987	27,778	27,383	22,055	18,462
Norway	3	50	34	221	846	1,171 [1]	1,810	2,157	1,862
Russia	-	-	-	5	-	-	10	424	70
UK (Engl. and Wales)	-	27	38	109	811	513	1,436	386	-
UK (Scotland)	-	-	-	19	26	84	232	25	-
United Kingdom	-	-	-	-	-	-	-	-	243
Total	61,156	38,813	36,890	35,259	40,780	37,302	35,978	35,755	29,964
Working Group estimate	61,396	39,326	37,950	35,423	40,817	36,957	36,288	35,826 [2]	-

Table 6.1.2. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Division Va 1981-1997, as officially reported to ICES.

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

Country	1989	1990	1991	1992	1993	1994	1995	1996 [1]	1997 [1]
Faroe Islands	719	739	273	23	166	910	13	14	26
Germany	-	-	-	-	-	1	2	4	-
Greenland	-	-	-	-	-	1	-	-	-
Iceland	58,330	36,557	34,883	31,955	33,968	27,696	27,376	22,055	16,603
Norway	-	-	-	-	-	-	-	-	-
Total	59,049	37,296	35,156	31,978	34,134	28,608	27,391	22,073	16,629
Working Group estimate	59,272 [2]	37,308 [3]	35,413 [4]	-	-	-	-	22,072	-

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.

Table 6.1.3. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Division Vb 1981-1997, as officially reported to ICES.

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

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997
Denmark	-	-	-	-	-	-	-	-	-
Faroe Islands	1,513	1,064	1,293	2,105	4,058	5,163	3,603	6,004	4750
France 6	...	...	...	3	2	...	...	29 [1]	-
Germany	73	43	24	71	24	8	1	21	41
Greenland	-	-	-	-	-	-	-	-	-
Norway	3	42	16	25	335	53	142	281 [1]	42
UK (Engl. and Wales)	-	-	-	1	15	-	31	122	-
UK (Scotland)	-	-	-	1	-	-	27	12	-
United Kingdom	-	-	-	-	-	-			26
Total	1,589	1,149	1,333	2,206	4,434	5,224	3,804	6,469 [1]	4,859
Working Group estimate	1,606 [2]	1,282 [3]	1,662 [4]	2,269 [5]	-	-	3,820 [7]	-	-

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 and 1993-1994.

Table 6.1.4. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Sub-area XIV 1981-1997, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988
Faroe Islands	-	-	-	-	-	78	74	98
Germany	2,893	2,439	1,054	818	636	745	456	595
Greenland	+	1	5	15	81	177	154	37
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
Working Group estimate	-	-	-	-	-	-	-	-

Country	1989	1990	1991	1992	1993	1994	1,995	1,996	1,997[1]
Denmark	-	-	-	-	-	-	-	1	+
Faroe Islands	87	-	-	-	181	168	147	130	148
Germany	420	293	279	311	391	639	808	3,343	3,324
Greenland	11	40	66	437	288	866	533	1,162	991
Iceland	+	-	-	-	19	82	7	-	1,859
Norway	-	8	18	196	511	1,118[1]	1,668[1]	1,874[9]	1,820[10]
Russia	+	-	-	5	-	-	10	424	70
UK (Engl. and Wales)	-	27	38	108	796	513	1405	264	
UK (Scotland)	-	-	-	18	26	84	205	13	-
United Kingdom	-	-	-	-	-	-	-	-	217
Total	518	368	401	1,075	2,212	3,470	4,783	7,211	8,429
Working Group estimate	-	736[2]	875[3]	1,176[4]	2,249[5]	3,125[6]	5,077[7]	7,283[8]	

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) Inside 200 EEZ: 1756t, Outside 200 EEZ: 64t.

Table 6.1.5. GREENLAND HALIBUT. Nominal catches (tonnes) by countries in Sub-area XII 1996-1997, as officially reported to the ICES.

Country	1996	1997
Faroe Islands		47
Norway	2	
Total	2	47

Table 6.1.6. 1997 Catch statistics for Greenland halibut in V and XIV. Working Group best estimates.

Va	**Long line**	**Trawl**	**Gill Net**	**Unknown**	**SUM**
Faroe Islands				26	26
Germany, Fed. Rep.					0
Greenland					0
Iceland	1,476	15,098	24	5	16,603
Norway					0
Total	1,476	15,098	24	31	16,629
	0.00	0.55	0.44		

Vb	**Long line**	**Trawl**	**Gill Net**	**Unknown**	**SUM**
Faroe Islands	20	2,636	2,095		4,750
France					0
Germany Fed. Rep.		41			41
Norway			42		42
UK (England & Wales)					0
UK (Scotland)					0
United Kingdom		26			26
Total	20	2,703	2,137	0	4,859

XII	**Long line**	**Trawl**	**Gill Net**	**Unknown**	**SUM**
Faroe Islands	47				47
Total	47	0	0	0	47

XIV	**Long line**	**Trawl**	**Gill Net**	**Unknown**	**SUM**
Denmark					0
Faroe Islands		148			148
Germany, Fed. Rep.		3,324			3,324
Greenland		991			991
Iceland (outside 200 EEZ)	1,859				1,859
Norway (inside 200 EEZ)	1,022	734			1,756
Norway (outside 200 EEZ)	33		31		64
Russia		70			70
UK (England & Wales)					0
UK (Scotland)					0
United Kingdom		217			217
Total	2,914	5,484	31	0	8,429

Summary of catch by gear	**Long line**	**Trawl**	**Gill Net**	**Unknown**	**SUM**
	4,457	23,285	2,192	31	29,964

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

	YEAR	1975	1976	1977
	AGE			
	5	120	43	0
	6	800	296	34
	7	1775	584	671
	8	1782	621	1727
	9	1259	431	2289
	10	926	240	834
	11	464	121	420
	12	459	86	423
	13	279	37	174
	14	193	32	120
	15	137	14	28
	+gp	85	9	141
0	TOTALNUM	8279	2514	6861
	TONSLAND	23494	6045	16578
	SOPCOF %	126	100	100

Catch numbers at age Numbers*10**-3

	YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
	AGE										
	5	23	29	47	26	8	10	83	125	245	182
	6	91	197	502	158	300	240	277	441	612	3123
	7	347	1605	1536	580	1140	1611	891	1018	1033	4863
	8	1037	2253	2630	1160	2451	2651	2139	2295	1942	2586
	9	1214	3090	3126	1430	2646	3060	3568	3454	2983	2156
	10	848	1693	2324	1764	2456	2443	2800	2749	3097	3476
	11	567	880	1739	1299	1803	1693	1825	1452	1683	1847
	12	312	394	849	664	963	978	1134	627	820	1829
	13	232	246	578	435	609	424	588	423	550	886
	14	218	189	306	252	331	174	363	137	202	243
	15	114	147	143	176	195	37	92	36	59	31
	+gp	204	125	116	159	132	47	20	46	34	5
0	TOTALNUM	5207	10848	13896	8103	13034	13368	13780	12803	13260	21227
	TONSLAND	14349	23616	31252	19239	32441	30888	34024	32075	32984	46622
	SOPCOF %	100	101	99	100	100	101	99	103	101	98

Catch numbers at age Numbers*10**-3

	YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	AGE										
	5	129	499	188	289	17	45	78	503	178	85
	6	742	1657	463	1225	421	401	672	1587	1488	544
	7	2068	4485	1513	1797	2023	1914	2197	3030	2908	2696
	8	2985	5961	3515	2866	3262	5072	3815	3286	3181	2553
	9	3166	5763	4186	2935	2646	4365	3648	2607	2119	2308
	10	2966	3246	3143	2074	3019	2887	2330	1962	1755	1235
	11	1848	1601	1224	1130	1962	1554	1715	1548	1610	966
	12	1761	1458	959	1072	1278	1425	990	1132	1216	927
	13	1851	1237	568	924	509	581	422	657	665	645
	14	701	506	358	554	144	137	371	444	548	370
	15	216	362	137	342	36	136	168	240	238	279
	+gp	246	145	61	82	56	14	177	232	503	693
0	TOTALNUM	18679	26920	16315	15290	15373	18531	16583	17228	16409	13301
	TONSLAND	51118	61396	39326	37950	35423	40817	36957	36288	35826	29964
	SOPCOF %	101	100	100	101	100	99	100	100	100	101

Table 6.4.1 Catch weights at age (kg)

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

Catch weights at age (kg)

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
5,	.9680,	.9110,	1.1250,	1.0710,	1.0100,	.9840,	.9420,	.9950,	1.0300,	1.0300,
6,	1.1990,	.9420,	1.2830,	1.2570,	1.3680,	1.3380,	1.2750,	1.2300,	1.2380,	1.2180,
7,	1.4230,	1.2780,	1.4870,	1.4400,	1.6180,	1.5770,	1.5920,	1.6300,	1.4990,	1.5330,
8,	1.8540,	1.6760,	1.7560,	1.6600,	1.9050,	1.8480,	1.8170,	1.9510,	1.9370,	1.8240,
9,	2.2560,	2.0720,	2.1530,	1.9670,	2.1870,	2.1590,	2.2400,	2.3670,	2.3630,	2.1870,
10,	2.6070,	2.3330,	2.2790,	2.2580,	2.5160,	2.4340,	2.4610,	2.6370,	2.6310,	2.6660,
11,	3.0810,	2.7230,	2.4980,	2.5150,	2.7610,	2.6030,	2.8350,	2.8290,	2.8480,	2.9960,
12,	3.5910,	3.2970,	3.0590,	2.9500,	3.1290,	3.0340,	3.2620,	3.3530,	3.3350,	3.5950,
13,	4.6040,	3.9850,	3.7830,	3.4500,	3.7850,	3.7840,	3.9620,	4.0060,	4.0390,	4.4310,
14,	4.6950,	4.6680,	4.5070,	4.0330,	4.4750,	4.4460,	4.9360,	4.7920,	4.9250,	5.1400,
15,	5.1510,	4.7920,	5.1390,	4.6520,	4.9850,	4.7510,	5.2300,	5.2310,	5.4660,	5.7640,
+gp,	6.4500,	5.3870,	5.9830,	5.3300,	6.0880,	6.3850,	7.1920,	6.3230,	5.9850,	7.2670,
0 SOPCOFAC,	.9993,	1.0124,	.9902,	1.0024,	.9997,	1.0110,	.9937,	1.0258,	1.0060,	.9785,

1

Catch weights at age (kg)

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
5,	1.1290,	.8420,	1.0290,	1.0010,	1.0160,	.9910,	1.1630,	.9500,	1.1010,	.9190,
6,	1.3040,	1.0470,	1.2100,	1.2470,	1.2560,	1.2490,	1.2540,	1.2130,	1.1240,	1.1070,
7,	1.5410,	1.4250,	1.5720,	1.4720,	1.4010,	1.4010,	1.4880,	1.4130,	1.3460,	1.3340,
8,	1.7700,	1.7270,	1.7900,	1.8100,	1.7180,	1.6850,	1.7360,	1.7030,	1.6490,	1.6400,
9,	2.2360,	2.1250,	2.1260,	2.0880,	2.0490,	1.9820,	2.1500,	2.0280,	1.9250,	1.8820,
10,	2.6830,	2.6370,	2.5360,	2.4400,	2.4360,	2.4250,	2.3520,	2.2790,	2.3420,	2.2400,
11,	3.0820,	3.2200,	3.2140,	2.9350,	2.8680,	2.9520,	2.7360,	2.6430,	2.5950,	2.5370,
12,	3.6240,	3.7330,	3.6930,	3.7370,	3.4780,	3.4290,	3.0820,	2.9920,	3.0130,	2.8450,
13,	4.3120,	4.1350,	4.4480,	4.4010,	4.5100,	4.4790,	3.6070,	3.5680,	3.5150,	3.3790,
14,	5.0980,	5.3800,	5.1970,	5.0220,	4.6810,	6.0430,	4.2420,	4.0680,	4.1230,	4.3400,
15,	5.2130,	6.5690,	5.8910,	5.9910,	6.0100,	5.8320,	5.2930,	5.3020,	4.9960,	4.8230,
+gp,	5.7640,	6.4970,	6.0490,	6.4120,	5.1280,	2.7560,	6.0870,	5.6140,	5.8450,	5.7790,
0 SOPCOFAC,	1.0063,	.9999,	.9998,	1.0097,	1.0033,	.9916,	1.0001,	1.0013,	1.0011,	1.0056,

Stock weights at age (kg)

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

Table 6.5.1 Proportion mature at age

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

Proportion mature at age

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
5,	.0000,	.0000,	.0000,	.0000,	.0000,	.0400,	.0000,	.0100,	.0100,	.0100,
6,	.0300,	.0300,	.0300,	.0300,	.0500,	.0700,	.0800,	.0600,	.0600,	.0600,
7,	.1000,	.1000,	.1000,	.1000,	.2000,	.1500,	.1900,	.2100,	.2100,	.2100,
8,	.3500,	.3500,	.3500,	.3500,	.3300,	.2800,	.3200,	.3500,	.3500,	.3500,
9,	.7700,	.7700,	.7700,	.7700,	.5000,	.3800,	.4200,	.4600,	.4600,	.4600,
10,	.9600,	.9600,	.9600,	.9600,	.7000,	.6000,	.6400,	.6400,	.6400,	.6400,
11,	1.0000,	1.0000,	1.0000,	1.0000,	.8500,	.8500,	.7500,	.8200,	.8200,	.8200,
12,	1.0000,	1.0000,	1.0000,	1.0000,	.9400,	.9800,	.9300,	.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,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
5,	.0100,	.0100,	.0100,	.0100,	.0200,	.0300,	.0300,	.1780,	.3040,	.2240,
6,	.0600,	.0600,	.0600,	.0600,	.0400,	.1200,	.1200,	.1810,	.3100,	.2910,
7,	.2100,	.2100,	.2100,	.2900,	.1100,	.2700,	.2700,	.4770,	.3930,	.3680,
8,	.3500,	.3500,	.3500,	.4800,	.2500,	.4000,	.4000,	.5970,	.4640,	.4380,
9,	.4600,	.4600,	.4600,	.5600,	.4700,	.4500,	.4500,	.5860,	.5260,	.4950,
10,	.6400,	.6400,	.6400,	.6200,	.6800,	.5400,	.5400,	.7050,	.6260,	.5880,
11,	.8200,	.8200,	.8200,	.8500,	.8500,	.6500,	.6500,	.7860,	.6900,	.6670,
12,	.9600,	.9600,	.9600,	1.0000,	.9600,	.7800,	.7800,	.7640,	.7730,	.7450,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.8300,	.8300,	.9610,	.8700,	.8490,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9700,	.9700,	1.0000,	.9530,	.9480,
15,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9810,	.9720,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9860,

Table 6.6.1.1 Output from XSA

```
Lowestoft VPA Version 3.1     4-May-98  12:04:32

 Extended Survivors Analysis

 G. halibut V & XIV (run: XSAEHJ04/X04)

 CPUE data from file /users/fish/ifad/ifapwork/nwwg/ghl_grn/FLEET.X04

 Catch data for  23 years. 1975 to 1997. Ages  5 to  16.

     Fleet,                First, Last, First, Last, Alpha,  Beta
                      ,     year, year,  age ,  age
 FLT06: Va TRW 85-96 ,     1985, 1997,    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 weighting not applied


 Tuning converged after   28 iterations


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


 Fishing mortalities
```

Age,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997
5,	.004,	.015,	.006,	.012,	.001,	.002,	.004,	.023,	.008,	.004
6,	.023,	.061,	.016,	.044,	.021,	.024,	.037,	.098,	.085,	.028
7,	.075,	.179,	.069,	.078,	.091,	.118,	.170,	.219,	.249,	.206
8,	.143,	.300,	.196,	.171,	.187,	.326,	.344,	.387,	.354,	.340
9,	.273,	.424,	.337,	.236,	.223,	.384,	.389,	.394,	.438,	.443
10,	.407,	.469,	.408,	.262,	.383,	.380,	.343,	.352,	.475,	.465
11,	.419,	.378,	.304,	.236,	.399,	.327,	.385,	.380,	.515,	.492
12,	.448,	.647,	.385,	.448,	.431,	.533,	.338,	.446,	.548,	.599
13,	.942,	.618,	.531,	.747,	.373,	.335,	.278,	.371,	.484,	.597
14,	.513,	.687,	.339,	1.576,	.225,	.153,	.350,	.497,	.571,	.514
15,	.535,	.515,	.372,	.594,	.342,	.324,	.268,	.378,	.512,	.607

Table 6.6.1.1 (Cont'd)

XSA population numbers (Thousands)

YEAR	AGE 5	6	7	8	9	10	11	12	13	14
1988	3.53E+04	3.51E+04	3.10E+04	2.41E+04	1.43E+04	9.56E+03	5.82E+03	5.26E+03	3.27E+03	1.88E+03
1989	3.61E+04	3.03E+04	2.95E+04	2.48E+04	1.80E+04	9.35E+03	5.48E+03	3.30E+03	2.89E+03	1.10E+03
1990	3.55E+04	3.06E+04	2.45E+04	2.13E+04	1.58E+04	1.01E+04	5.04E+03	3.23E+03	1.49E+03	1.34E+03
1991	2.58E+04	3.04E+04	2.59E+04	1.97E+04	1.50E+04	9.71E+03	5.79E+03	3.20E+03	1.89E+03	7.53E+02
1992	2.10E+04	2.19E+04	2.50E+04	2.07E+04	1.43E+04	1.02E+04	6.43E+03	3.93E+03	1.76E+03	7.71E+02
1993	2.33E+04	1.81E+04	1.85E+04	1.96E+04	1.47E+04	9.84E+03	6.00E+03	3.72E+03	2.20E+03	1.04E+03
1994	2.13E+04	2.01E+04	1.52E+04	1.41E+04	1.22E+04	8.64E+03	5.79E+03	3.72E+03	1.88E+03	1.35E+03
1995	2.35E+04	1.82E+04	1.66E+04	1.10E+04	8.63E+03	7.12E+03	5.28E+03	3.39E+03	2.29E+03	1.22E+03
1996	2.45E+04	1.98E+04	1.42E+04	1.15E+04	6.44E+03	5.01E+03	4.31E+03	3.11E+03	1.87E+03	1.36E+03
1997	2.39E+04	2.09E+04	1.56E+04	9.55E+03	6.95E+03	3.58E+03	2.68E+03	2.22E+03	1.55E+03	9.92E+02

Estimated population abundance at 1st Jan 1998

, .00E+00, 2.05E+04, 1.75E+04, 1.09E+04, 5.85E+03, 3.84E+03, 1.94E+03, 1.41E+03, 1.05E+03, 7.32E+02,

Taper weighted geometric mean of the VPA populations:

, 2.87E+04, 2.53E+04, 2.16E+04, 1.72E+04, 1.25E+04, 8.38E+03, 5.37E+03, 3.38E+03, 1.87E+03, 9.40E+02,

Standard error of the weighted Log(VPA populations) :

, .2685, .2760, .2889, .3229, .3497, .3571, .2843, .2763, .3490, .4678,

YEAR	AGE 15
1988	5.62E+02
1989	9.70E+02
1990	4.75E+02
1991	8.23E+02
1992	1.34E+02
1993	5.30E+02
1994	7.71E+02
1995	8.22E+02
1996	6.41E+02
1997	6.61E+02

Estimated population abundance at 1st Jan 1998

, 5.11E+02,

Taper weighted geometric mean of the VPA populations:

, 4.25E+02,

Standard error of the weighted Log(VPA populations) :

, .7945,

1

Log catchability residuals.

Fleet : FLT06: Va TRW 85-96

Age	1985	1986	1987
7	.02	-.57	.42
8	.12	-.47	-.21
9	.25	.15	-.11
10	.36	.26	.26
11	.36	.36	.28
12	.26	.27	.11

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
7	.05	.23	-.10	-.43	.07	-.10	.31	.06	.05	-.09
8	-.04	.23	.21	-.17	.00	.21	.21	.00	-.16	-.08
9	.28	.37	.33	-.17	-.17	.04	-.10	-.25	-.27	-.05
10	.34	.45	.28	-.23	.06	-.10	-.31	-.43	-.31	-.07
11	.40	.31	.04	-.18	-.01	-.22	-.27	-.39	-.20	.10
12	.25	.69	-.01	.51	.02	-.02	-.62	-.63	-.40	.08

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

Age	7	8	9	10	11	12
Mean Log q	-6.3484	-5.6370	-5.3189	-5.2119	-5.2810	-5.0553
S.E(Log q)	.2566	.1980	.2287	.3012	.2729	.4111

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,	1.01,	-.042,	6.30,	.56,	13,	.27,	-6.35,
8,	.87,	.785,	6.18,	.79,	13,	.17,	-5.64,
9,	.71,	2.546,	6.52,	.89,	13,	.13,	-5.32,
10,	.72,	1.651,	6.29,	.79,	13,	.20,	-5.21,
11,	.84,	.639,	5.82,	.63,	13,	.24,	-5.28,
12,	.94,	.111,	5.23,	.30,	13,	.41,	-5.06,

1

Terminal year survivor and F summaries :

Age 5 Catchability dependent on age and year class strength

Year class = 1992

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT06: Va TRW 85-96 ,	1.,	.000,	.000,	.00,	0,	.000,	.000
P shrinkage mean ,	25329.,	.28,,,,				.766,	.003
F shrinkage mean ,	10289.,	.50,,,,				.234,	.008

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
20523.,	.24,	9.94,	2,	41.123,	.004

Age 6 Catchability dependent on age and year class strength

Year class = 1991

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT06: Va TRW 85-96 ,	1.,	.000,	.000,	.00,	0,	.000,	.000
P shrinkage mean ,	21599.,	.29,,,,				.750,	.023
F shrinkage mean ,	9256.,	.50,,,,				.250,	.053

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
17471.,	.25,	9.78,	2,	39.075,	.028

Age 7 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
FLT06: Va TRW 85-96 ,	9967.,	.300,	.000,	.00,	1,	.693,	.224
F shrinkage mean ,	13518.,	.50,,,,				.307,	.170

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
10943.,	.26,	.17,	2,	.653,	.206

Age 8 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

Table 6.6.1.1 (Cont'd)

```
FLT06: Va TRW 85-96 ,      5743.,   .214,        .064,    .30,   2,  .779,     .345

  F shrinkage mean  ,       6260.,    .50,,,,                           .221,     .321

 Weighted prediction :

 Survivors,         Int,       Ext,    N,     Var,     F
 at end of year,    s.e,       s.e,    ,    Ratio,
      5854.,        .20,       .05,    3,    .246,   .340


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

 Year class = 1988

 Fleet,                   Estimated,    Int,        Ext,    Var,    N, Scaled,  Estimated
   ,                      Survivors,    s.e,        s.e,   Ratio,   , Weights,    F
 FLT06: Va TRW 85-96 ,      3632.,     .178,       .059,    .33,   3,  .802,     .463

  F shrinkage mean  ,       4826.,     .50,,,,                          .198,     .367

 Weighted prediction :

 Survivors,         Int,       Ext,    N,     Var,     F
 at end of year,    s.e,       s.e,    ,    Ratio,
      3843.,        .17,       .08,    4,    .488,   .443


1
 Age 10   Catchability constant w.r.t. time and dependent on age

 Year class = 1987

 Fleet,                   Estimated,    Int,        Ext,    Var,    N, Scaled,  Estimated
   ,                      Survivors,    s.e,        s.e,   Ratio,   , Weights,    F
 FLT06: Va TRW 85-96 ,      1835.,     .164,       .107,    .66,   4,  .805,     .485

  F shrinkage mean  ,       2413.,     .50,,,,                          .195,     .389

 Weighted prediction :

 Survivors,         Int,       Ext,    N,     Var,     F
 at end of year,    s.e,       s.e,    ,    Ratio,
      1936.,        .16,       .10,    5,    .628,   .465


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

 Year class = 1986

 Fleet,                   Estimated,    Int,        Ext,    Var,    N, Scaled,  Estimated
   ,                      Survivors,    s.e,        s.e,   Ratio,   , Weights,    F
 FLT06: Va TRW 85-96 ,      1332.,     .153,       .098,    .64,   5,  .812,     .514

  F shrinkage mean  ,       1805.,     .50,,,,                          .188,     .403

 Weighted prediction :

 Survivors,         Int,       Ext,    N,     Var,     F
 at end of year,    s.e,       s.e,    ,    Ratio,
      1411.,        .16,       .10,    6,    .632,   .492

1
 Age 12   Catchability constant w.r.t. time and dependent on age

 Year class = 1985

 Fleet,                   Estimated,    Int,        Ext,    Var,    N, Scaled,  Estimated
   ,                      Survivors,    s.e,        s.e,   Ratio,   , Weights,    F
 FLT06: Va TRW 85-96 ,       944.,     .152,       .090,    .59,   6,  .764,     .648

  F shrinkage mean  ,       1466.,     .50,,,,                          .236,     .462

 Weighted prediction :

 Survivors,         Int,       Ext,    N,     Var,     F
 at end of year,    s.e,       s.e,    ,    Ratio,
      1047.,        .17,       .11,    7,    .684,   .599
```

Table 6.6.1.1 (Cont'd)

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

Year class = 1984

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT06: Va TRW 85-96 ,	553.,	.147,	.079,	.54,	6,	.682,	.734
F shrinkage mean ,	1337.,	.50,,,,				.318,	.370

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
732.,	.19,	.21,	7,	1.129,	.597

1

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

Year class = 1983

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT06: Va TRW 85-96 ,	390.,	.145,	.084,	.58,	6,	.619,	.631
F shrinkage mean ,	791.,	.50,,,,				.381,	.361

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
511.,	.21,	.19,	7,	.892,	.514

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

Year class = 1982

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT06: Va TRW 85-96 ,	265.,	.148,	.127,	.86,	6,	.510,	.681
F shrinkage mean ,	364.,	.50,,,,				.490,	.537

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
310.,	.26,	.12,	7,	.479,	.607

Table 6.6.1.2 Fishing mortality (F) at age ,Terminal Fs derived using XSA (With F shrinkage)

YEAR,	1975,	1976,	1977,
AGE			
5,	.0053,	.0018,	.0000,
6,	.0480,	.0153,	.0017,
7,	.1515,	.0426,	.0415,
8,	.2563,	.0688,	.1619,
9,	.2989,	.0857,	.3640,
10,	.3559,	.0803,	.2245,
11,	.2382,	.0671,	.1864,
12,	.3647,	.0597,	.3311,
13,	.7896,	.0421,	.1561,
14,	.6760,	.1746,	.1767,
15,	.4876,	.0849,	.2157,
+gp,	.4876,	.0849,	.2157,
0 FBAR 8-12,	.3028,	.0723,	.2536,

Fishing mortality (F) at age

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
5,	.0009,	.0009,	.0012,	.0007,	.0003,	.0004,	.0028,	.0029,	.0058,	.0048,
6,	.0044,	.0090,	.0182,	.0049,	.0094,	.0090,	.0118,	.0172,	.0169,	.0893,
7,	.0198,	.0941,	.0856,	.0250,	.0419,	.0608,	.0397,	.0520,	.0483,	.1717,
8,	.0791,	.1636,	.2080,	.0817,	.1327,	.1230,	.1017,	.1293,	.1258,	.1553,
9,	.1549,	.3352,	.3376,	.1579,	.2556,	.2304,	.2290,	.2242,	.2337,	.1899,
10,	.2095,	.3167,	.4277,	.3056,	.4174,	.3746,	.3222,	.2619,	.3036,	.4406,
11,	.2217,	.3299,	.5882,	.4255,	.5525,	.5359,	.5015,	.2601,	.2394,	.2821,
12,	.1946,	.2236,	.5763,	.4388,	.6103,	.6251,	.8023,	.3010,	.2168,	.4179,
13,	.2879,	.2191,	.5570,	.6236,	.8843,	.5625,	.9330,	.7622,	.4432,	.3624,
14,	.2822,	.3794,	.4369,	.4742,	1.4492,	.6383,	1.3907,	.5403,	1.0056,	.3372,
15,	.2400,	.2949,	.5202,	.4560,	.7885,	.5506,	.7958,	.4273,	.4440,	.3697,
+gp,	.2400,	.2949,	.5202,	.4560,	.7885,	.5506,	.7958,	.4273,	.4440,	.3697,
0 FBAR 8-12,	.1719,	.2738,	.4275,	.2819,	.3937,	.3778,	.3914,	.2353,	.2239,	.2972,

1

Fishing mortality (F) at age

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	FBAR 95-97
AGE											
5,	.0039,	.0150,	.0057,	.0122,	.0009,	.0021,	.0040,	.0234,	.0079,	.0038,	.0117,
6,	.0230,	.0609,	.0164,	.0444,	.0209,	.0242,	.0368,	.0984,	.0847,	.0285,	.0705,
7,	.0746,	.1787,	.0689,	.0776,	.0912,	.1183,	.1696,	.2186,	.2487,	.2058,	.2244,
8,	.1434,	.3003,	.1962,	.1707,	.1867,	.3260,	.3438,	.3873,	.3538,	.3398,	.3603,
9,	.2731,	.4244,	.3365,	.2361,	.2227,	.3842,	.3888,	.3942,	.4376,	.4429,	.4249,
10,	.4069,	.4686,	.4080,	.2617,	.3830,	.3802,	.3433,	.3523,	.4747,	.4648,	.4306,
11,	.4185,	.3782,	.3036,	.2363,	.3987,	.3273,	.3846,	.3800,	.5152,	.4918,	.4623,
12,	.4478,	.6470,	.3854,	.4478,	.4310,	.5335,	.3377,	.4458,	.5480,	.5995,	.5311,
13,	.9417,	.6181,	.5307,	.7475,	.3734,	.3349,	.2778,	.3707,	.4836,	.5974,	.4839,
14,	.5133,	.6868,	.3392,	1.5764,	.2247,	.1526,	.3498,	.4966,	.5707,	.5141,	.5271,
15,	.5347,	.5149,	.3719,	.5945,	.3421,	.3237,	.2678,	.3780,	.5116,	.6072,	.4989,
+gp,	.5347,	.5149,	.3719,	.5945,	.3421,	.3237,	.2678,	.3780,	.5116,	.6072,	
0 FBAR 8-12,	.3379,	.4437,	.3259,	.2705,	.3244,	.3903,	.3596,	.3919,	.4659,	.4677,	

Table 6.6.1.3 Stock number at age (start of year) Numbers*10**-3

YEAR,	1975,	1976,	1977,
AGE			
5,	24538,	25829,	26128,
6,	18408,	21009,	22191,
7,	13606,	15102,	17808,
8,	8494,	10064,	12456,
9,	5252,	5658,	8086,
10,	3333,	3352,	4470,
11,	2360,	2010,	2663,
12,	1619,	1601,	1617,
13,	551,	968,	1298,
14,	423,	215,	798,
15,	383,	185,	156,
+gp,	236,	119,	781,
0 TOTAL,	79203,	86111,	98452,

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

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
5,	27507,	34852,	40624,	40137,	33602,	29604,	32534,	45751,	46033,	41007,
6,	22488,	23654,	29971,	34922,	34522,	28914,	25471,	27925,	39262,	39394,
7,	19068,	19271,	20176,	25330,	29911,	29435,	24664,	21666,	23626,	33226,
8,	14705,	16090,	15098,	15941,	21264,	24687,	23841,	20402,	17704,	19377,
9,	9119,	11695,	11759,	10555,	12644,	16028,	18789,	18535,	15431,	13436,
10,	4836,	6723,	7199,	7221,	7758,	8428,	10957,	12861,	12749,	10514,
11,	3074,	3376,	4215,	4040,	4579,	4399,	4988,	6833,	8519,	8100,
12,	1902,	2119,	2089,	2015,	2272,	2268,	2216,	2600,	4534,	5771,
13,	1000,	1348,	1459,	1011,	1118,	1062,	1045,	855,	1656,	3142,
14,	956,	645,	932,	719,	466,	397,	521,	354,	343,	915,
15,	576,	620,	380,	518,	385,	94,	181,	112,	177,	108,
+gp,	1027,	525,	306,	465,	258,	119,	39,	142,	102,	17,
0 TOTAL,	106257,	120919,	134208,	142874,	148780,	145437,	145243,	158035,	170137,	175007,

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

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	GMST 75-95	AMST 75-95
AGE													
5,	35286,	36118,	35497,	25790,	21014,	23345,	21284,	23491,	24456,	23936,	0,	30991,	31903,
6,	35126,	30251,	30624,	30378,	21930,	18071,	20051,	18247,	19752,	20884,	20523,	26465,	27277,
7,	31009,	29545,	24500,	25929,	25010,	18485,	15182,	16635,	14233,	15620,	17471,	22111,	22818,
8,	24086,	24771,	21269,	19684,	20650,	19650,	14134,	11029,	11507,	9553,	10943,	17158,	17876,
9,	14279,	17962,	15790,	15045,	14283,	14747,	12207,	8626,	6444,	6953,	5854,	12180,	12854,
10,	9564,	9352,	10113,	9707,	10226,	9839,	8644,	7122,	5006,	3581,	3843,	7817,	8332,
11,	5825,	5480,	5038,	5789,	6431,	6001,	5790,	5278,	4310,	2680,	1936,	4675,	4990,
12,	5258,	3299,	3232,	3201,	3934,	3715,	3723,	3392,	3107,	2216,	1411,	2761,	2970,
13,	3271,	2892,	1487,	1892,	1761,	2200,	1876,	2286,	1870,	1546,	1047,	1472,	1627,
14,	1882,	1098,	1342,	753,	771,	1043,	1355,	1223,	1358,	992,	732,	716,	817,
15,	562,	970,	475,	823,	134,	530,	771,	822,	641,	661,	511,	335,	427,
+gp,	635,	386,	211,	196,	207,	54,	809,	790,	1344,	1627,	1073,		
TOTAL,	166783,	162123,	149578,	139185,	126351,	117680,	105825,	98942,	94027,	90249,	65344,		
1													

Table 6.6.1.4 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 5	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 8-12,
1975,	24538,	122679,	46782,	23494,	.5022,	.3028,
1976,	25829,	158183,	53959,	6045,	.1120,	.0723,
1977,	26128,	159844,	65047,	16578,	.2549,	.2536,
1978,	27507,	176146,	75988,	14349,	.1888,	.1719,
1979,	34852,	175908,	76649,	23616,	.3081,	.2738,
1980,	40624,	212814,	79100,	31252,	.3951,	.4275,
1981,	40137,	214268,	73246,	19239,	.2627,	.2819,
1982,	33602,	246802,	80137,	32441,	.4048,	.3937,
1983,	29604,	240301,	72537,	30888,	.4258,	.3778,
1984,	32534,	244059,	84115,	34024,	.4045,	.3914,
1985,	45751,	267425,	96570,	32075,	.3321,	.2353,
1986,	46033,	285076,	105440,	32984,	.3128,	.2239,
1987,	41007,	298301,	117015,	46622,	.3984,	.2972,
1988,	35286,	300946,	122517,	51118,	.4172,	.3379,
1989,	36118,	266497,	112392,	61396,	.5463,	.4437,
1990,	35497,	255172,	98254,	39326,	.4002,	.3259,
1991,	25790,	239832,	107670,	37950,	.3525,	.2705,
1992,	21014,	219131,	87177,	35423,	.4063,	.3244,
1993,	23345,	207654,	88662,	40817,	.4604,	.3903,
1994,	21284,	192430,	81901,	36957,	.4512,	.3596,
1995,	23491,	166487,	92423,	36288,	.3926,	.3919,
1996,	24456,	155161,	82267,	35826,	.4355,	.4659,
1997,	23936,	137951,	67498,	29964,	.4439,	.4677,
Arith. Mean ,	31233,	214916,	85537,	32551,	.3743,	.3253,
0 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: 1998								
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	23000.000	0.1500	0.2350	0.0000	0.0000	0.990	0.0120	0.990
6	19721.000	0.1500	0.2610	0.0000	0.0000	1.148	0.0750	1.148
7	16430.000	0.1500	0.4130	0.0000	0.0000	1.364	0.2380	1.364
8	10943.000	0.1500	0.5000	0.0000	0.0000	1.664	0.3810	1.664
9	5854.000	0.1500	0.5360	0.0000	0.0000	1.945	0.4500	1.945
10	3843.000	0.1500	0.6400	0.0000	0.0000	2.287	0.4560	2.287
11	1936.000	0.1500	0.7140	0.0000	0.0000	2.592	0.4890	2.592
12	1411.000	0.1500	0.7610	0.0000	0.0000	2.950	0.5620	2.950
13	1047.000	0.1500	0.8930	0.0000	0.0000	3.487	0.5120	3.487
14	732.000	0.1500	0.9670	0.0000	0.0000	4.177	0.5580	4.177
15	511.000	0.1500	0.9840	0.0000	0.0000	5.040	0.5280	5.040
16+	1073.000	0.1500	0.9950	0.0000	0.0000	5.746	0.5280	5.746
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 1999								
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	23000.000	0.1500	0.2350	0.0000	0.0000	0.990	0.0120	0.990
6	.	0.1500	0.2610	0.0000	0.0000	1.148	0.0750	1.148
7	.	0.1500	0.4130	0.0000	0.0000	1.364	0.2380	1.364
8	.	0.1500	0.5000	0.0000	0.0000	1.664	0.3810	1.664
9	.	0.1500	0.5360	0.0000	0.0000	1.945	0.4500	1.945
10	.	0.1500	0.6400	0.0000	0.0000	2.287	0.4560	2.287
11	.	0.1500	0.7140	0.0000	0.0000	2.592	0.4890	2.592
12	.	0.1500	0.7610	0.0000	0.0000	2.950	0.5620	2.950
13	.	0.1500	0.8930	0.0000	0.0000	3.487	0.5120	3.487
14	.	0.1500	0.9670	0.0000	0.0000	4.177	0.5580	4.177
15	.	0.1500	0.9840	0.0000	0.0000	5.040	0.5280	5.040
16+	.	0.1500	0.9950	0.0000	0.0000	5.746	0.5280	5.746
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	23000.000	0.1500	0.2350	0.0000	0.0000	0.990	0.0120	0.990
6	.	0.1500	0.2610	0.0000	0.0000	1.148	0.0750	1.148
7	.	0.1500	0.4130	0.0000	0.0000	1.364	0.2380	1.364
8	.	0.1500	0.5000	0.0000	0.0000	1.664	0.3810	1.664
9	.	0.1500	0.5360	0.0000	0.0000	1.945	0.4500	1.945
10	.	0.1500	0.6400	0.0000	0.0000	2.287	0.4560	2.287
11	.	0.1500	0.7140	0.0000	0.0000	2.592	0.4890	2.592
12	.	0.1500	0.7610	0.0000	0.0000	2.950	0.5620	2.950
13	.	0.1500	0.8930	0.0000	0.0000	3.487	0.5120	3.487
14	.	0.1500	0.9670	0.0000	0.0000	4.177	0.5580	4.177
15	.	0.1500	0.9840	0.0000	0.0000	5.040	0.5280	5.040
16+	.	0.1500	0.9950	0.0000	0.0000	5.746	0.5280	5.746
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANEHJ03
Date and time: 05MAY98:14:35

Greenland halibut (Fishing Areas V and XIV)

Table 6.7.1.2 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	0.0390	0.0000	0.0000	1021.000	0.0070	1021.000
6	.	0.1500	0.0820	0.0000	0.0000	1226.000	0.0440	1226.000
7	.	0.1500	0.2030	0.0000	0.0000	1482.000	0.1440	1482.000
8	.	0.1500	0.3700	0.0000	0.0000	1795.000	0.2850	1795.000
9	.	0.1500	0.5650	0.0000	0.0000	2156.000	0.4250	2156.000
10	.	0.1500	0.7300	0.0000	0.0000	2500.000	0.5080	2500.000
11	.	0.1500	0.8480	0.0000	0.0000	2883.000	0.5130	2883.000
12	.	0.1500	0.9310	0.0000	0.0000	3382.000	0.6090	3382.000
13	.	0.1500	0.9710	0.0000	0.0000	4071.000	0.7520	4071.000
14	.	0.1500	0.9930	0.0000	0.0000	4764.000	0.8850	4764.000
15	.	0.1500	0.9980	0.0000	0.0000	5365.000	0.6420	5365.000
Unit	Numbers	-	-	-	-	Grams	-	Grams

Notes: Run name : YLDJBO05
Date and time: 06MAY98:16:33

Greenland halibut (Fishing Areas V and XIV)

Table 6.7.2.1. 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	12696.723	2.594	8010.780	2.594	8010.780
0.0500	0.0234	0.077	236.860	5.581	11855.007	2.399	7230.584	2.399	7230.584
0.1000	0.0468	0.142	422.556	5.386	11119.992	2.228	6553.798	2.228	6553.798
0.1500	0.0702	0.195	568.051	5.212	10475.914	2.077	5964.917	2.077	5964.917
0.2000	0.0936	0.240	681.967	5.056	9909.525	1.942	5450.930	1.942	5450.930
0.2500	0.1170	0.278	771.081	4.916	9409.672	1.823	5000.895	1.823	5000.895
0.3000	0.1404	0.311	840.719	4.789	8966.949	1.716	4605.600	1.716	4605.600
0.3500	0.1638	0.339	895.070	4.674	8573.411	1.621	4257.271	1.621	4257.271
0.4000	0.1872	0.363	937.424	4.570	8222.329	1.535	3949.341	1.535	3949.341
0.4500	0.2106	0.384	970.368	4.474	7907.999	1.457	3676.247	1.457	3676.247
0.5000	0.2340	0.402	995.933	4.387	7625.568	1.387	3433.270	1.387	3433.270
0.5500	0.2574	0.418	1015.715	4.307	7370.908	1.324	3216.398	1.324	3216.398
0.6000	0.2808	0.433	1030.967	4.233	7140.490	1.266	3022.214	1.266	3022.214
0.6500	0.3042	0.445	1042.674	4.165	6931.297	1.213	2847.802	1.213	2847.802
0.7000	0.3276	0.457	1051.608	4.102	6740.743	1.165	2690.666	1.165	2690.666
0.7500	0.3510	0.467	1058.375	4.043	6566.603	1.121	2548.667	1.121	2548.667
0.8000	0.3744	0.477	1063.451	3.988	6406.961	1.080	2419.966	1.080	2419.966
0.8500	0.3978	0.486	1067.208	3.937	6260.162	1.042	2302.980	1.042	2302.980
0.9000	0.4212	0.494	1069.938	3.889	6124.774	1.007	2196.343	1.007	2196.343
0.9500	0.4446	0.501	1071.870	3.843	5999.553	0.975	2098.871	0.975	2098.871
1.0000	0.4680	0.508	1073.183	3.801	5883.417	0.945	2009.540	0.945	2009.540
1.0500	0.4914	0.515	1074.017	3.761	5775.422	0.917	1927.457	0.917	1927.457
1.1000	0.5148	0.521	1074.482	3.723	5674.742	0.891	1851.846	0.891	1851.846
1.1500	0.5382	0.526	1074.664	3.687	5580.654	0.867	1782.028	0.867	1782.028
1.2000	0.5616	0.532	1074.628	3.653	5492.521	0.844	1717.408	0.844	1717.408
1.2500	0.5850	0.537	1074.427	3.621	5409.782	0.822	1657.466	0.822	1657.466
1.3000	0.6084	0.542	1074.101	3.590	5331.942	0.802	1601.740	0.802	1601.740
1.3500	0.6318	0.546	1073.682	3.561	5258.563	0.783	1549.828	0.783	1549.828
1.4000	0.6552	0.551	1073.194	3.532	5189.254	0.765	1501.370	0.765	1501.370
1.4500	0.6786	0.555	1072.656	3.506	5123.669	0.748	1456.050	0.748	1456.050
1.5000	0.7020	0.559	1072.081	3.480	5061.499	0.732	1413.586	0.732	1413.586
1.5500	0.7254	0.563	1071.483	3.455	5002.466	0.717	1373.728	0.717	1373.728
1.6000	0.7488	0.566	1070.868	3.432	4946.323	0.703	1336.250	0.703	1336.250
1.6500	0.7722	0.570	1070.243	3.409	4892.847	0.689	1300.954	0.689	1300.954
1.7000	0.7956	0.573	1069.614	3.387	4841.836	0.676	1267.660	0.676	1267.660
1.7500	0.8190	0.577	1068.984	3.366	4793.111	0.663	1236.207	0.663	1236.207
1.8000	0.8424	0.580	1068.356	3.345	4746.506	0.651	1206.450	0.651	1206.450
1.8500	0.8658	0.583	1067.731	3.326	4701.873	0.640	1178.259	0.640	1178.259
1.9000	0.8892	0.586	1067.112	3.307	4659.077	0.629	1151.515	0.629	1151.515
1.9500	0.9126	0.589	1066.499	3.288	4617.996	0.619	1126.111	0.619	1126.111
2.0000	0.9360	0.591	1065.894	3.271	4578.518	0.609	1101.950	0.609	1101.950
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YLDJBO05
Date and time : 06MAY98:16:33
Computation of ref. F: Simple mean, age 8 - 12
F-0.1 factor : 0.4661
F-max factor : 1.1652
F-0.1 reference F : 0.2181
F-max reference F : 0.5453
Recruitment : Single recruit

Table 6.7.3.1. Greenland halibut (Fishing Areas V and XIV)

Prediction with management option table

Year: 1998					Year: 1999					Year: 2000	
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
0.7948	0.3716	130834	62984	23000	0.0000	0.0000	129862	61152	0	153634	76260
.	.	.	.	.	0.0500	0.0234	.	61152	1642	151867	75068
.	.	.	.	.	0.1000	0.0468	.	61152	3251	150135	73903
.	.	.	.	.	0.1500	0.0701	.	61152	4829	148438	72762
.	.	.	.	.	0.2000	0.0935	.	61152	6375	146774	71646
.	.	.	.	.	0.2500	0.1169	.	61152	7892	145144	70554
.	.	.	.	.	0.3000	0.1403	.	61152	9379	143546	69485
.	.	.	.	.	0.3500	0.1637	.	61152	10837	141980	68439
.	.	.	.	.	0.4000	0.1870	.	61152	12267	140445	67415
.	.	.	.	.	0.4500	0.2104	.	61152	13669	138940	66413
.	.	.	.	.	0.5000	0.2338	.	61152	15044	137465	65432
.	.	.	.	.	0.5500	0.2572	.	61152	16393	136019	64472
.	.	.	.	.	0.6000	0.2806	.	61152	17715	134602	63533
.	.	.	.	.	0.6500	0.3039	.	61152	19013	133212	62613
.	.	.	.	.	0.7000	0.3273	.	61152	20285	131849	61712
.	.	.	.	.	0.7500	0.3507	.	61152	21533	130513	60831
.	.	.	.	.	0.8000	0.3741	.	61152	22758	129202	59968
.	.	.	.	.	0.8500	0.3975	.	61152	23959	127918	59123
.	.	.	.	.	0.9000	0.4208	.	61152	25137	126658	58296
.	.	.	.	.	0.9500	0.4442	.	61152	26293	125422	57486
.	.	.	.	.	1.0000	0.4676	.	61152	27428	124210	56693
.	.	.	.	.	1.0500	0.4910	.	61152	28541	123022	55916
.	.	.	.	.	1.1000	0.5144	.	61152	29633	121856	55156
.	.	.	.	.	1.1500	0.5377	.	61152	30704	120713	54411
.	.	.	.	.	1.2000	0.5611	.	61152	31756	119592	53682
.	.	.	.	.	1.2500	0.5845	.	61152	32788	118491	52968
.	.	.	.	.	1.3000	0.6079	.	61152	33801	117412	52268
.	.	.	.	.	1.3500	0.6313	.	61152	34796	116353	51583
.	.	.	.	.	1.4000	0.6546	.	61152	35771	115315	50912
.	.	.	.	.	1.4500	0.6780	.	61152	36729	114296	50255
.	.	.	.	.	1.5000	0.7014	.	61152	37670	113296	49612
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANEHJ03
Date and time : 06MAY98:16:45
Computation of ref. F: Simple mean, age 8 - 12
Basis for 1998 : TAC constraints

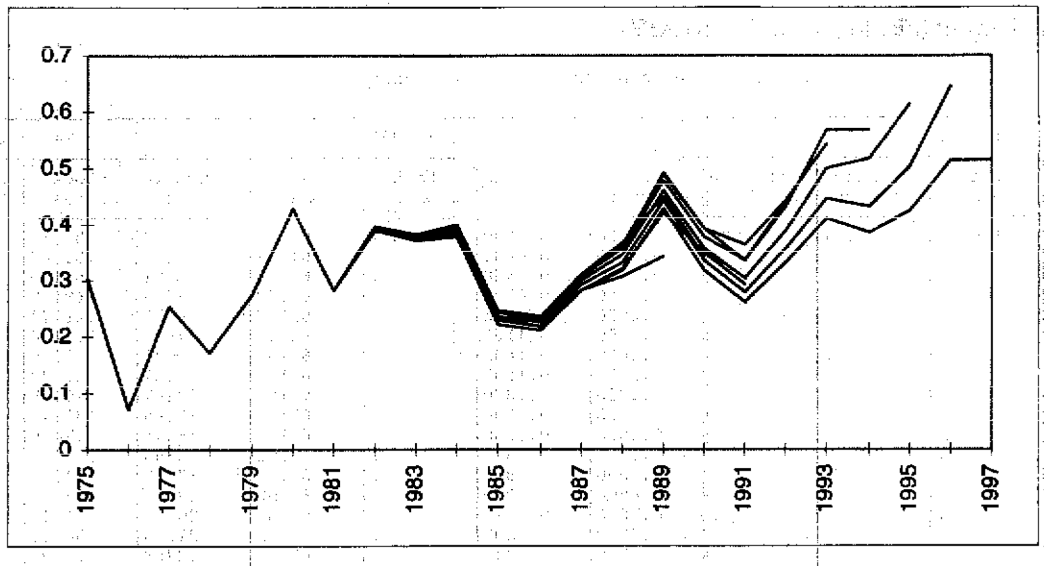


Figure 6.6.1.1a

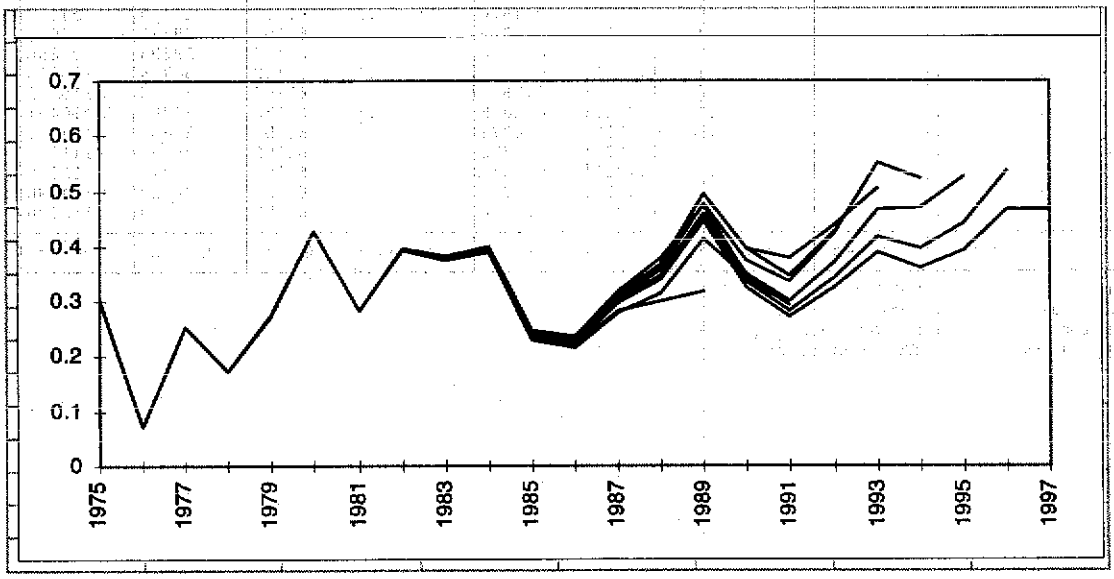


Figure.6.6.1.1b Restrospective plots of F(8–12) GREENLAND HALIBUT XIV+V. Upper S.E.=1.0, lower S.E.=0.5.

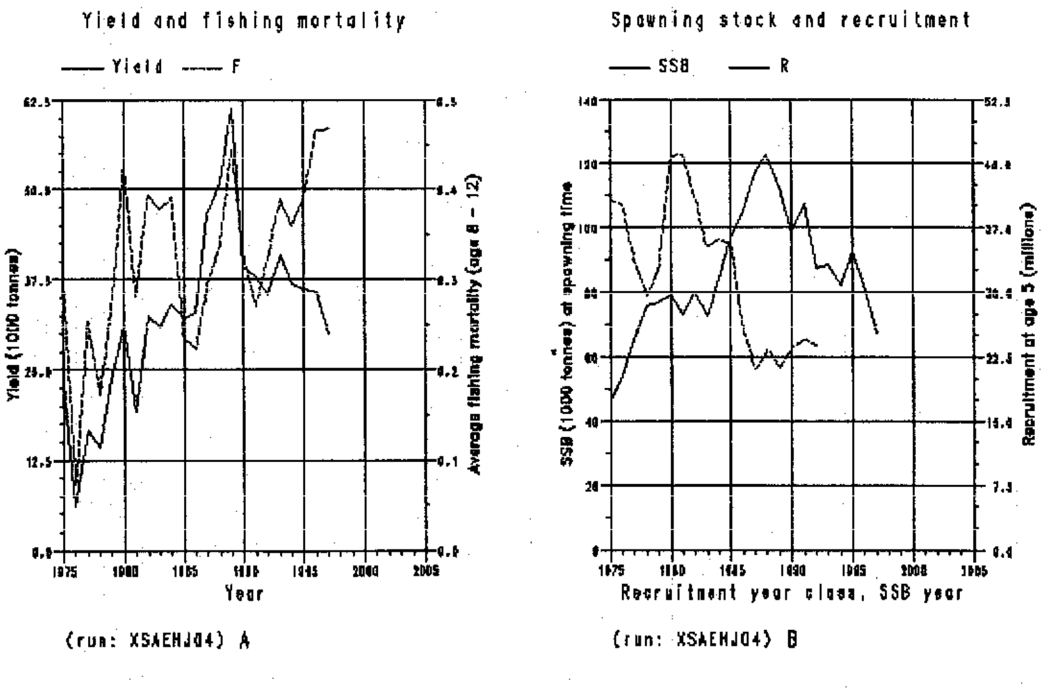


Figure 6.6.1.2ab

Fish Stock Summary
Greenland halibut (Fishing Areas V and XIV)
6—5—1998

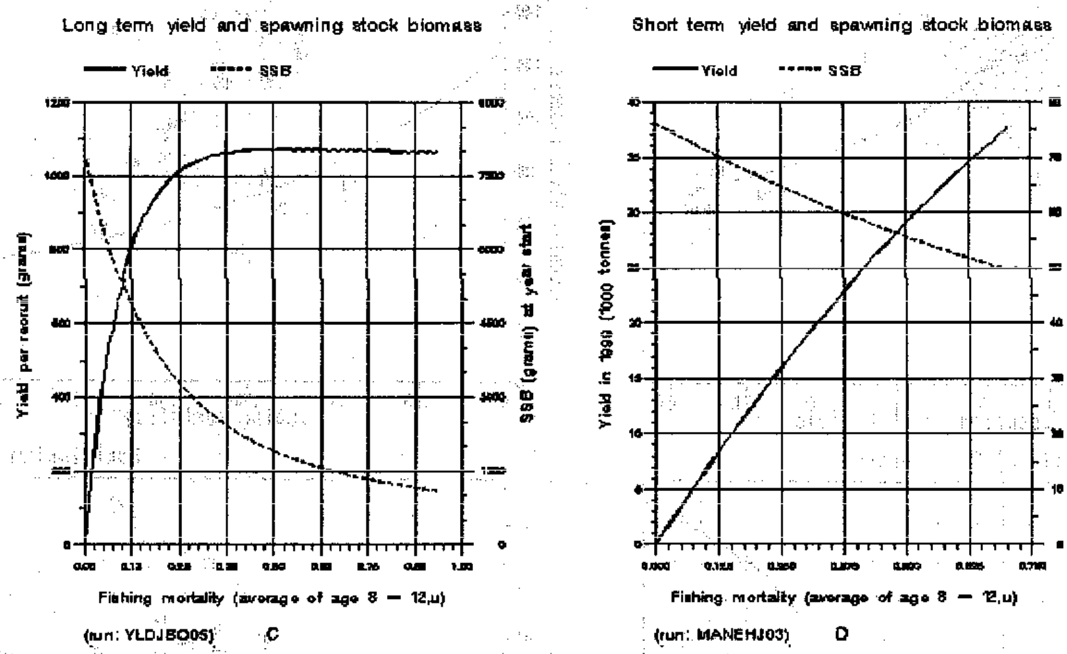


Figure 6.6.1.2cd

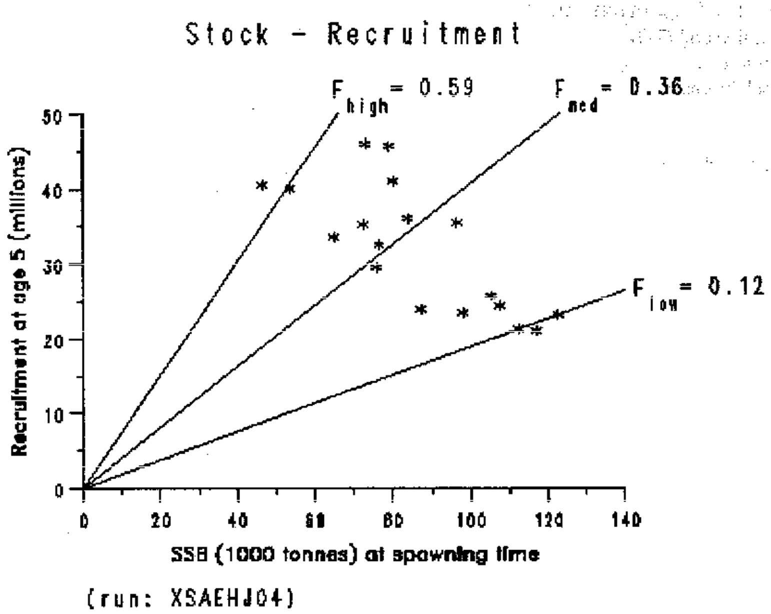


Figure 6.7.2 Stock Recruitment relationship for Greenland halibut.

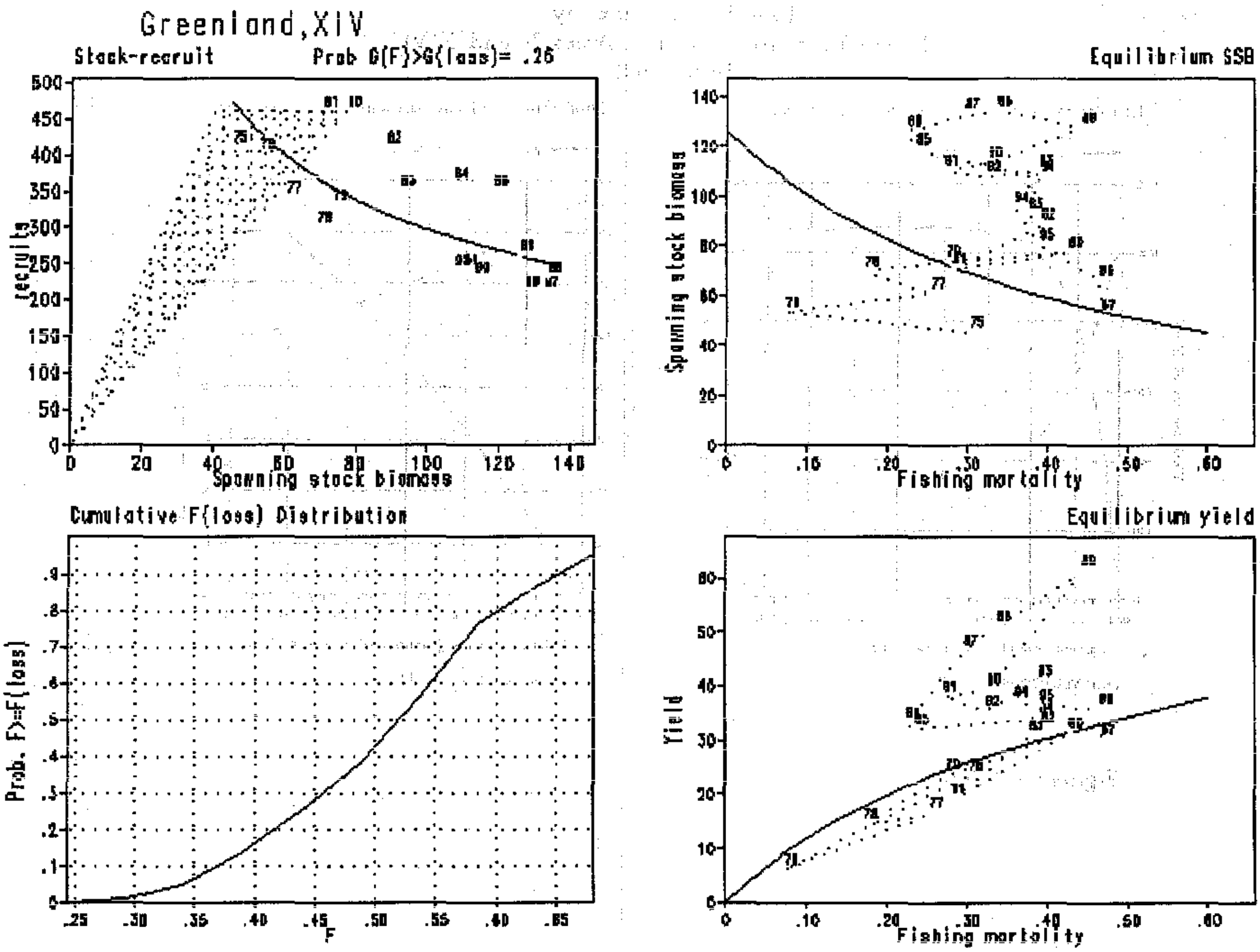


Figure 6.8.1. Greenland halibut. Output of the G_{loss} programme.
A: Stock-recruitment data with expected recruitment line and G_{loss} (vertical shading) and G_F (horisontal shading) distributions.
B: Plot of observed fishing mortality - spawning stock biomass with expected equilibruim SSB curve (solid line).
C: The cumulative distribution of F_{loss}.
D: Observed fishing mortality - yield with expected equilibruim yield curve (solid line).

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.

Besides the general requirements, NEAFC and ICES have asked the North Western Working Group to provide information and advice on some specific items on redfish which are as follows:

a) update survey and fishery information on the stocks of redfish in Sub-areas V, VI, XII and XIV;

b) update information on the stock composition, distribution and migration of the redfish stocks in Sub-areas V and XIV and comment on the possible relationship between pelagic "deep sea" *Sebastes mentella* and the *S. mentella* fished in demersal fisheries on the continental shelf and slope.

c) provide information on the relationship between pelagic "deep sea" *Sebastes mentella* and the *S. mentella* fished in demersal fisheries on the continental shelf and slope;

d) provide advice on the medium-term consequences of an adaptive harvesting strategy, based on a constant annual catch within each 5 year period, set at a level required to obtain sustainable yields of "Oceanic" *S. mentella* and "deep sea *S. mentella*;

e) describe the depth distribution of the pelagic components of *S. mentella* by season, area and year and provide information on the stock identity of the deep sea type and oceanic type *S. mentella*;

f) advice NEAFC on an appropriate scientific monitoring scheme for the pelagic fishery for *S. mentella* in the Irminger Sea considering the current knowledge of the stock complexity and respond not later than 1 May 1998.

The working group address these questions in the next chapters. The requested items h), i) and k) are described in the sections 7.1 and 7.2. The term of reference l) are dealt in section 7.3. Items c) and j) are treated in the corresponded sections for each species. Some of these request were elaborated and discussed during the Study Group on Redfish Stocks held in Hamburg in January 1998 (ICES CM 1998/G:3).

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 last one has not been of any commercial value. It should however be noted that Iceland has started to fish *S. viviparus* in 2 small areas South of Iceland at depths of 150 - 250 m. The catches in 1997 were 1,160 t.

Figure 7.1.1 shows schematically some possible relationships between different stocks of redfish in the Irminger Sea and along the continental slope of E-Greenland-Iceland-Faroe Islands. The question marks indicate lack of knowledge regarding relationships between stocks or components of redfish in the different areas. Furthermore, it remains unclear whether redfish in the Irminger Sea constitute a single stock or whether two or more stocks may be involved. Data indicate that redfish in upper ocean layers differ from those in deeper layers in some respects (cf. ICES C.M. 1997/Assess:13). Fishermen thus prefer to fish in deeper layers as this generally yields larger fish with a lower incidence of parasites. Acoustic studies (Melnikov *et al.*, WD7 in ICES C.M. 1998/G:3) give abundance data separately for depths above and below 500m. The results indicate that peak abundance in the upper layer (above 500 m) occurs far to the Southwest from locations of peak abundance in the lower layer (below 500 m). This is in agreement with the horizontal and vertical distribution of catches in the fishery.

Two hypotheses have been put forward to describe redfish in the Irminger Sea:

1. The <u>single-stock hypothesis</u>, suggesting that the mature individuals of a single stock segregate according to age/size;

2. The two-stock hypothesis, suggesting that there is a distinct deep-sea stock, separate from the oceanic stock proper, occupying deeper layers. On this hypothesis, it is an open question whether or not the deep-sea stock in the Irminger Sea is separate from the deep-sea stock on the continental slope.

These questions and hypotheses and methods for their evaluation are discussed in section 7.2 .

7.1.1 *S. marinus*

7.1.1.1 Adult stock

The status of *S. marinus* in ICES Divisions V and XIV was evaluated in a report of the joint NAFO/ICES study group on biological relationships of the West Greenland and Irminger Sea Redfish stocks, held in 1983 (ICES, 1983). Since then, little new knowledge of the general biology of the species has been obtained but the stock size has declined drastically during the last 10 years (ICES C.M. 1997/ Assess:13). The bulk of larval extrusion takes place in April - May. The only known areas of larval extrusion are Southwest and West of Iceland (Magnússon and Magnússon, 1977; Magnússon, 1980) and South of the Faroe Islands (ICES C.M. 1983/G:3). Larval extrusion has not been observed in other regions.

During the last two or three decades the most important fishing grounds for *S. marinus* have been SW and West of Iceland. From the annual Icelandic groundfish survey in March (Pálsson *et al.* 1989) and also from other surveys (Magnússon and Magnússon, 1975; Magnússon *et al.* 1988; Magnússon *et al.* 1990; Sigurðsson *et al.*,1997), it has been shown that the size of *S. marinus* increases from North to South. These results indicate a migration from the nursery areas North and East of Iceland towards the fishing grounds in the West and Southwest. Another important fishery is the "Rosengarten" area (SE Iceland and the shelves Faroe Islands (Reinert, 1990). The catches in these areas have, however, declined drastically in recent years.

7.1.1.2 Juveniles – nursery areas

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 and that it is mixed with *S. mentella* in variable proportions in different sub-areas and periods (Sigurðsson, WD1 in ICES CM 1998/G:3).

There are only available data on nursery grounds of *S. marinus* in Icelandic and Greenlandic waters but no nursery grounds are known in the Faroe Islands area.

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. During the period since the Icelandic groundfish survey started in 1985 there seem to have been two relatively strong year classes (Stefánsson and Sigurðsson, 1997) growing up North and Northwest of Iceland, most probably the 1985 and 1990 year classes. The former has started to recruit to the fishery at the fishing banks west and Southwest of Iceland.

Nursery grounds of *S. marinus* off East and West Greenland are found on the continental shelf are mixed with *S. mentella.* In recent years the abundance of *S. marinus* at West and East Greenland has been extremely low and there are no indications of recruitment according to German investigations (Rätz, 1997b). Earlier investigations have shown much larger quantities of juvenile *S. marinus* on the continental shelf and slope of Greenland (i.e. ICES, 1961).

7.1.1.3 "Giant" redfish

In 1960, Kotthaus (ICES, 1961) hypothesised that there might be a new stock or even a new species of *Sebastes.* New information presented in Johansen *et al.* (1996) and information later presented in Johansen *et al.* (1997b) were briefly discussed during 1997 NWWG meeting (ICES C.M. 1997/Assess:13). At that time, it was concluded that, due to the size, the genetic difference and the morphological resemblance with *S. marinus*, these large redfish most likely belong to the so called "giant" *S. marinus* observed and described from waters outside Greenland and Iceland (e.g., Altukhov and Nefyodov 1968, Kotthaus 1960a,b; Kosswig 1974). Therefore it was concluded that there was "sufficient biological evidence to keep these "giants" as a separate management unit not included in the catch statistics or assessment of common *S. marinus* at East-Greenland, Iceland and the Faroe Islands".

A fishery on the "giant" redfish with longliners and gillnets started on the Reykjanes ridge in 1996 outside the Icelandic 200 miles EEZ. The highest catch rates of redfish were at depths between 500 and 800 m (ICES CM 1998/G:3; WD2). According to Faroe-Norwegian investigations (Hareide and Thomsen, 1997) one of the main species in this fishery was a *Sebastes* type morphologically similar to *S. marinus*. Most of these fishes were above 65 cm (length distribution between 46 and 89 cm) and 5 kg. Independent Icelandic and Norwegian otolith readings using the same method showed that the age of these fishes were in the range of 15-50 years old (ICES CM 1998/G:3; WD 2).

Information presented at the Study Group of Redfish Stocks (Hareide, WD2 in ICES CM 1998/G:3) could indicate that the "giants" do mature at much greater lengths than *S. marinus* (50-65 cm for females and 46-60 cm for males). Nevertheless, samples taken from various areas in ICES Sub-areas V and XIV as well as in the Arctic areas have shown that nearly 100% of the *S. marinus* of lengths greater than 40-45 cm are mature; this applies to both males and females. Therefore, these new maturity data support the indications mentioned above from genetic and morphological work that the "giant" redfish might be a separate stock.

The limits of the distribution area of giant redfish is unknown. It is found along the shelves both off Iceland and Greenland. (Jakob Magnússon. Pers. comm.). Along the Reykjanes Ridge the species is distributed south to 52°N (Hareide & Thompson 1997, Langedal & Hareide 1997). "Giant" *S. marinus* caught by fishermen back to the 1930s in Icelandic and Greenland waters show that the geographical distribution may have been wider in former days. "Giant" *S. marinus* are still occasionally caught in demersal trawl in Division V. The young fish and nursery areas for these large redfish have not yet been found.

7.1.2 *S. mentella*

As described above there are different views on the stock structure of *S. mentella* in the ICES Sub-areas V, XII and XIV(Figure 7.1.1). In order to be consistent with these different views, this overview of *S. mentella* deals with the following 3 groups: Deep-sea *S. mentella* on the shelf, oceanic *S. mentella* and "pelagic deep-sea *S. mentella*".

7.1.2.1 Deep-sea *S. mentella* on the shelf

Traditionally, the *S. mentella* on the shelves and banks around the Faroe Islands, Iceland and at East Greenland are 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. This implies extensive migrations of the mature fish (mainly females) between the feeding and the spawning areas and of the immature fish between nursery and feeding areas (see i.e. ICES, 1983).

This definition of a stock unit has been questioned. 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 this component and the two pelagic types in the Irminger Sea has been raised several times, for example in many reports of the North Western Working Group.

7.1.2.2 Oceanic *S. mentella*

A pelagic stock of *S. mentella* with main distribution of adult fish in the open Irminger Sea was defined by the ICES Study Group on Redfish Stocks in 1992 and named oceanic *S. mentella* (ICES C.M. 1992/G:14). The spawning area of this redfish is to the west of the Reykjanes Ridge in the Irminger Sea, geographically partly overlapping the spawning areas of the deep-sea *S. mentella*. The nursery areas are not known but the pelagic fry drift towards Greenland and it is believed that nursery areas are along the coast of East- and West Greenland. Feeding and copulation areas are both in the international parts of the Irminger Sea as well as in the national EEZ's of Greenland and Iceland.

As stated above the status of this fish assemblage as a separate stock unit has been debated for many years. Central in this debate has been the possible relationships to the other pelagic *S. mentella* type in the Irminger Sea and to the shelf deep-sea *S. mentella*. In section 7.2 of this report a list of criteria used to separate the oceanic and the deep-sea redfish can be found. One of these criteria is the heavy infestation rate of the ectoparasite *Sphyrion lumpii*. This parasite is also found on the deep-sea *S. mentella* from the shelves although the infestation rate is much smaller; however, from many sources it can be found that this infestation rate was higher in the past. A careful monitoring of the infestation rate is therefore necessary and several nations have already implemented registration of infestation rates and parasite distribution patterns in their routine sampling schemes of this fishery.

The fishery on this stock has since 1996 been regulated through TAC's agreed upon in North-East Atlantic Fisheries Commission (NEAFC). The TAC level is based on the estimates from acoustical surveys covering depths shallower than 500 m. And, as stated above, most of the fishery takes place below 500 m. The problem is magnified considerably by the finding of another type of *S. mentella* deeper than 500 m (see below) and of the fact that the oceanic *S. mentella* also has been distributed deeper than 500 m in recent years.

Given these uncertainties, the above mentioned development in the catches must be described as uncertain because it is at present not known how much of the oceanic *S. mentella* 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.

7.1.2.3 "Pelagic deep-sea *S. mentella*"

During the 1980s a second type of *S. mentella*, resembling the deep-sea *S. mentella*, was found pelagic in the Irminger Sea, at that time distributed below the oceanic *S. mentella* (Magnússon, 1983 and Reinert, 1987). The status of this redfish is not known at present but due to difficulties in separating the catches in the area into the two types, the North Western Working Group at the 1997 meeting – for practical reasons – decided to treat all pelagic *S. mentella* in the Irminger Sea as one management unit. Biologically, however, there are indications of two types, and consequently this redfish in principle should be treated separately as pelagic deep-sea *S. mentella* until more is known on this matter.

For the same reasons as for the oceanic *S. mentella*, it is not known how large a proportion of the catches this pelagic deep-sea type *S. mentella* constitute, but due to the changed behaviour of the fishing fleet and to the higher marked value of this fish, a considerable part of the catches in recent years could be from this type.

It can not be excluded that this redfish might be related to the shelf deep-sea *S. mentella*. If this is the case and the precautionary approach is applied in the management of this stock, than the catches of redfish in the Irminger Sea below 500 m should be reduced considerably (or even stopped) until a recovery has been observed on the shelves.

7.2 Stock identification

Several methods have been used to identify, delimit and discriminate stocks, such as analysis of populational, physiological, behavioural, meristic, morphometric (external shape and osteology) biochemical and genetic parameters (Ihssen *et al.*, 1981; ICES C.M. 1996/M:1). The most used have been morphometric analysis, protein electrophoresis and more recently DNA analysis.

In the Northeast Atlantic, two stocks of *S. marinus* are considered to exist (Northeast Arctic and East Greenland-Iceland-Faroes stock) and three *S. mentella* stocks (Northeast Arctic, Greenland-Iceland-Faroe Island deep-sea stock and Irminger Sea oceanic stock). Large redfish, named "giant" redfish, have been found in different areas of the Reykjanes Ridge, on the continental slopes of Iceland and Greenland and Faroe Islands (see Section 7.1.1.3. Although they are morphologically similar to *S. marinus*, some evidence (mainly genetic) shows differences.

In the Northwest Atlantic there are considered to exist nine redfish management units (Davis Strait and West Greenland (NAFO Sub-area 0+1), Labrador and North of Newfoundland (SA2 + Div 3K), Great Bank of Newfoundland (Div 3LN), Flemish Cap (Div 3M), Southwest (Tail) of the Great Bank (Div 3NO), St Pierre Bank (Div 3P), Gulf of St Lawrence (Div 4RST), Nova Scotia (Div 4VWX), Gulf of Maine-Georges Bank (Div 5).

In the Irminger Sea *S. mentella* is considered to exist as two types. The mature part of the oceanic type *S. mentella*, is pelagic and inhabits depths from about 50 m to 1,000 m in the Irminger Sea. In 1983 another mature *S. mentella* type resembling the deep-sea *S. mentella* was discovered in the Irminger Sea in pelagic waters mainly deeper than 500 meters, far from the continental shelves (see section 7.1.2.3). Until then, deep-sea *S. mentella* was considered to be restricted along the continental. The reported differentiation of the two *S. mentella* types in the Irminger Sea has been based on the following criteria (e.g., Magnússon *et al.* 1994, Magnússon *et al.* 1995):

Colour.....................................	the deep-sea type is redder, while the oceanic type is more greyish red
Length-weight relationship.....	the deep-sea type being more stout and heavier at a certain length
Length at first maturity...........	The deep-sea type being longer when first mature
Parasite infestation................	The deep-sea type being less infested by the *Sphyrion lumpi* ectoparasite

In addition, the following criteria are used to aid in the identification of types (Magnússon, 1991):

- The general appearance is different: the oceanic redfish does usually not have the uniform, bright colour as the deep-sea redfish. It is somewhat darker on the back and the colour in general gives an impression of not being "clean".
- The oceanic redfish is very frequently with black and red spots or a mixture of both on the skin. Such spots are sometimes observed on the deep-sea redfish but rather seldom.
- Dark or grey spots are frequently in the fillet of the oceanic redfish but are hardly seen in the fillet of the deep-sea redfish.
- The oceanic redfish is often slightly thinner (just behind the head) than the deep-sea redfish.

Iceland has discriminated between the two types in the fisheries since 1995. ICES has however, to date, treated them as one stock unit. It is thought that the nursery grounds for the oceanic redfish could be in the Davis Strait, off West and East Greenland, Baffin Island and Labrador and the distribution of the deep-sea redfish is more restricted to east Greenland (Magnússon and Magnússon 1995). Bakay (1988) used *S. lumpi* along with other parasites to study samples of *S. mentella* from different areas in the Irminger Sea and Flemish Cap Bank. He concluded that there is isolation between fish from the two locations, but indication of interrelation between oceanic and deep-sea *S. mentella* from the north-east, central and southern areas of the Irminger Sea.

The general view has been that infestation rate decreased with increased depth (see i.e., Magnússon *et al*, 1995; Magnússon and Magnússon, 1995). Studies from 1995 and 1996 based on infestation rates and parasites distribution pattern (Del Rio *et al.*, 1996; Sarralde *et al.*, 1997) have, however, showed the opposite. According to the 1996 study (Sarralde *et al*, 1997), the results must be taken with caution because the samples from different depths were taken at different seasons and the seasonality in the infestation rates has been shown to be significant (Bakay, 1988).

NEAFC has requested ICES to provide information on the relationship between deep-sea *S. mentella* of the Irminger Sea and the deep-sea *S. mentella* fished in demersal fisheries on the continental shelf and slope. Work is currently being done to gain more knowledge about what is believed to be pelagic deep-sea *S. mentella* in the Irminger Sea (e.g., genetic analyses).

Usually two groups of fish are considered as two different stocks when evidence (i.e. biological parameters, genetic and morphometric) shows clear differences; meanwhile both groups are considered as a single stock. However, it is common to consider two groups of fish, well geographically separated as two stocks (or at least as a separate management unit) based on the distribution patterns of the adult fishes. Regarding the two types of *S. mentella* in the Irminger Sea (oceanic and deep-sea) it is known that they live in the same area with a considerable overlap in distribution.

Although there are some indications of difference between different types of *S. mentella* (section 7.2), the conclusion made by the last Study Group on Redfish Stocks was that there is, at the present time, no sufficient conclusive evidence to allow us to determine whether the pelagic *S. mentella* in the Irminger Sea should be treated and managed as one or two stocks. The NWWG supports this conclusion but e.g., preliminary genetic results presented at the meeting (WD 25) have led the Working Group to strongly recommend an improved and more detailed scientific monitoring.

7.2.1 Genetic work

The genetic methods that have been used to study North Atlantic *Sebastes* species and stocks have mainly focused on species discrimination with the use of genetic markers.

Population structures of North-eastern Atlantic redfish species have been analysed by Nedreaas and Nævdal (1989; 1991a); Nedreaas *et al.* (1994) and Dushchenko (1987) and of the Pacific Ocean by Seeb and Gunderson (1988), using haemoglobins and isozyme analyses.

In those studies, the genetic variation and differentiation within and between the redfish species were found to be low and lowest in *S. mentella*. A need for genetic markers with higher resolution power such as nDNA markers is evident.

At present various genetic methods are being employed to study the four North Atlantic redfish species (*S. marinus*, *S. mentella*, *S. viviparus* and *S. fasciatus*) by: The Marine Research Institute, Iceland; the University of Bergen and The Institute of Marine Research, Bergen, Norway. The methods applied are: haemoglobins, multilocus isozymes, RAPD, cDNA RFLP, microsatellites, rDNA and mtDNA analyses. The researchers involved have written three ICES papers (unpublished) on the progress of the North-eastern Atlantic redfish population genetic work: on *S. marinus* along the Reykjanes Ridge (Johansen *et al.* 1997b) and on the deep-sea and oceanic *S. mentella* in the Irminger Sea and adjacent waters (Johansen *et al.* 1996; 1997a. Preliminary results on the "giant" *S. marinus* haemoglobin phenotypes showed that they were different from the types seen in the ordinary *S. marinus,* in *S. mentella* and *S. viviparus* and that there were significant differences in allele frequencies suggesting that the "giant" could be a separate stock. Redfish samples from two locations at Reykjanes Ridge consisted of different ratios of the "giant" *S. marinus* and ordinary *S. marinus* haemoglobin types. The genetic relationship between "giants" from Reykjanes Ridge and Icelandic continental shelf has not been examined and only few samples have been collected from the latter location.

The ongoing genetic work has so far revealed some phenotypes and alleles of the heamoglobin protein and IDHP isozyme that are unique for some of the deep-sea *S. mentella* (*Hb* types D & E in 20% of the deep-sea specimens and *IDHP-2*60 and 120* allele in 2%). This, in addition to a significant difference in *MEP-2** allele frequencies between the two groups pre-identified and grouped morphologically by Icelandic scientists as deep-sea and oceanic *S.mentella* in the Irminger Sea give preliminary indication of possible population differences. Statistical analyses of pooling the two groups/types together showed significant heterozygote deficiency in genotype distribution compared to the expected numbers according to the Hardy-Weinberg equilibrium. Heterozygote deficiency is the most common deviation when groups consist of mixed populations. Within the deep-sea *S.mentella* in the Irminger Sea and Icelandic continental shelf significant variation was also observed, whereas no significant variation was observed within the oceanic *S. mentella* group. Based on four enzyme loci (SOD, MDH, IDHP and MEP) these preliminary results were presented in a Working Document (no. 25) to the Working Group. These preliminary results show that the oceanic and deep sea types cluster into two different groups of *S. mentella* in the sampled area, although the genetic distance (e.g., Nei 1987) may be small. However, Nedreaas and Naevdal (1989) showed that the genetic distance even between species of the genus *Sebastes* is at a level more common for differences between populations in other species. Some critique was put forward in the Working Group to the pre-identification and grouping of the samples according to the morphology and not designing the work out from a null hypothesis that all *S.mentella* are similar. Nevertheless, the Working Group acknowledge the preliminary results presented at the meeting and the important ongoing work.

The ongoing genetic work goes further than to protein electrophoresis. DNA work is currently conducted in Canada, Iceland and Norway to find markers (RAPD, cDNA RFLP, microsatellites, AFLP, rDNA and mtDNA) for use in the detection and characterisation of the redfish at different levels of genetic differentiation, i.e. species (larvae origin) and stocks/populations. No results from this ongoing work were presented to the Working Group.

7.2.2 Morphological work

Historically, different anatomic features have been used to identify both species and populations. Several structures and methodologies have been used. At present, multivariate morphometric analysis and, to a lesser extent, meristic analysis are considered to the only valid tool for stock discrimination. Morphometry has been widely used for stock discrimination in several species of fishes and different areas with successful results even where genetics methods have not shown differences between populations (Safford and Booke, 1992; Kinsey *et al.*, 1994). Truss analysis, removing size dependence in the variables, is considered the optimal methodology in morphometric analysis.

In redfish, morphometry has been applied mainly for species identification (Misra and Ni, 1983; Power and Ni, 1985 Kenchington, 1986; Saborido-Rey, 1994), showing the usefulness of this tool. It has, however, been used in very few cases for stock discrimination (Reinert and Lastein, 1992; Saborido-Rey, 1994) showing clear differences between the stocks analysed.

Differences have been shown between Irminger Sea, Faroes and Norway, both in *S. marinus* and *S. mentella* (Reinert and Lastein, 1992). However, in the case of Faroese *S. mentella*, some within variation occurs, indicating that there could be a mixture of several populations in that area. However, the results indicate that the Irminger Sea *S. mentella* stock is a separated stock from Northeast and Faroes stocks.

Morphometric analysis will be started in 1998 by Spanish and Icelandic researchers trying to clarifying the existence or not of two types or populations of *S. mentella* in Irminger Sea and their relation with another possible stocks in adjacent waters such as the shelves of Iceland and Greenland.

7.3 Research on redfish in ICES areas V, XII and XIV

7.3.1 Ongoing Research

- Icelandic groundfish survey since 1985 (4-5 vessels for 2-3 weeks in March). 580 stations on Icelandic shelf down to 500 m depth (*S. marinus* and partly deep sea *S. mentella*).

- Icelandic autumn survey since 1996 (2 vessels in October). 300 stations on Icelandic shelf (excluding the South coast) down to 1500 m depth (*S. marinus* and deep sea *S. mentella*).
- Iceland has planned a survey on oceanic redfish in May 1998, where the main purpose will be to define the distribution area of the deep-sea component of *S. mentella*. The survey area will extend from the shelf SW of Iceland to south of the areas where the commercial fleet usually trawls on the deeper component.
- German groundfish survey since 1982 (1 vessel in Sept - Oct). Around 200 stations on the shelf of West and East Greenland down to 400 m depth (*S. marinus* and *S. mentella*).
- Greenland trawl survey since 1992 (1 vessel in July-October). Around 80 hauls on East Greenland and 160 on West at depths down to 600 m (*S. marinus* and *S. mentella*).
- Faroese groundfish surveys. One survey has been carried out in February-March since 1982 covering 100–150 stations. The other was initiated in 1991 in July-August with 200 stations. Both conducted on the shelf of Faroes Islands down to 500 m depth (*S. marinus*).
- A special redfish survey has been carried out annually in September/October since 1990 covering both *S. marinus* and *S. mentella* in Division Vb.
- Russian ichtyoplankton surveys (since 1982).
- Russian summer trawl acoustic survey (since 1982).
- Genetic - Stock identification of *S. mentella*. Work is ongoing both in Norway and Iceland. Material sampled mostly with pelagic- and bottom trawl.
- Genetic - "giants" work ongoing both in Norway and Iceland. Material sampled from longliners and trawl.
- Morphological work on redfish stocks has been going on in Spain for several years (in ICES areas I, II and NAFO areas) but will be started in 1998 on *S. mentella* in the Irminger Sea both in Spain and Iceland.

In addition, biological information is collected from numerous other surveys and information from fishery related data is also collected.

7.3.2 Further research - recommendations

- Studies on stock identification of *S. mentella* and *S. marinus* should be continued. It is important to work further on genetic methods and morphological methods should also be applied. The Working Group recommends that all available genetic results related to the stock structure of *S.mentella* in the Irminger Sea should be dealt with as a Term of reference by the ICES Working Group on the Application of Genetics in Fisheries and Mariculture in 1999. A suggested Term of reference might be: Review all available genetic results to make conclusions about how the *S.mentella* types in the Irminger Sea and adjacent waters should be structured into stocks or populations in order to make an optimal biological management.

- An operational manual for the identification of different *S. mentella* types is urgently required.

- Reproductive biology – both spawning and larval drift—of *S. marinus* in the area between Iceland and the Faroe Islands needs to be studied in order to determine whether these fish might constitute a separate stock element.

- Age readings. In order to assess the redfish stocks successfully, it is important to investigate further the possibility of developing a reliable age reading technique. Iceland has just started to investigate the otoliths of *S. marinus* collected in recent years and Norway, Russia and Spain has worked further on the matter since the last age reading workshop held in Germany in 1995 (ICES C.M.1996/G:1).

- An Acoustic survey on Irminger Sea should be conducted in June/July 1999. Due to the decreasing catch rates in the fishery on oceanic redfish (ICES C.M. 1997/Assess 13) as well as low biomass estimate in most recent acoustic surveys (ICES C.M. 1996/G:8; WD7) the Study Group on Redfish Stocks (ICES C.M. 1998/G:3) recommended a more frequent monitoring of oceanic redfish abundance in the Irminger sea in the future. The frequency of joint international surveys should be increased and conducted at least every second year. In the light of the recent shift in fishing effort towards deeper water on the Reykjanes Ridge (ICES, C.M. 1997/Assess:13) the Study Group finds the need for further deep-sea hauls (>500) in future surveys. Furthermore, it is important prior to the survey to investigate the possibilities of applying narrow beam transducers, and new development in technology, in order to give an estimate of fish deeper than 500 meters.

NEAFC requests ICES for advice on an appropriate monitoring scheme for the pelagic fishery for *S.mentella* in the Irminger Sea considering current knowledge of the stock complexity.

The different countries currently participating in the pelagic *S.mentella* fishery in the Irminger Sea have their own national programs for biological sampling and collection of fishery data but with varying degree of completeness.

The following give an overview of the different nations current sampling programs:

In addition to the national sampling program of commercial catches, data from the **German** fishery have been collected within the frame of an EU-financed project since 1995 applying an effort of one man-month per quarter. Data recordings are performed on board fishing vessels and have provided information on effort, catch, CPUE, fish size, sexual composition, maturity and infestation rates by area, year, quarter and depth.

Spain national sampling program of commercial catches in Irminger Sea started in 1995 when Spanish trawlers begun to fish in the area. The effort of the sampling was high in 1995 and reduced to a man-month to cover the four vessels operating in Irminger Sea in 1996. The observer move every month and a half to a different vessel, thus samples from two vessels are taken every quarter. Data have provided information on effort, catch, CPUE, fish size, sexual composition, maturity and infestation rates by area, year, quarter and depth. Difficulties came from the fact that usually in the beginning of the year the Spanish commercial vessels move from NAFO areas to Irminger Sea directly and therefore it is not possible to place an observer onboard.

Icelandic national biological sampling program from catches in the Irminger Sea, conducted both by fishermen and observers onboard, have been ongoing since 1995. Samples are collected by depth and analysed by the Marine Research institute (length, weight, sex, maturity, infestation rate etc.). In addition, all Icelandic vessels participating in the fishery provides information about the vessels, their gear, effort, catch, depth, and environmental observations. Those data are all available on a computer system on haul basis and the reported catches in the logbooks counts for 80-90% of the landings. In 1997 and also in 1998, program is ongoing to measure discards by depth and the results from 1997 are presented in section 7.4.

At present there is no national **Russian** project to monitor the pelagic fishery for the redfish in the Irminger Sea. Nevertheless 1-2 scientific observers from the Research Institutes in Murmansk and Kaliningrad collect the biological data onboard of commercial trawlers every year.

Norway and **the Faroes** have at present no sampling program for their fishery in the Irminger Sea. In addition to catch statistics (based on both landings and log-books) information about e.g., catch, effort and geographical position based on log-books are the only data provided. In the Faroes logbooks start and stop depth are recorded for every trawl haul, while in the Norwegian log-books a code for the depth-interval (less than 500 m, 500-600 m or deeper than 600 m) is recorded.

For **other countries** only total landings statistics for the total area are available.

The Working Group see an urgent need for a stronger scientific monitoring of this fishery and has come up with the following recommendation :

- A scientific observer program should be developed to cover as good as possible the effort exerted in the area. An observer program is considered necessary to provide necessary and good quality information about catchrates (CPUE), improved biological sampling by depth, improvement and documentation of the conversion factors used to convert fillets or gutted weight to round weight, and to report the amount and size of the fish discarded.
- It is considered necessary to have observers onboard the commercial vessels. One man-month by nation, fleet and quarter is required as a minimum.
- The observer should move, if possible also at sea, between vessels to have a better estimation of catch, effort and CPUE.
- For each vessel sampled the observer should collect data for estimation of the conversion factor for the different fish products.
- Length measurements of the catch should be made regularly, especially if there is a shift in the fishery behaviour of the vessel (shift in common tow depth, change of area etc.)
- Biological data should be collected, especially otoliths, maturation, sex composition and recording of parasite infestation.
- Minimum and maximum fishing depth together with the dominating trawling depth should be recorded for each haul. It is most important that this depth information is recorded in the official log-books.

7.4 Nominal Catches and Splitting of the Landings in Stocks

7.4.1 Nominal catches of Redfish by countries and areas

The total catch of redfish in 1997 approximated 80,000 t excluding the catch figures from the oceanic *S. mentella* fishery and was almost identical with the catch in 1996. The catches in last years have decreased from a level of 120–130,000 t in 1991–1994. The decrease in the last years is caused by a decreased catch of both *S. marinus* and deep-sea *S. mentella* in Division Va, due to effort reduction and because of reduction in the German deep-sea *S. mentella* fishery in Sub-area XIV in 1994.

The preliminary reported landings of oceanic *S. mentella* in 1997 are about 120,000 t, compared with over 175,000 t in 1996. Thus the total catch of redfish in the area amounts to about 200,000 t in 1997 compared to about 255,000 t in 1996.

In Division Va (Iceland), the total redfish landings reached 87,600 t including 15,000 t of oceanic *S. mentella*. Apart from the oceanic *S. mentella* landings, the catches in Division Va remained relatively stable from 1988–1995 at 92,000-97,000 t then have decreased in 1996 and 1997 (Tables 7.4.1–7.4.2), manly due to quota regulations.

In Division Vb (Faroes) (Tables 7.4.3–7.4.4) the largest redfish catch was taken in 1986 (21,000 t). Since then catches have decreased steadily to about 12,000 t in 1990 but increased again to about 15,000 and 16,000 t in 1991 and 1992, respectively. Since then catches have decreased to about 7-8,000 t in 1994–1997.

Landings from Sub-area VI increased from 1992 - 1996, mainly due to a reported increase in the UK redfish landings (Tables 7.4.5–7.4.6) and in 1996 the Faroes also report 550 t taken in that area. In 1997, reported catches were 500 t. The catches have not been sampled but it is expected that the UK catches are probably *S. marinus*, and the Faroes catches are assumed to be deep-sea *S. mentella*.

All landings from Sub-area XII are oceanic *S. mentella* taken by large pelagic trawl (Tables 7.4.7-7.4.8) except about 76 t of "Giant" *S. marinus* taken by longliners and gillnet in 1996 and 21 t in 1997. There are many nations participating in the oceanic redfish fishery not reporting to ICES. Therefore data from NEAFC and FAO have been used to estimate the catches of oceanic redfish. FAO and NEAFC do not split the catches according to the ICES areas and therefore the working group decided to allocate those catches to Sub-area XII.

The highest landings from Sub-area XIV were reported in 1996, having reached 135 000 t (Tables 7.4.9–7.4.10). After high levels in 1987-88 (90-95,000 t), landings dropped to about 25,000 t in 1989 before increasing to almost 60,000 t in 1994. Data for 1995 show a decrease to about 43,000 t. This decline is mainly caused by a decrease in the German deep-sea *S. mentella* fishery due to redirected effort to other resources but also due to a shift of in the oceanic *S. mentella* fishery towards Sub-area XII. Some of the "giant" *S. marinus* catches in 1996 and 1997 (approximately 830 t and 22 t respectively) were taken in Division XIV. It should be noted that due to incomplete area-reportings of oceanic *S. mentella*, the exact share taken in areas XII and XIV in recent years is just an approximate Of the total landings from this area in 1997, about 99% were oceanic *S. mentella*.

In order to have the catch statistics for the international fishery of *S.mentella* in the Irminger Sea as complete and updated as possible (also by depth) in advance of the North Western Working Group meeting every year, the Working Group recommends ICES to put forward a formal request both to NEAFC and FAO to send their statistics as a routine to ICES since not all countries report directly to ICES. Otherwise the quality of the advice from ICES may be of reduced quality.

7.4.2 Splitting of the catches

As in recent years, the redfish catches in Division Va were split into *S. marinus* and *S. mentella*, using both data from log-books and data collected by the staff of the Icelandic Marine Research Institute The split is basically based on the idea to separate the catches by stratum according to the ratio of *S. marinus/S. mentella* as observed in samples from the same stratum. Each stratum is defined by 15 min Latitude and 30' Longitude.

The following data were used:

1. Samples from the fresh-fish trawlers taken by the Marine Research Institute (MRI) and the Icelandic Catch Supervision (ICS) personnel.
2. Landing statistics from Germany.
3. Information on landed products from freezer trawlers.
4. Logbook data.
5. Landing statistic from the different fleets.

Splitting of catches from freezer trawlers:

In the freezer fleet, the products are usually labelled according to species. Reliable data on this basis are available from 1993 to 1997, and assuming that the species composition is the same in the split and unsplit catches, the total catches were split according to the products.

Splitting of the catches from the fresh fish trawlers:

i. For each year: The catches from each year were pooled into rectangles (15 min. Latitude by 30 min. Longitude) and scaled to the total unsplit catch of the two species for each rectangle. It is therefore assumed that the distribution of catches not reported in logbooks was the same as those in the reported catches. Catches taken by other gears were included (about 2% of total catch). All catches and hauls taken by the freezer trawlers were excluded as well as hauls taken in trips where the trawlers landed in Germany.

ii. For each stratum and each year: The samples taken were used to split the catches according to the average composition in the samples and raised to the total catches from that fleet. If no information on the species composition in strata for a year were available, the composition in ± 1 year, ± 2 years (max. 5 years) were used. If there were no observations in the period from 1988 to 1996, the splitting was done according to depth and the captain's experience. Only a small proportion of the catches were split using the last criteria.

The landings in Germany are split at the market and reported.

The results are given in the following text table:

Type of fleet	% *S. marinus*	% *S. mentella*
A. Freezer vessels	29.7	70.3
B. Landings in Germany	32.3	67.7
C. Landings in Iceland (excluding from freezer vessels).	68.9	31.1
Results (weighted by catch)	**48.8**	**52.2**

The splitting values (%) between *S. marinus* and deep sea *S. mentella* for the years 1992–1997 are given in the following text table:

Year	Results from 1992–1997 (%)	
	S. marinus	*S. mentella*
1992	54.00	46.00
1993	46.96	53.04
1994	40.40	59.60
1995	46.40	53.60
1996	48.90	51.10
1997	48.80	52.20

For other areas and divisions, catches were split according to information from different laboratories (Tables 7.4.11-7.4.12).

7.4.3 CPUE

As early as 1978, Magnússon and Magnússon (1978) indicated that the proportion of *S. marinus* and *S. mentella* is highly dependent on depth and stated that redfish catches in waters deeper than 500 m, were >80% *S. mentella*. Also, they noted that catch percentages of *S. mentella* in waters shallower than 450 m were less than 20% in the SW area where most of the catches were taken. The same conclusion was reached in studies of samples taken by the Marine Research Institute (MRI) and the Icelandic Catch Supervision (ICS) in the period 1988 - 1997. This would suggest that CPUE in redfish can be split into CPUE for *S. mentella* and *S. marinus*, by depth.

Therefore, the CPUE for the Icelandic bottom trawl fleet for different depth intervals was calculated for the period 1986 to 1997.

The results are given in Figure 7.4.1. The CPUE indices are computed by simply aggregating tows where the percentage of redfish in each tow is above a certain level. This level corresponds to 10% (Figure 7.4.1). Knowing that *S. marinus* is rarely caught at depths deeper than 500 m, it is assumed that these results give a CPUE for *S. mentella*.

Similarly, it is assumed that for the redfish fishery at water depths shallower than 500 m, the calculated CPUE reflects a CPUE for *S. marinus*.

Catch and effort statistics were also available for the Faroes fishery of *S. mentella* in Vb.

7.5 Juvenile Redfish

7.5.1 Recruitment indices

7.5.1.1 Icelandic 0-group survey

Indices for 0-group redfish in the Irminger Sea and at East Greenland are available from the Icelandic 0-group surveys from 1970 - 1995 (Table 7.5.1). In 1972, 1973 and 1974 the indices were well above the overall average of 14.8 suggesting good year classes in those years. During the ten-year period 1975–1984 the indices were below average in all the years, particularly in 1976 and from 1978–1984. Values were high in 1985, 1987, 1990, 1991 and in 1995 the index was 13.9 near the average.

Although the indices in 1986 and 1989 were slightly below average the indices suggest generally strong year classes from 1985 to 1991 (with an average index of 19.8 for that period) following a period of poor values (1975–1984, average index 5.9). In 1992–1994 the indices were below the overall average. The survey was discontinued after 1995.

7.5.1.2 Icelandic Groundfish survey

The Icelandic groundfish survey, which covers depths to 500 m, provides indices of the recruitment to the *S. marinus* stock. Age determinations are not available, but length distributions from the survey are given in Figure 7.5.1. The points in each plot represent the individual data points in terms of frequency. The solid lines represent smooth curves drawn through the scatterplot using a generalised additive model (GAM) with several degrees of freedom. Year classes can be seen in these plots and it is also seen that the recruitment to the *S. marinus* stock is quite variable, but there is no indication of any recruitment failure in recent years. The length distributions also illustrate the diminishing number of large fish in the latest years and the recruitment of probably year-class 1985 to the fishable stock and the (probably) 1990 year class with an average length around 27 cm in 1998.

7.5.1.3 German Groundfish Survey

Abundance, biomass indices and length compositions have been derived using annual groundfish surveys covering shelf areas and the continental slope off West and East Greenland down to 400 m depth. Surveys commenced in 1982 and were primarily designed for the assessment of cod. A description was given in chapter 5.1.1 and more detailed in the 1993 report of the North Western Working Group (ICES, 1993) and Working Doc. 12. Juvenile redfish (<17 cm) were classified as *Sebastes spp.* due to difficult species identification.

Trends in survey abundance and biomass for juvenile redfish (<17 cm) broken down by stratum at West and East Greenland were listed in Tables 7.5.2 and 7.5.3. Respective values were shown in Figures 7.5.2 and 7.5.3. Small and unspecified redfish are very abundant and were distributed both off West and East Greenland. A lack of these size groups during the years 1982-84 might be caused by irregular recording of catches. Since 1993 when the indices showed a pronounced peak, both survey abundance and biomass decreased.

Length distributions were illustrated in Figures 7.5.4 and 7.5.5 aggregated for West and East Greenland. Peaks at 6.5, 10.5–12.5 and 15.5–16.5 cm re-occurred frequently and might indicate the length of age groups 0-2.

7.5.1.4 Greenland Trawl Survey

Juvenile redfish are caught both off West and East Greenland during the Greenland trawl survey, which are available from 1992 off West Greenland and from 1992 – 1996 off East Greenland. The Survey is directed towards shrimp. The survey design covers the depth range 0-600 m. The survey gear used is a Skjervoy 3000/20 trawl with a bobbin groundrope and a new double-bag 20 mm mesh size codend and the trawl doors were of the type 'Perfect'. Standard hauls were of 60 min. duration with a towing speed of 2.5 knots. Trawling was restricted to the day light hours.

Juvenile redfish abundance and biomass are calculated by the swept area method in which tow lengths are calculated from GPS registrations and wing-spread was taken as the average of Scanmar width measurements (20.7 m).

Table 7.5.4 and 7.5.5 describe the trends in survey abundance and biomass for juvenile redfish in the Greenland shrimp trawl survey broken down by stratum at West- and East Greenland. Off West Greenland, both abundance and biomass indices are quite variable.

Off East Greenland the survey indicate an increase in the stock abundance and biomass from 426 million individuals and 29,665 t in 1992 to 4.6 billion individuals and 160,719 t in 1996. East Greenland waters are usually sparsely covered on the Greenland Shrimp Survey due to difficult bottom topography and lack of major shrimp concentrations. Catch indices should therefore be considered with high uncertainty. The survey however has not indicated any sigh of significant stock declining of juvenile redfish during the past 6 years. Age determinations are not available, but length distributions from the survey are illustrated in Figure 7.5.6. Reappearing peaks at 6-7 cm and 12 cm are found at West Greenland and might indicate annual growth increments and represent the age 1 and 2 year groups. The survey was discontinued off East Greenland after 1996.

7.6 Discards of redfish

7.6.1 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.

The shrimp fishery at both West and East Greenland takes small redfish as a by-catch.

Samples from each major shrimp area have been collected since 1996 by observers from Greenland Fishery Licence Control in order to quantify and estimate the by-catches and length structure of redfish in the East Greenland shrimp fishery.

During the 1996 fishing season sampling was made on 7 different vessels in the period of November-December. In 1997 sampling was made on 1 vessel in March. The samples were used to calculate the average bycatch of redfish per kg shrimp catch and the average length distribution of redfish. Under the assumption that the average bycatch rates are representative for the whole shrimp fishing season, the total bycatch of redfish at East Greenland is estimated by raising with the total annual shrimp catch. The estimated bycatch and the sample fractions are listed in Table 7.6.1. The redfish length distribution of the estimated bycatch are illustrated on Figure 7.6.1 .

Bycatch of redfish off West Greenland was previously estimated at approximately 3,100 t (100 million individuals) related to an annual shrimp catch of about 50,000 t (ICES CM 1996/Assess:15).

7.6.2 Discards of Oceanic redfish

During the last years, Icelandic landings of oceanic redfish have been raised by 16% due to discards of redfish infected with *Sphyrion lumpi*. This value of 16% 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. A total of 115 samples were taken and the total number of fishes was more than 28 thousand. fishes (Table 7.6.2), and the length distribution from different depth intervals are given in Figure 7.6.2. The results indicate a lower discard rate than previously and the total discard rate was estimated to be 10%. This new value was used for raising the Icelandic catches of oceanic redfish, as reported officially in the two last years. Prior to 1996, the same value was used as used previously.

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.

7.6.3 Regulations of small redfish bycatch 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 protections:

- legislate the mandatory use of a "fish grid or grate" as is the case in the Barents Sea and in Icelandic waters.

- 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 7.4.1. REDFISH. Nominal catches (tonnes) by countries, in Division Va 1984-1997, as officially reported to ICES.

Country	1984	1985	1986	1987	1988	1989	1990
Belgium	291	400	423	398	372	190	70
Faroe Islands	686	291	144	332	372	394	624
Germany, Fed. Rep.	-	-	-	-	-	-	-
Iceland	108,270	91,381	85,992	87,768	93,995	91,536	90,891
Norway	12	8	2	7	7	1	-
Total	109,259	92,080	86,561	88,505	94,746	92,121	91,585

Country	1991	1992	1993	1994	1995	1996	1997[1]
Belgium	146	107	96	50			-
Faroe Islands	412	389	438	202	521	309	242
Germany, Fed. Rep.	-	-	-	46	229	233	-
Iceland[2]	96,770	94,382	96,577	95,091	89,474	67,757	71,200
Norway	-	-	-	-	-	134[1]	-
Total	97,328	94,878	97,111	95,389	90,224	68,433	71,442

1) Provisional
2) Oceanic *S. mentella* not included

Table 7.4.2 Landings of REDFISH (in tonnes) by countries in Division Va as used by the Working Group.

Year	Belgium	Faroes	FRG	Iceland	Norway	Total
1978	1,549	242		33,318	93	35,202
1979	1,385	629		62,253	43	64,310
1980	1,381	1,055		69,780	33	72,249
1981	924	1,212		93,349	32	95,517
1982	283	1,046		115,051	11	116,391
1983	389	1,357		122,749	32	124,527
1984	291	686		108,270	12	109,259
1985	400	291		91,381	8	92,080
1986	423	253		85,992	2	86,670
1987	398	332		87,768	7	88,505
1988	372	372		94,011	7	94,762
1989	190	394		91,536	1	92,121
1990	70	624		90,891	0	91,585
1991	146	412		96,770	0	97,328
1992	107	389		96,350 [2]	0	96,846
1993	96	438		99,180 [3]	0	99,714
1994	50	202	46	110,563 [4]	0	110,861
1995	0	521	229	91,017 [5]	0	91,767
1996	0	309	233	72,367 [6]	0	72,909
1997 [1]		242	0	87,599 [7]	0	87,841

1 Provisional data
2) Including 1968 tonnes oceanic *S. mentella.*
3) Including 2603 tonnes oceanic *S. mentella.*
4) Including 15472 tonnes oceanic *S. mentella.*
5) Including 1543 tonnes oceanic *S. mentella.*
6) Including 4610 tonnes oceanic *S. mentella.*
7) Including 15253 tonnes oceanic *S. mentella.*

Table 7.4.3 REDFISH. Nominal catches (tonnes) by countries, in Division Vb 1982-1997, as officially reported to ICES.

Country	1982	1983	1984	1985	1986	1987	1988	1989
Denmark	-	-	-	-	36	176	8	-
Faroe Islands	3,999	4,642	8,770	12,634	15,224	13,477	12,966	12,636
France	204	439	559	1,157	752	819	582	996
Germany, Fed. Rep. [2]	4,660	4,300	4,460	5,091	5,142	3,060	1,595	1,191
Iceland	1	-	-	-	-	-		21
Norway	7	3	1	4	2	5	5	-
UK (Engl. and Wales)	-	-	-	-	-	-		-
USSR	-	-	142	-	-	-		
Total	8,871	9,384	13,932	18,886	21,156	17,537	15,156	14,844
Country	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997 [1]**
Denmark	+	-	-	-	-	-	-	-
Faroe Islands	10,017	14,090	15,279	9,687	8,872	7,978	7,286	7,216
France[1]	909	473	114	32	90	111	62	30
Germany, Fed. Rep. [2]	441	447	450	239	155	91	189	36
Norway	21	20	34	16	31 [1]	34	35 [1]	25
UK (E/W/NI)	-	2	21	28	1	2	40	.....
UK (Scotland)	+	1	8	1	18	24	43	....
United Kingdom								36
USSR/Russia [3]	-	-	15	44	3			3 [4]
Total	11,388	15,033	15,921	10,047	9,170	8,240	7,655	7,346

1) Provisional
2) Includes former GDR
3) As from 1991.
4) Reported to the Faroese Coastal Guard Service

Table 7.4.4 Landings of REDFISH (in tonnes) by countries in Division Vb as used by the Working Group.

Year	Denmark	Faroes	France	FRG	Iceland	Lithuania	Norway	Nederl	UK	Russia [2]	Total
1978	0	1,525	448	7,767	0		9	0	57	0	9,806
1979	0	5,693	862	6,108	0		11	0	0	0	12,674
1980	0	5,509	627	3,891	0		12	0	0	0	10,039
1981	0	3,232	59	3,841	0		13	0	0	0	7,145
1982	0	3,999	204	5,230	1		7	0	0	0	9,441
1983	0	4,642	439	4,300	0		3	0	0	0	9,384
1984	0	8,770	559	4,460	0		1	0	0	142	13,932
1985	0	12,634	1,157	5,091	0		4	0	0	868	19,754
1986	36	15,224	752	5,142	0		2	0	0	320	21,476
1987	176	13,478	819	3,060	0		5	0	0	0	17,538
1988	8	13,318	582	1,595	0		5	0	0	0	15,508
1989	0	12,860	996	1,191	0		21	0	0	0	15,068
1990	0	10,364	909	441	0		21	0	0	2	11,737
1991	0	14,090	473	447	0		20	0	3	4	15,037
1992	0	15,279	114	450	0	4	35	35	39	47	16,003
1993	0	10,040	32	239	0	0	16	22	29	44	10,422
1994	0	7,978	90 [3]	155	0	0	31	0	19	3	8,276
1995	0	7,286	111 [3]	91	0	0	34	0	26	9 [3]	7,557
1996	0	7,286	62 [3]	189	0		35		83	0	7,655
1997	0	7,216	30 [3]	36	0		25		36	3 [3]	7,346

1 Provisional data.
2 USSR 1978-1991, Russia since1992.
3 Reported to Faroese costal guard service.

Table 7.4.5 REDFISH. Nominal catches (tonnes) by countries, in Sub-area VI 1982-1997, as officially reported to ICES.

Country	1982	1983	1984	1985	1986	1987	1988	1989
Faroe Islands	-	-	19	18	-	-	1	61
France	44	93	102	397	480	1,032	1,024	726
Germany, Fed. Rep.	604	359	563	76	24	-	16	1
Ireland	-	-	-	-	-	-	-	-
Norway	4	2	9	-	14	2	1	2
Spain	-	2	-	-	-	-	-	
UK (Engl. and Wales)	2	-	1	1	2	3	75	1
UK (Scotland)	-	-	1	-	10	17	6	6
Total	654	456	695	492	530	1,054	1,123	797

Country	1990	1991	1992	1993	1994	1995	1996	1997 [1]
Faroe Islands	-	22	6	-	-	2		
France [1]	684	483	127	268	555	596	558	
Germany, Fed. Rep.	6	8	-	77	87	5	9	1
Ireland	-	-	1	1	-	4		
Norway	5	+	4	3	2 [1]	8 [1]	6 [1]	5
Spain								
UK (E/W/NI)	29	12	4	4	9	105	54	
UK (Scotland)	6	40	32	94	118	500	603	
United Kingdom								533
Total	730	565	174	447	771	1,220	1,230	539

1) Provisional

Table 7.4.6 Landings of REDFISH (in tonnes) by countries in Sub-area VI as used by the Working Group.

Year	Faroes	France	FRG	Ireland	Norway	Spain	UK	Total
1978	0	307	18	0	4	0	2	331
1979	1	215	604	0	4	0	1	825
1980	0	202	907	0	2	0	0	1,111
1981	0	24	983	0	3	1	0	1,011
1982	0	44	604	0	4	0	2	654
1983	0	93	359	0	2	2	0	456
1984	19	102	563	0	9	0	2	695
1985	18	397	76	0	0	0	1	492
1986	0	480	24	0	14	0	12	530
1987	0	1,032	0	0	2	0	20	1,054
1988	1	1,024	16	0	1	0	81	1,123
1989	61	726	1	0	2	0	7	797
1990	0	684	6	0	5	0	35	730
1991	22	483	8	0	+	0	52	565
1992	6	127	0	1	4	0	36	174
1993	0	268	77	1	3	0	98	447
1994	0	555	87	0	2	0	127	771
1995	2	596	5	4	8	0	605	1,220
1996	550	558	9		6		657	1,780
1997 [1]	0		1		5		533	539

1) Provisional

Table 7.4.7 REDFISH. Nominal catches (tonnes) by countries, in Sub-area XII 1983-1997, as officially reported to ICES and/or FAO.

Country	1983	1984	1985	1986	1987	1988	1989
Bulgaria	-	-	-	-	-	-	-
Estonia	-	-	-	-	-	-	-
Faroe Islands	-	-	-	-	-	-	-
Germany, Fed. Rep.	2,209	-	-	-	-	-	353
Germany, Dem. Rep.	-	-	-	-	-	-	-
Greenland	-	-	-	-	-	-	567
Iceland	-	-	-	-	-	-	-
Latvia	-	-	-	-	-	-	-
Lithuania	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-
Poland	-	-	-	-	-	-	112
UK (Scotland)	-	-	-	-	-	-	-
Ukraine	-	-	-	-	-	-	-
USSR	60,079	60,643	17,300	24,131	2,948	9,772	15,543
Total	62,288	60,643	17,300	24,131	2,948	9,772	16,575

Country	1990	1991	1992	1993	1994	1995	1996	1997[1]
Bulgaria	1,617	-	628	3,216	3,600	3,800	3,500	
Estonia	-	-	1,810	6,365	17,875	421	4,697	1,985
Faroe Islands	-	-	-	4,026	2,896	3,467	3,127	1,400
Germany' Fed. Rep.[3]	7	62	1,084	6,459	6,354	9,673	4,391	8,866
Greenland	-	-	9	710	-	1,856	3,537	
Iceland	185	95	361	8,098	17,892	19,577	3,613	1,130
Latvia	-	-	780	6,803	13,205	5,003	1,084	
Lithuania	-	-	6,656	7,899	7,404	22,893	10,649	
Netherlands	-	-	-	-	-	13		
Norway	249	726	380	5,911	4,275	4,593[1]	1,010	2,699
Poland	-	-	-	-	-			662
Spain						20	410	
UK(E/WNI)							33	
UK(Scotland)							13	
UK	-	-	-	+	-			+
Ukraine	-	-	-	2,782	5,561	3,185	518	
USSR/Russia[2]	4,274	6,624	2,485	4,106	10,489	34,730	606	
Total	6,332	7,507	14,193	56,375	89,551	109,231	37,188	16,742

1) Provisional
2) As from 1991.
3) Includes former GDR

Table 7.4.8 Landings of REDFISH (in tonnes) by countries in Sub-area XII as used by the Working Group. All catchfigures taken from FAO are set to this Division.

Year	Bulgaria[8]	Canada	Estonia[8]	Faroes	France	FRG[4]	Greenland	Iceland	Japan	Latvia	Lithuania[8]	Nederland	Norway	Poland	Ukraine[8]	Russia[3]	Spain	UK	Total
1981	0		0		0	0	0	0					0	0		0			0
1982	0		0		0	0	0	0					0	0		39,783			39,783
1983	0		0		0	0	0	0					0	0		60,079			60,079
1984	0		0		0	0	0	0					0	0		60,643			60,643
1985	0		0		0	0	0	0					0	0		17,300			17,300
1986	0		0		0	0	0	0					0	0		24,131			24,131
1987	0		0		0	0	0	0					0	0		2,948			2,948
1988	0		0		0	0	0	0					0	0		9,772			9,772
1989	0		0		0	353	0	658 [5]					0	112		15,543			16,666
1990	1,617		0		0	7	0	215 [5]					926 [2]	0		4,274			7,039
1991	0		2,195		0	370	0	110 [5]					762 [2]	0		6,624			10,061
1992	628		1,810		2	1,280	9	419 [5]		780	6,656		399 [2]	0		11,266			23,249
1993	3,216		6,365	4,026	0	6,144	8	9,394 [5]		6,803	7,899		6207 [2]	0	2,782	18,669			71,512
1994	3,600		17,875	2,896	606 [6]	7,058	0	20,755 [5]		13,205	7,404		4292 [2]	0	5,561	10,489			93,741
1995	3,800	602 [7]	16,854 [8]	5,239	226 [6]	9,673	156	22,709 [5]	1,148	5,003	22,893	13	4731 [2]	0	3,185	32,730	20		128,982
1996	3,500	650 [7]	7,092	4,198		4,419	0	3,974 [5]	415	1,084	10,649		1039 [2]		518	606	500	260	38,904
1997 [1]		111	1,985	3,420	0	8,866	0	1,243 [6]	31				57 [2]	662		0	0		16,375

1 Provisional data.
2 Area and/or quantum adjusted according to official log-books and raised (by 5% prior to 1994 and 3% in 1994-1996) to account for discarding.
3 USSR 1981-1991, Russia since 1992.
4 Includes former GDR.
5 Raised by 16% to account for discarding from 1989- 1995 and by 10 % in 1996-1997.
6 As reported to Greenland
7 Taken in NAFO area 1F
8 As reported to FAO for the North East Atlantic.

Table 7.4.9 REDFISH. Nominal catches (tonnes) by countries, in Sub-area XIV 1983-1997, as officially reported to ICES and/or FAO.

Country	1983	1984	1985	1986	1987	1988	1989
Bulgaria	-	2,961	5,825	11,385	12,270	8,455	4,546
Denmark	-	-	-	-	-	-	-
Faroe Islands	27	-	-	5	382	1,634	226
Germany, Dem. Rep,	155	989	5,438	8,574	7,023	22,582 [4]	8,816 [4]
Germany, Fed. Rep.	28,878	14,141	5,974	5,584	4,691		
Greenland	1	10	5,519	9,542	670	42	3
Iceland	-	-	+	-	-	-	814
Norway	-	17	-	-	-	-	-
Poland	-	239	135	149	25	-	-
UK (Engl. and Wales)	-	-	-	-	-	-	5
UK (Scotland)	-	-	-	-	-	-	-
United Kingdom						-	-
USSR/Russia	-	-	42,973	60,863	68,521	55,254	7,177
Total	29,061	18,357	65,864	96,102	93,582	87,967	21,587

Country	1990	1991	1992	1993	1994	1995	1996 [1]	1997 [1]
Bulgaria	1,073	-	-	-				
Denmark	-	-	-	-				
Faroe Islands	-	115	3,765	3,095	164	8	298	40
Germany, Fed. Rep [4]	11,218	9,122	7,959	26,969	22,406	9,702	16,996	11,610
Greenland	24	42	962	264	422	2,936	2,699	
Iceland	3,726	7,477	12,982	11,650	29,114	8,947	49,381	36,390
Norway	6,070	4,954	14000	8,351	2,609 [1]	2,003 [1]	6,286 [1]	433
Poland								114
Portugal	-	-	-	-	1,887	5,125	2,379	3,644
Spain						4,534	3,897	
UK (E/W/NI)	39	219	178	241	138	48	247	
UK (Scotland)	3	+	28	8	4	10	6	
United Kingdom	-	-	-	-				28
USSR/Russia [3]	3,040	2,665	1,844	6,560	13,917	9,439	45,142	36,930
Total	25,193	24,594	41,718	57,138	70,661	42,752	127,331	89,189

1) Provisional data
2) Fished mainly by Japan
3) As from 1991
4) Includes former GDR

Table 7.4.10 Landings on REDFISH (in tonnes) by country in Sub-area XIV, as used by the working group.

Year	Bulgaria	Danmark	Faroes	FRG[5]	Greenland	Iceland	Japan	Norway	Poland	Portugal	UK	Russia[3]	Spain	Total
1978	0		0	20,711	3	151	0	2	0		13	0		20,880
1979	0		0	20,428	0	0	0	0	0		0	0		20,918
1980	0		0	32,520	0	89	0	0	0		0	0		32,609
1981	0		18	42,980	1	0	0	0	0		0	0		42,999
1982	0		0	42,815	0	17	0	0	581		0	20,217		63,630
1983	0		27	30,970	1	0	0	0	0		0	0		30,998
1984	2,961		0	15,130	10	0	0	15	239		0	0		18,355
1985	5,825		0	11,412	5,519	0	0	0	135		0	42,973		65,864
1986	11,385		5	14,158	9,542	0	0	0	149		0	60,683		95,922
1987	12,270		382	11,714	2,912	0	0	0	25		0	68,521		95,824
1988	8,455		1,634	22,582	3,751	0	0	0	0		0	55,254		91,676
1989	4,546		226	8,816	285	3,158[4]	307	0	0		5	7,177		24,520
1990	1,073		0	11,218	24	4,322[4]	3,450	6,159[2]	0		42	4,973		31,261
1991	0		115	10,028	42	8,673[4]	1,224	5,434[2]	0		219	2,665		28,400
1992	0		3,765	8,893	3,769	13,091[4]	0	14,322[2]	0		206	4,467		48,513
1993	0		3,095	26,404	264	10,911[4]	938	8,848[2]	0		249	5,496		56,205
1994			164	23,474	422	17,105[4]		2,665[2]		1,887	142	13,917		59,776
1995		14	10	9,702	400[6]	10,379[4]	89[6]	3,378[2]		5,125	58	9,452	4,535	43,142
1996		0	2,153	16,996	350[6]	54,319[4]		6,461[2]		2,379	253	45,142	6,729	134,782
1997[1]				11,581	192[6]	24,776[4]		3,161[2]	114	3,644	28	36,930	7,500	87,926

1) Provisional data.
2) Area and/or quantum adjusted according to official log-books catches and oceanic *S. mentella* raised by 5% prior to 1994 and 3% in 1994-1997 to account for discarding.
3) USSR 1978-1991; Russia since 1992.
4) Area and/or quantum adjusted according to official landings (by 16% prior to 1996 and 10% in 1996-1997) to account for discarding.
5) Includes former GDR
6) Estimated bycatch in the shrimfishery

Table 7.4.11. Proportions used for splitting the 1996 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.

Table 7.4.12. Proportions used for splitting the 1997 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. "Giant"	*S.mar.*	*S.ment.* deep-sea	*S.ment.* oceanic	*S.mar. "Giant"*
Bulgaria								1					
Belgium													
Canada								1.00					
Danmark													
Estonia								1.00					
Faroes	1.00			0.39	0.61	0.00	1.00	1.00				1.00	
France					1.00		1.00						
Germany					1.00		1.00	1.00				1.00	
Greenland								1.00		0.10	0.90		
Iceland	0.40	0.42	0.17					1.00				1.00	
Ireland													
Japan								1.00					
Latvia								1.00					
Lithuania													
Nederlands													
Norway				1.00	0.00	1.00	0.00	0.42	0.58	0.00		0.99	0.01
Poland												1.00	
Portugal												1.00	
Russia				1.00				1.00				1.00	
Spain								1.00				1.00	
Ukraine													
UK				1.00	0.00	1.00		1.00		0.10	0.90		

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

Table 7.5.1 Number of O- group REDFISH millions per nautical mile^2 from the Icelandic O- group survey.

Year	Number	Year	Number
1970	8.6	1984	4.3
1971	12.6	1985	22.6
1972	31.1	1986	12.1
1973	74.0	1987	22.9
1974	23.6	1988	17.0
1975	12.5	1989	14.3
1976	5.8	1990	23.5
1977	13.0	1991	26.4
1978	6.5	1992	11.6
1979	1.3	1993	4.0
1980	3.0	1994	5.8
1981	9.0	1995	13.9
1982	2.7		
1983	0.7		

Table 7.5.2 *Sebastes spp.* (<17 cm). Abundance indices (n*1000) for West, East Greenland and total by stratum as derived from the German groundfish survey, 1982-97. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling.

YEAR	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2	7.1	7.2	WEST	EAST	TOTAL	CI
1982	1057	358	121	27	8	42	22			152		607		1553	1635	2312	3947	44
1983	3956	505	14	138	9	17	21			92	8	1709		859	4660	2668	7328	56
1984	5021	3714	20	219	141	28	14		129			693		206	9157	(1028)	(10185)	67
1985	4889	9615	54	2712	47	67	55		817414	149899	210	5068		98	17439	972689	990128	164
1986	10740	237636	113	1811	54	218	38			2651	69	12312		5757	250610	20789	271399	168
1987	12455	113990	4		20		18		2343	2580	132	8961		123715	126487	137731	264218	87
1988	19679	42481	0	107	20	139	0		1579	2983	896	13064		18457	62426	36979	99405	41
1989	7717	13160	3071	5370	18		69		1331	3171	150	4274		2155	29405	11081	40486	36
1990	11256	35932	15417	1538	73		6199	848	2267	3183	482	13708		4358	71263	23998	95261	52
1991	51939	59845	34871	22668	13692	2508	892	1541	45453	3051	209	1708		622	187956	51043	238999	38
1992	25715	19084	12691	17277	17463	13973	41	13716						1373	119962	(1373)	(121335)	54
1993	5460	39035	664	11331	355	2773	14		3401243	2403634	244	810639		6009	59632	6621769	6681401	111
1994	3405	12002	9827	4013	1189	1731	10843	9867						57889	52877	(57889)	(110766)	95
1995					399	10236	855	34694	274128	2671933	4072	188899		3061	46184	3142093	3188277	106
1996	457	14357	5210	9377	26961	11571	2488	107237	405272	223348	1373189	2423		3071	177658	2007303	2184961	98
1997	6519	47117	0	15852	43421	20194	444	68931	225859	89354		374542		1372	202479	691127	893605	62

Table 7.5.3 *Sebastes spp.* (<17cm). Biomass indices (tons) for West, East Greenland and total by stratum as derived from the German groundfish survey, 1982-97. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling.

YEAR	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2	7.1	7.2	WEST	EAST	TOTAL	CI
1982	37	13	6	1	0	2	1			11		36		72	60	119	179	41
1983	103	21	1	6	0	1	1			5	0	73		17	133	95	228	51
1984	91	104	1	5	5	1	1		4			19		9	208	(32)	(240)	71
1985	82	367	2	58	2	3	1		15335	7129	6	200		5	515	22675	23190	142
1986	454	6645	3	77	2	6	1			123	3	218		73	7188	417	7605	168
1987	265	5021	0		1		0		147	137	4	288		6502	5287	7078	12365	93
1988	218	1491	0	4	1	5	0		67	144	42	618		1414	1719	2285	4004	56
1989	111	270	22	49	0		1		81	167	7	317		135	453	707	1160	42
1990	99	369	63	20	0		9	2	67	118	20	833		268	562	1306	1868	58
1991	198	797	73	242	29	24	2	15	563	94	4	63		34	1380	758	2138	46
1992	152	385	49	111	74	220	1	65						18	1057	(18)	(1075)	54
1993	72	512	17	265	6	77	1		51857	75676	12	48523		260	950	176328	177278	90
1994	26	216	55	57	30	64	141	277						2704	866	(2704)	(3570)	132
1995					6	330	10	347	3834	40792	46	9749		190	693	54611	55304	97
1996	3	285	13	117	91	297	19	3301	5840	10853	26882	135		171	4126	43881	48007	96
1997	61	344	0	214	163	544	15	2437	5017	2141		16112		73	3779	23344	27123	81

Table 7.5.4. Redfish (*Sebastes* spp.). Abundance indices (1000) for West and East Greenland as derived from the Greenland shrimp survey. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr.	CI
1992	7647	45740	6227	1032000	205200	55770	29050	5386	6528	1387698	66
1993	9222	28290	5838	408100	22430	173300	189900	660000	248500	1145834	58
1994	48530	89130	12470	1747000	357800	291200	102300	12740	118900	2768033	52
1995	56920	23260	10430	604800	55970	216300	95150	4592	5163	1062188	45
1996	2452	3956	5493	1980000	66080	118500	67390	10740	63060	2311710	58
1997											

Year	East1	East2	East3	East4	Eastgr.	CI
1992	19030	392400	13690	450	425555	162
1993	1546000	114200	5841	936	1667207	152
1994	-	1375000	15740	1509	1391792	107
1995	1241000	1642000	45740	782	2929167	73
1996	106200	4444000	30540	32320	4612889	123
1997						

Table 7.5.5. Redfish (*Sebastes* spp.). Biomass indices (tons) for West and East Greenland as derived from the Greenland shrimp survey. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr	CI
1992	279	490	329	13970	2928	1419	837	76	279	20278	56
1993	309	701	270	8117	330	1640	3997	1324	1289	17706	61
1994	1604	2138	451	17303	2912	4063	883	200	1519	30623	45
1995	1225	231	569	4178	1012	2618	1982	256	68	11569	47
1996	40	61	495	14879	1727	3015	2161	157	921	22962	55
1997											

Year	East1	East2	East3	East4	Eastgr.	CI
1992	2620	26670	343	32	29665	88
1993	69513	11643	144	128	81419	131
1994	-	48854	424	41	49319	99
1995	10296	51931	4703	53	66984	95
1996	1364	157888	879	588	160719	117
1997						

Table 7.6.1 Estimated bycatch in the Greenland shrimp fishery

Year	Number of fish discarted	Tons fish discarted	No. of samples	Sample fraction of fleet
1996	7.7 mill.	350	47	70%
1997	7.1 mill.	286	15	8%

Table 7.6.2. Oceanic redfish. Measuring of discard in the Icelandic fishery on oceanic redfish in 1997, by depth.

	Depth (m)						
Data	300-399	400-499	500-599	600-699	700-799	>800	Total
n. of fishes processed	988	987	868	5899	14008	2774	25524
n. of discarded fishes	119	187	88	1107	1122	309	2932
% discard	11%	16%	9%	16%	7%	10%	10%
stddev of % discard	10%	13%	4%	24%	19%	8%	
n. of samples	5	6	4	30	57	13	115

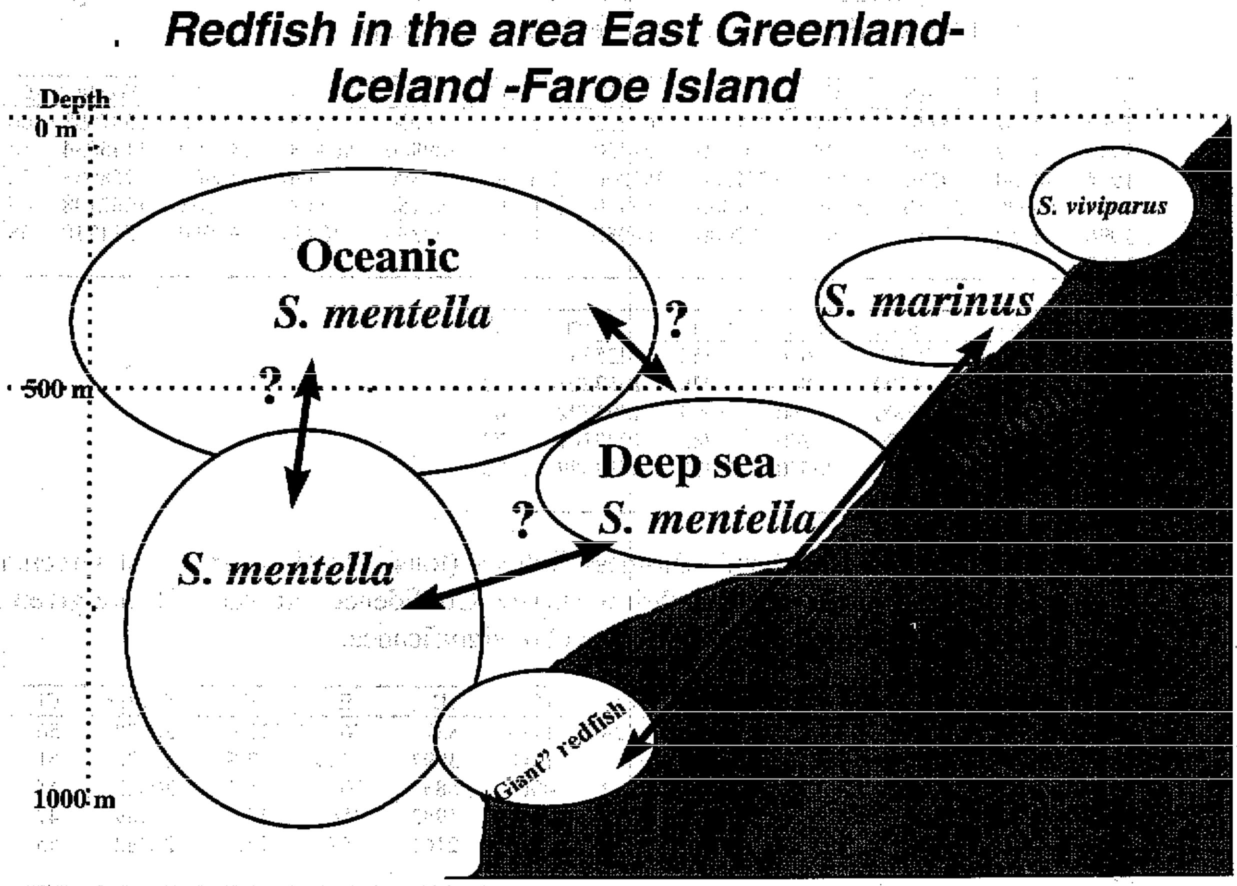


Figure 7.1.1 Schematically possible relationship between different stocks of redfish in the Irminger Sea and along the continental slope of E-Greenland-Iceland-Faroe Island.

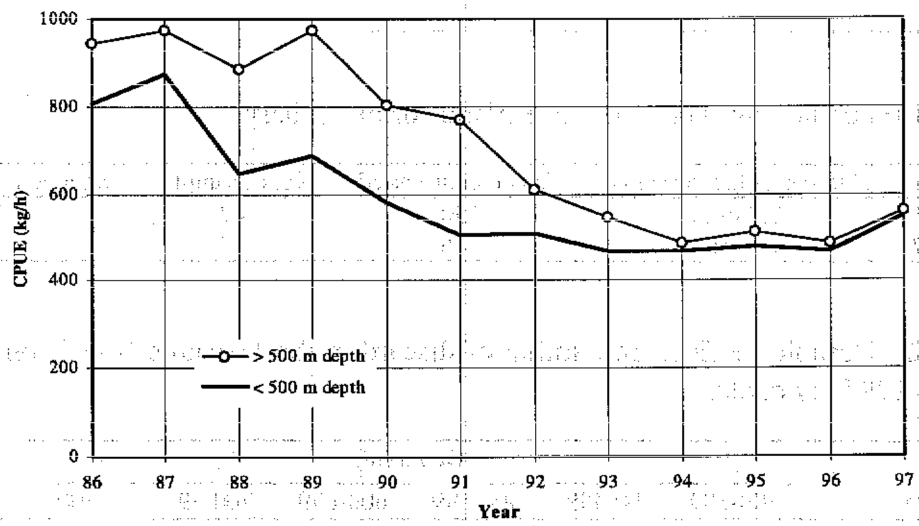


Figure 7.4.1. Results of CPUE from icelandic trawlers data at different depths, and where redfish is more than 10% of total catch in haul.

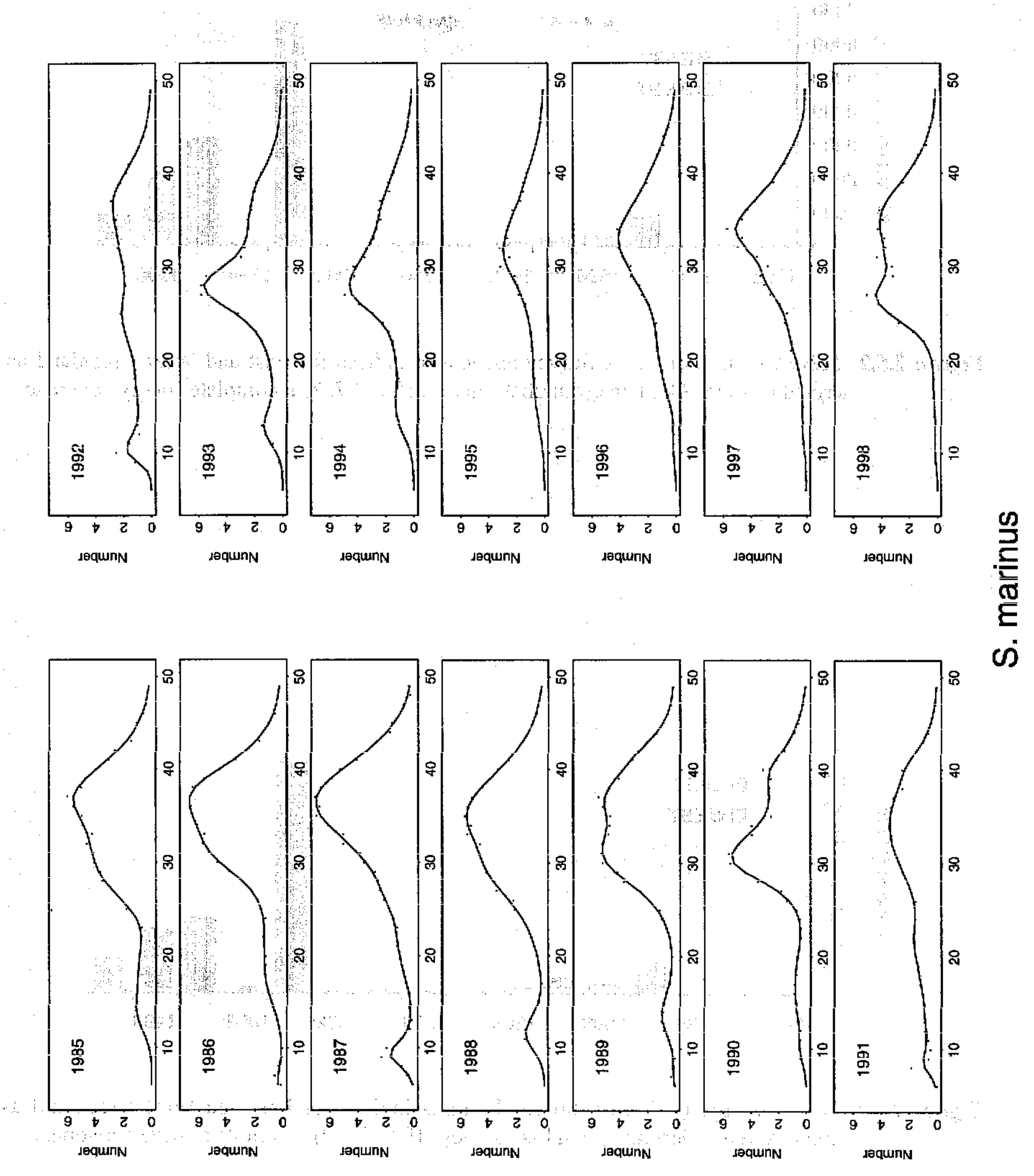


Figure 7.5.1. *S. marinus*. Length distribution from icelandic grounfish survey of 0-500 m depth range. Number of fish per towing mile by cm groups. All areas.

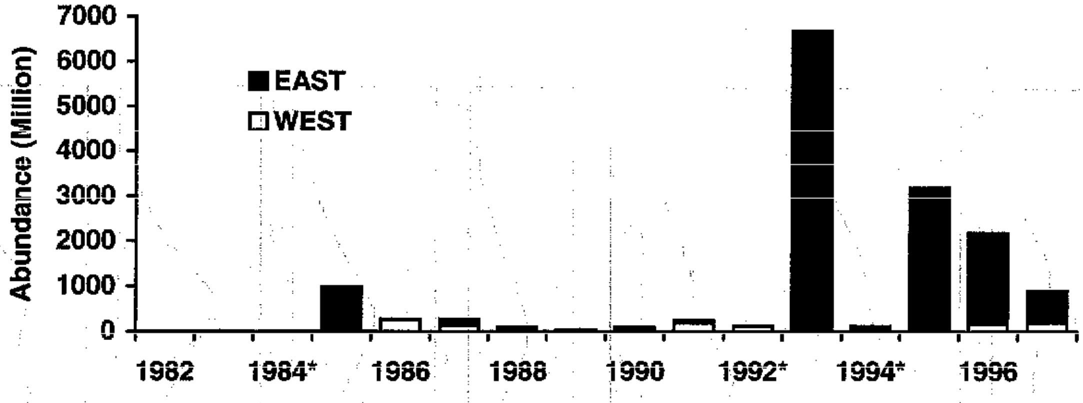


Figure 7.5.2 *Sebastes spp.* (<17 cm). Survey abundance indices for East and West Greenland as derived from the German groundfish survey, 1982-97. *) incomplete survey coverage.

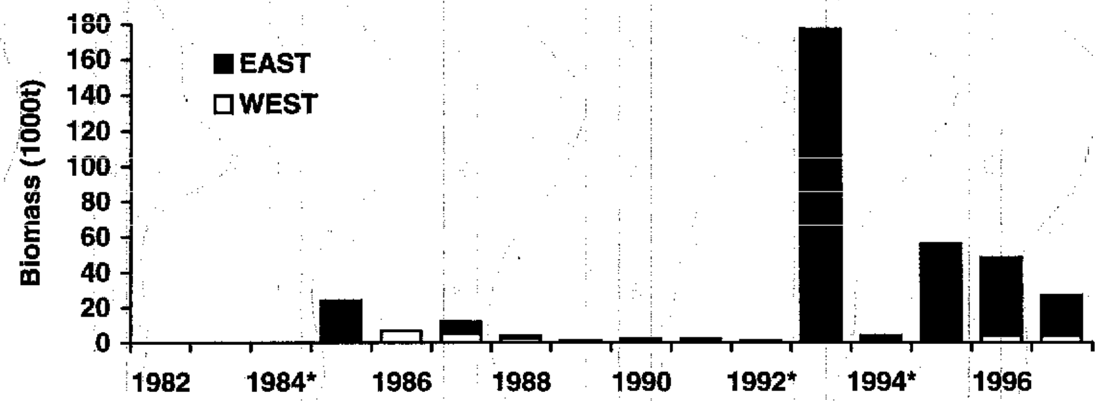


Figure 7.5.3 *Sebastes spp.* (<17 cm). Survey biomass indices for East and West Greenland as derived from the German groundfish survey, 1982-97. *) incomplete survey coverage.

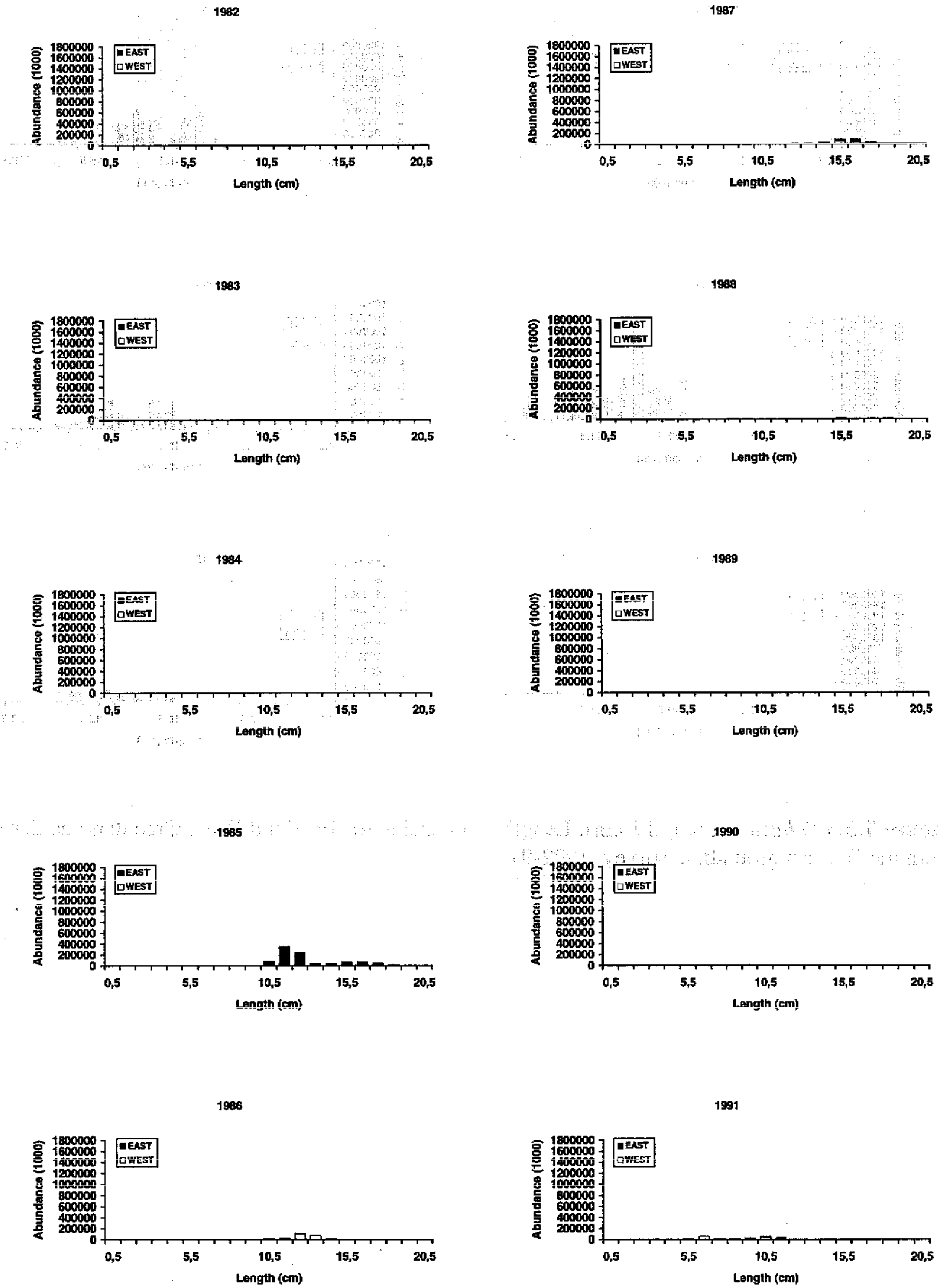


Figure 7.5.4 *Sebastes spp.* (<17 cm). Length frequencies for East and West Greenland as derived from the German groundfish survey, 1982-91.

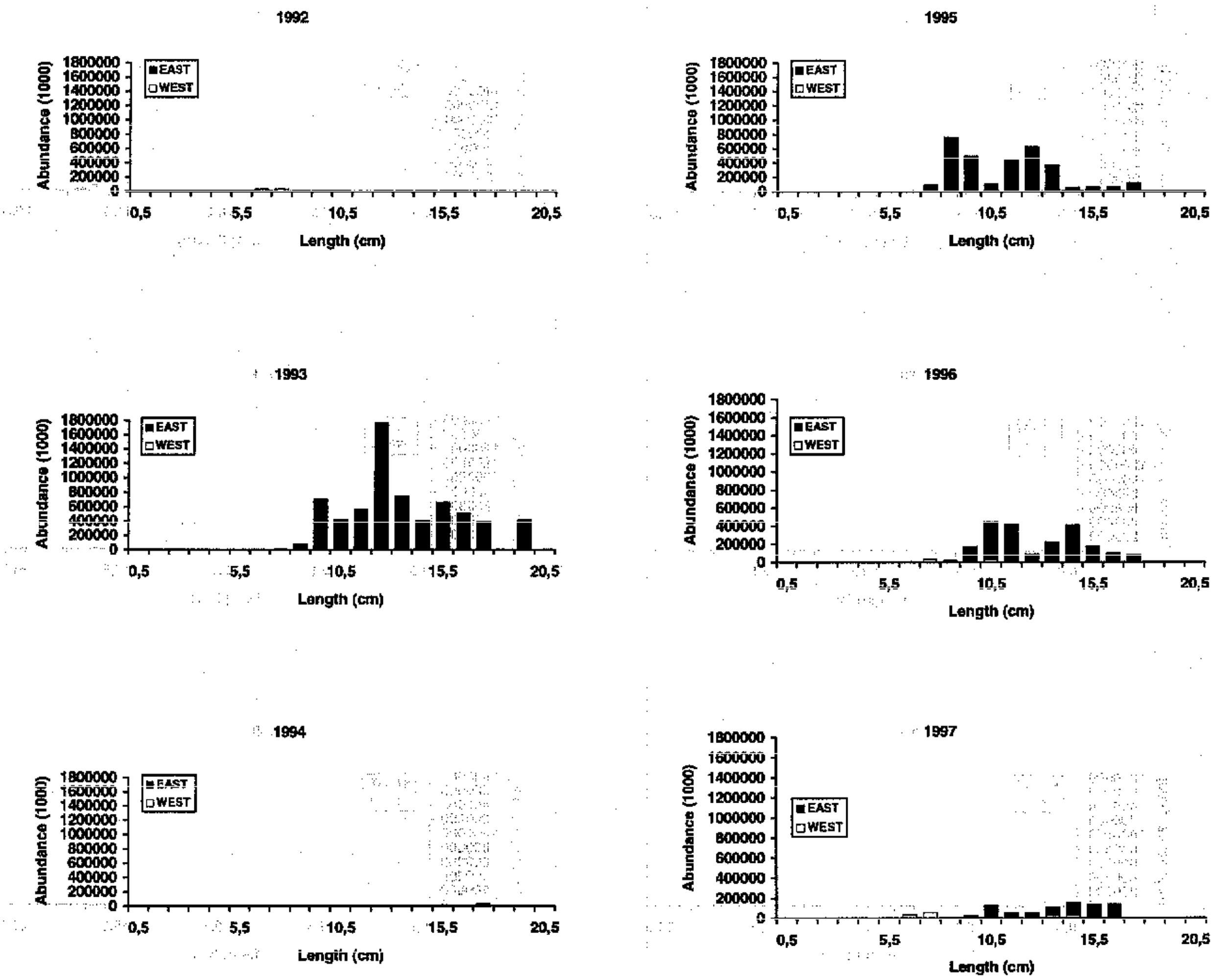


Figure 7.5.5 *Sebastes spp.* (<17 cm). Length frequencies for East and West Greenland as derived from the German groundfish survey, 1992-97

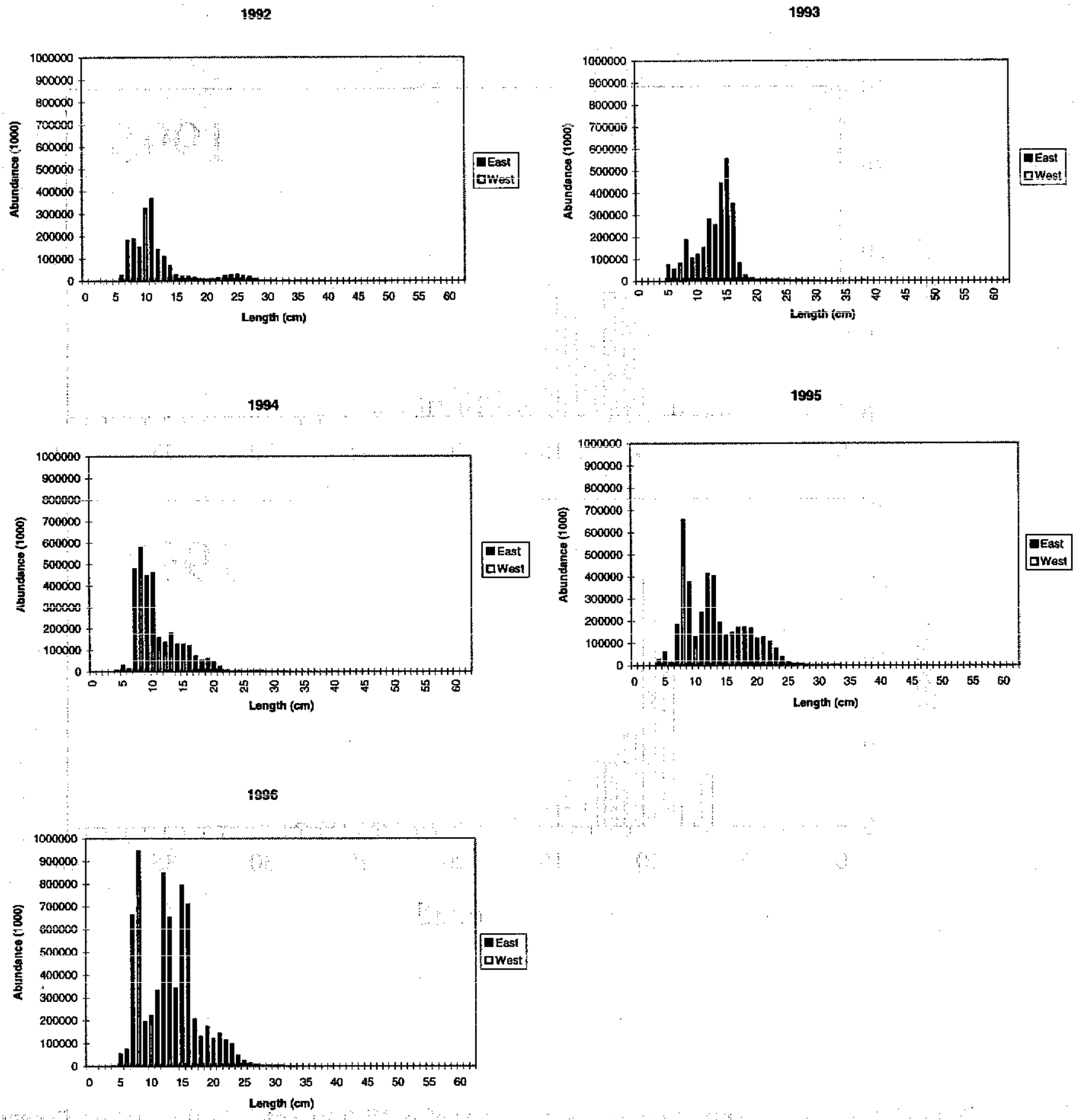


Figure 7.5.6. *Sebastes* spp. Length frequencies for East and West Greenland, 1992-1996 data from the Greenland Shrimp Trawl Survey.

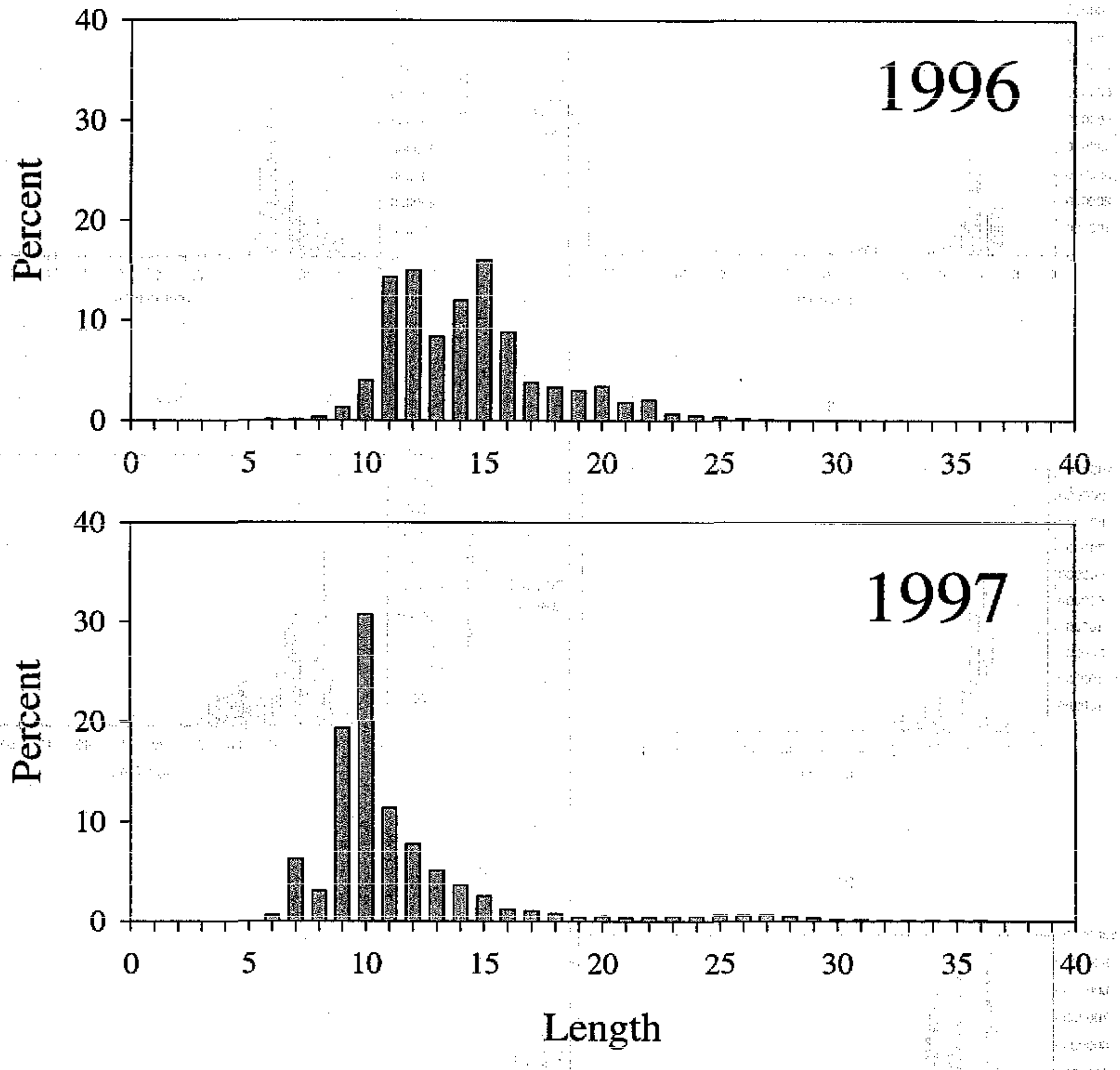


Figure 7.6.1 ***Sebastes*** **spp. Length distributions of redfish by-catch in the shrimp fishery in ICES XIVb, 1996-1997.**

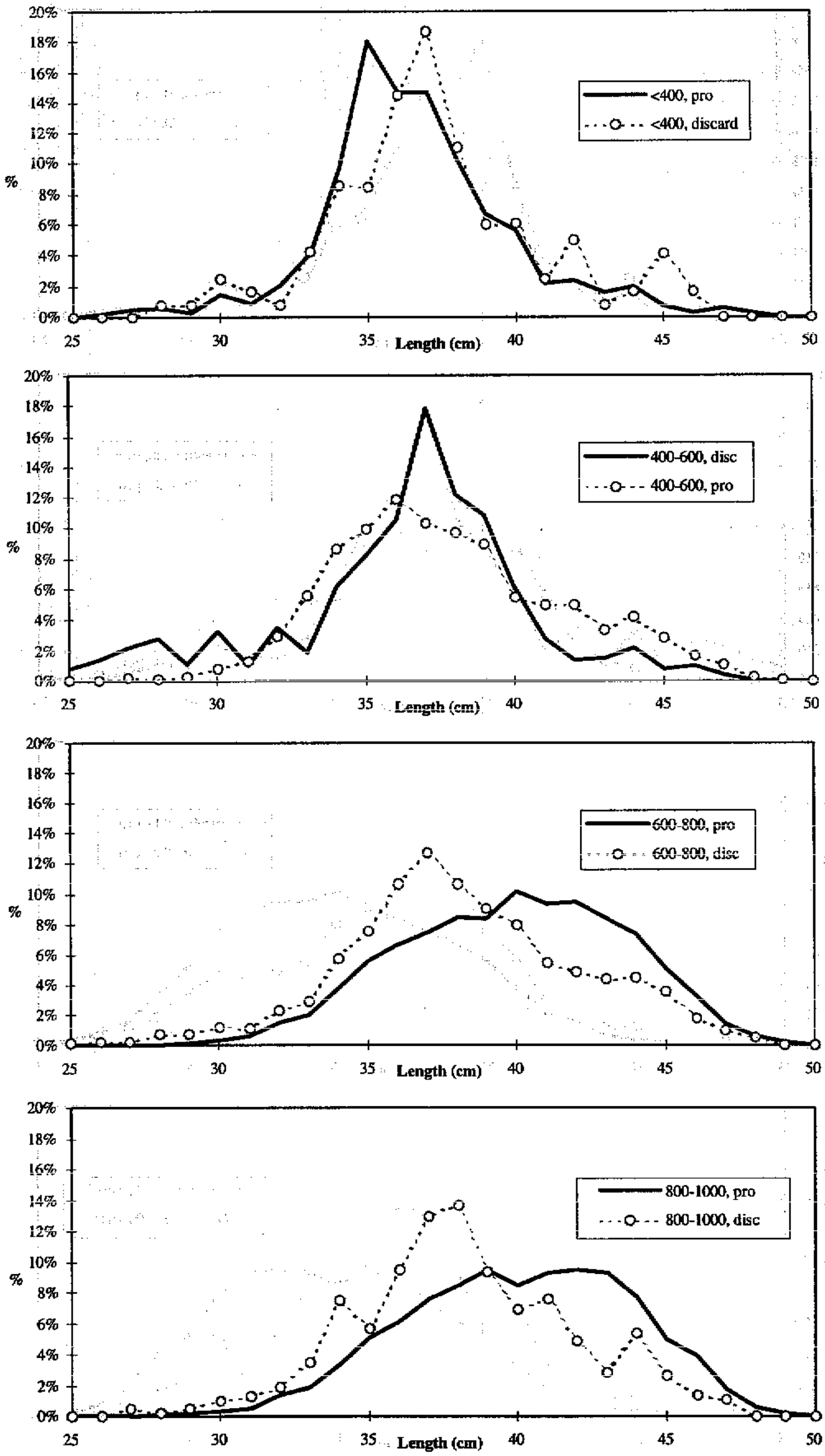


Figure 7.6.2. **Oceanic redfish. Length distribution of discarded and processed redfish from different depth intervals. Based on data from the Icelandic fleet in 1997**

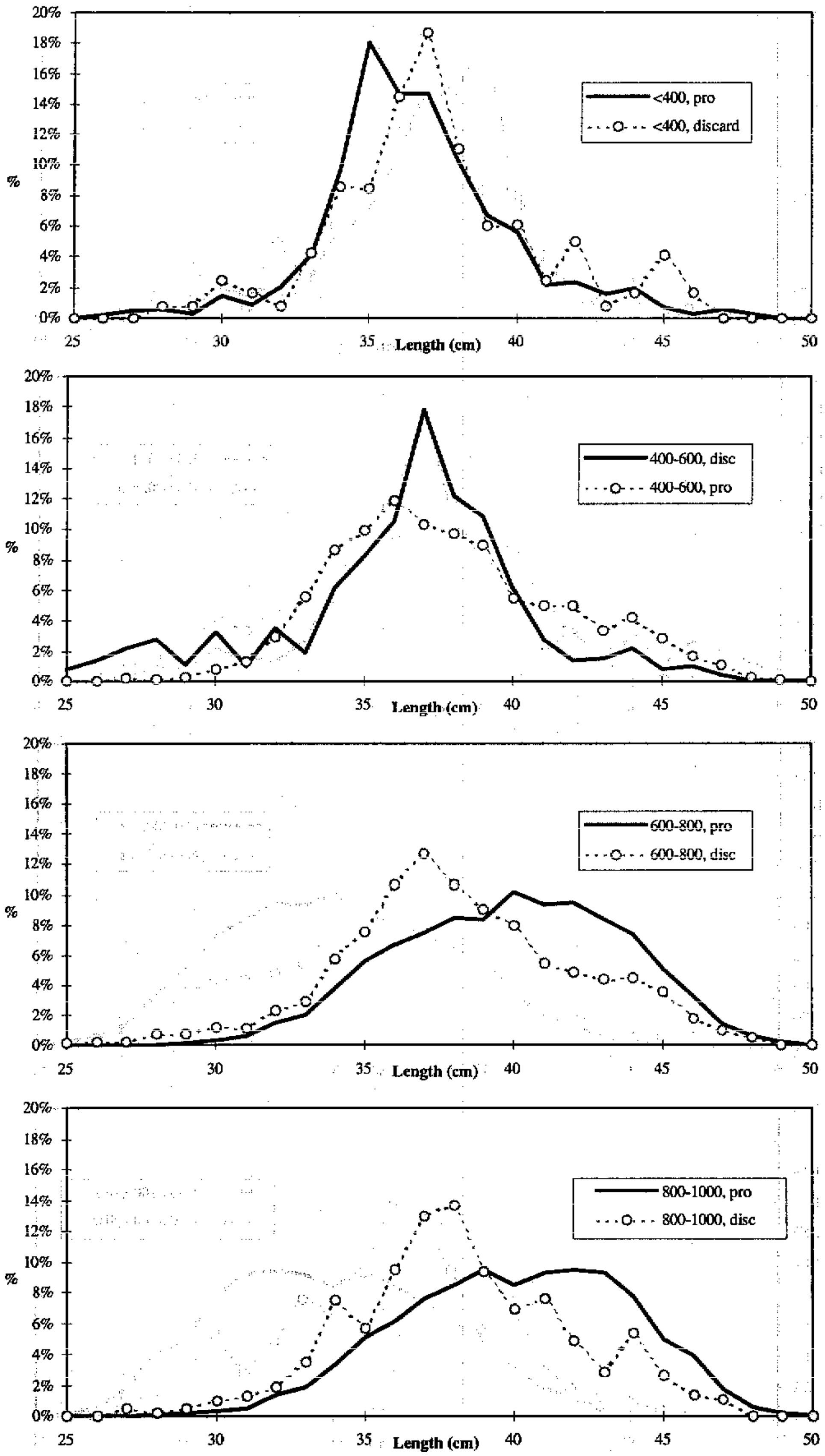


Figure 7.6.2. Oceanic redfish. Length distribution of discarded and processed redfish from different depth intervals. Based on data from the Icelandic fleet in 1997

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 37,000 and 38,000 t in 1996 and 1997, 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 1996 and 1997 occurred in area Va, where 34,000-35,000 t were caught compared to 42,000 t in 1995 (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 1997 was 35,000 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 and in 1997 are the lowest catch of *S. marinus* in Va since 1978. The length distributions in the Icelandic landing 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. As shown in WD4, 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 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 650 t which are the highest catches in the whole period from 1978 (Table 8.1.1). The provisional catch in 1997 were over 500 t. The major proportion of the catches has been taken by trawlers. No length distribution was available.

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 and there have not been any directed fishery for *S. marinus* in Division XIV in 1997. Most of the catches were taken as bycatch in the shrimp fishery. In former years most of the catches were taken by large bottom trawlers, targeting on redfish and cod.

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.

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 revised. The fishery in 1997 was not a great success, with only 43 t reported by Norway. There has been a considerable fishing effort on the Reykjanes ridge also in 1997, but the target demersal species seems to have been Greenland halibut (see chapter 6).

8.2 Assessment

8.2.1 Trends in CPUE and survey indices

Figure 8.2.1 and 8.2.2 shows the *S. marinus* abundance index with 95% confidence intervals using Icelandic groundfish survey data. The index is a biomass index of the fishable stock computed by using a fishable stock ogive as shown in Figure 8.2.3. The index is a Cochran index (see Pálsson *et.al*, 1989) and the stratification is based on depth intervals and is shown in Figure 8.2.4. The reason for not using the same stratification as used last year by the Working Group is to reduce the effect of large hauls taken at the shelf where there are relatively large changes in depth so that the effect of these large hauls are reduced since the stratification is based on depth intervals. As shown on Figure 8.2.1 and 8.2.2, the confidence intervals shows much higher variation in the series while using all data, compared to the index when only depth down to 400 m is used.. The main reason is that on depth between 4-500 m, only 4-7 stations have been taken annually, where 2-4 of them have shown to be within the distribution area of redfish. As seen in Table 8.2.1 the contribution of the stations below 400 m to the total index of fishable stock is highly variable.

The index indicates an increase in the fishable biomass from the low level in 1995. The length distribution from the survey (Figure 7.5.1) shows that the peak in the length distribution which have been followed during the last years now has reached to 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 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).

The results from the trawler fleet do also reflect the situation shown in the groundfish survey and although the CPUE has been at a low level in recent years (Figure 8.2.5), it increased in 1997 and there is a further increasing in 1998.

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 - 1998 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 in 1997 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 1982-97, abundance and biomass indices from the German groundfish survey for *S. marinus* (≥17 cm) are listed in Tables 8.2.2 and 8.2.3 by stratum, West and East Greenland, aggregated to total and accompanying confidence intervals, and illustrated in Figures 8.2.7 and 8.2.8. Values in 1984, 1992 and 1994 were indicated as incorrect due to incomplete sampling off East Greenland. Ignoring these years, total figures showed a declining trend from 680,000 million to 325 million individuals and 440,000 t to 140,000 t during 1982–1985. Since 1986, an almost continuous reduction in survey biomass from 300,000 t to 11,000 t in 1995 was observed, which is the minimum of the time series among years with complete survey coverage. The 1997 index amounted to 18,000 t and confirmed the severely depleted stock status. Apart from the year 1990 which has the maximum value amounting to 780 million fish caused by the occurrence of juveniles (<25 cm), there was the same decreasing trend regarding the survey abundance. During 1987-97, abundance estimates decreased from 610 million to 27 million.

It can be taken from Figures 8.2.9 and 8.2.10 that the redfish were mainly distributed off East Greenland, while the minor abundance and biomass indices off West Greenland decreased almost to zero. It should be underlined that the enormous variation of catch per tow data resulted in high confidence intervals, ranging between 40% and 60% of the stratified mean in most of the years.

The length frequencies were illustrated for West and East Greenland and aggregated to total in Figures 8.2.9 and 8.2.10, respectively. They revealed pronounced year and area effects. Usually, the few individuals off West Greenland showed a peak around 30 cm while fish lengths off East Greenland varied over a wide range. Since 1984, juveniles (<30 cm) contributed important and increasing parts to the stock. Peaks at lengths of 20, 25, 28, 29, and 30 cm between the successive years 1985-89 and at lengths of 20-22 and 25-26 cm between the successive years 1990-91 and 1995-96 might indicated the annual growth increments of single cohorts.

8.2.2 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. A slight improvement in fishable biomass has, however, been seen in the most recent years due to improved recruitment. In the long term the 1990 year class is expected to contribute significantly to the fishable biomass. In Division Vb the CPUE from the Faroes groundfish survey show an increase in 1997 but the catches are still at a very low level. *S.marinus* in Sub-area XIV has nearly been depleted in the most recent 6 years.

The working group also tried a new version of an age-production model. The model is described in Stefánsson and Sigurðsson (ICES C.M. 1997/DD10) an improved version of the model used earlier by the working group (ICES CM1996/ Assess:16). The model was applied to the cod stock in Division Va for comparison with the standard methods of estimating the state of the stock The model utilises survey indices and length distributions from survey and catch data. The recruitment estimates as obtained from applying the redfish model and from the 1996 working group report show the same overall trend in the recruitment of the cod stock in Division Va. Applying the model to *S. marinus* the model showed the same general trend in the fishable biomass as the Icelandic groundfish survey and it seem to be able to reflect the peak in the recruitment of the assumed 1985 and 1990 year classes (Figure 8.2.11).

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	51,825	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	33,202	62
97	567	35,307	62
98	568		
Average 85-90			
	969	av.86-89	66.3

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.

By assuming same effort in 1999 as it was in 1997 (calculated from the survey index from depth down to 400 m) and calculating the catch in 1999 as:

$$\textbf{Catch}_{99} = \textbf{Survey index}_{98} * \textbf{Effort}_{97},$$

the catch will be around 35 000 t.

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.

8.3 Biological reference points

S. marinus is mainly caught in Division Va. Based on survey data, the lowest recorded biomass was reached in 1995. That refers to the survey index of 359, which is 63% of current level and only 31% of the highest level measured in 1987. The fishable stock seems to have started to recover from that level. The long lasting recruitment (at least 10 years) and poor data environment for recruits (species identification of juveniles), SSB and stock dynamics prevents the estimate of appropriate biological reference points at present.

It should be noted that this assumption is only based on the data from Division Va. 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 *S.marinus* is almost depleted and no direct fishery have been going on for the last three years.

8.4 Special comments on "giants"

ACFM last year decided to treat all *S. marinus* in ICES Sub-areas V, XII and XIV , including the 'giant', as one management unit.

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 identify as 'giants' (i. e., nearly 100% in international waters) in a TAC meant for *S. marinus* within the EEZs.

Countries participating should analyse and present effort and CPUE data together with catch statistics and biological data from this international fishery to ICES.

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	51,825	4,140	373	0	685	57,023
1990	63,156	2,407	382	0	687	66,632
1991	49,677	2,140	292	0	4,255	56,364
1992	51,464	3,470	40	0	746	55,721
1993	45,890	2,621	101	0	1,738	50,350
1994	38,669	2,048	129	0	1,443	42,288
1995	41,516	2,361	613	0	61	44,551
1996	33,558	2,318	663	0	59	36,598
1997 [1]	35,514	2,846	538	0	29	38,927

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 . Number of stations by depth interval and index on fishable stock of *S.marinus* In the icelandic groundfish survey by depth.

Number of stations by depth interval														
Depth interv/year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
<100m	39	39	32	33	33	36	35	38	56	53	55	41	39	40
100-200m	245	235	230	225	233	232	231	234	241	240	244	228	225	200
200-400m	167	166	168	150	164	163	165	164	160	164	163	166	163	159
400-500m	**10**	**12**	**8**	**8**	**9**	**7**	**10**	**9**	**7**	**7**	**7**	**4**	**6**	**7**
Total 0-400 m	557	546	531	511	533	535	534	537	564	562	568	534	525	478
Total	593	585	566	545	568	567	570	571	597	596	600	540	533	486
Index on fishable stock														
Depth interv/year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
<100m	1	1	2	1	1	2	2	1	1	0	0	1	1	2
100-200m	92	89	124	96	97	66	74	60	48	58	38	45	60	55
200-400m	124	159	134	97	114	85	48	55	47	50	44	75	68	70
400-500m	22	12	10	4	11	25	9	10	19	1	13	25	41	3
Total 0-400 m	**228**	**259**	**266**	**200**	**217**	**156**	**128**	**118**	**97**	**109**	**82**	**122**	**129**	**130**
Total	252	273	277	221	231	195	139	129	118	112	96	147	170	132

Table 8.2.2 *S. marinus* (≥17 cm). Abundance indices (n*1000) for West, East Greenland and total by stratum as derived from the German groundfish survey, 1982-97. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling.

YEAR	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2	7.1	7.2	WEST	EAST	TOTAL	CI
1982	7015	6340	88792	5512	5736	14876	4087			195798		312132		38899	132358	546829	679187	55
1983	4025	3186	3355	6523	4043	5865	1697			140766	453	264813		14365	26714	420397	449111	53
1984	1324	3438	460	1209	10671	2776	4214		6888			47974		9890	24092	(64752)	(88644)	65
1985	4658	10451	6158	1569	3220	14441	4973		78118	32397	1787	141500		25944	45470	279746	325216	52
1986	6327	4324	2077	3483	21503	2883	2717			124613	470	298706		22234	43314	446023	489337	53
1987	906	653	1327		9612		659		50961	9422	245	507387		27920	13157	595935	609092	39
1988	831	2239	342	2255	5938	1954	731		3012	5015	148	132458		34352	14290	174985	189275	54
1989	421	422	776	690	6489		361		4003	33320	625	110663		76934	9159	225545	234704	60
1990	120	433	279	709	1038		146	2271	14974	72316	391	653009		37483	4996	778173	783169	75
1991	227	256	96	691	236	527	21	1671	1385	13237	172	64692		28201	3725	107687	111412	51
1992	126	106	73	190	193	477	192	835						32622	2192	(32622)	(34814)	151
1993	169	481	59	267	80	132	0		175	6043	77	54424		4170	1188	64889	66077	93
1994	111	325	156	167	65	46	151	247						3348	1268	(3348)	(4616)	41
1995					51	67	38	146	346	1521	153	38892		2060	302	42972	43274	97
1996	152	267	22	244	381	383	29	298	647	3145	494	21110		2366	1776	27762	29538	47
1997	252	609	16	175	120	311	36	552	721	913		21257		1611	2072	24501	26573	40

Table 8.2.3 *S. marinus* (≥17.5cm). Biomass indices (tons) for West, East Greenland and total by stratum as derived from the German groundfish survey, 1982-97. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling.

YEAR	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2	7.1	7.2	WEST	EAST	TOTAL	CI
1982	1798	1354	34440	2558	3206	9794	2532			155971		194379		30115	55682	380465	436147	54
1983	846	945	1572	3042	1873	4815	1084			161687	269	229541		15607	14177	407104	421281	61
1984	309	894	196	519	4935	2284	2089		3601			21281		12052	11225	(36934)	(48159)	55
1985	1020	1819	2968	472	1427	9209	2718		8613	22453	1317	65299		23762	19633	121444	141077	35
1986	1262	1215	752	1229	10122	1705	1762			43119	362	213268		24368	18067	281137	299204	38
1987	255	247	660		4954		438		9539	5346	106	230844		19327	6554	265162	271716	38
1988	146	404	118	942	2570	1342	382		1092	4930	68	98131		48262	5904	152483	158387	60
1989	182	137	272	249	2619		209		970	14920	442	54589		34360	3668	105281	108949	47
1990	39	149	75	275	479		79	1343	6761	27245	154	130530		14723	2439	179413	181852	45
1991	44	83	24	226	120	273	3	1007	725	10631	120	34265		62979	1780	108720	110500	98
1992	18	35	20	61	53	241	70	447						12076	945	(12076)	(13021)	130
1993	46	112	19	114	39	55	0		75	1377	30	20179		2899	385	24560	24945	68
1994	34	146	48	64	26	35	40	80						1540	473	(1540)	(2013)	38
1995					19	19	20	43	114	712	51	8696		1141	101	10914	11015	36
1996	64	102	4	60	128	118	8	132	139	1714	196	10855		1408	616	14312	14928	40
1997	41	261	5	61	35	188	10	246	163	447		15411		1225	847	17246	18092	58

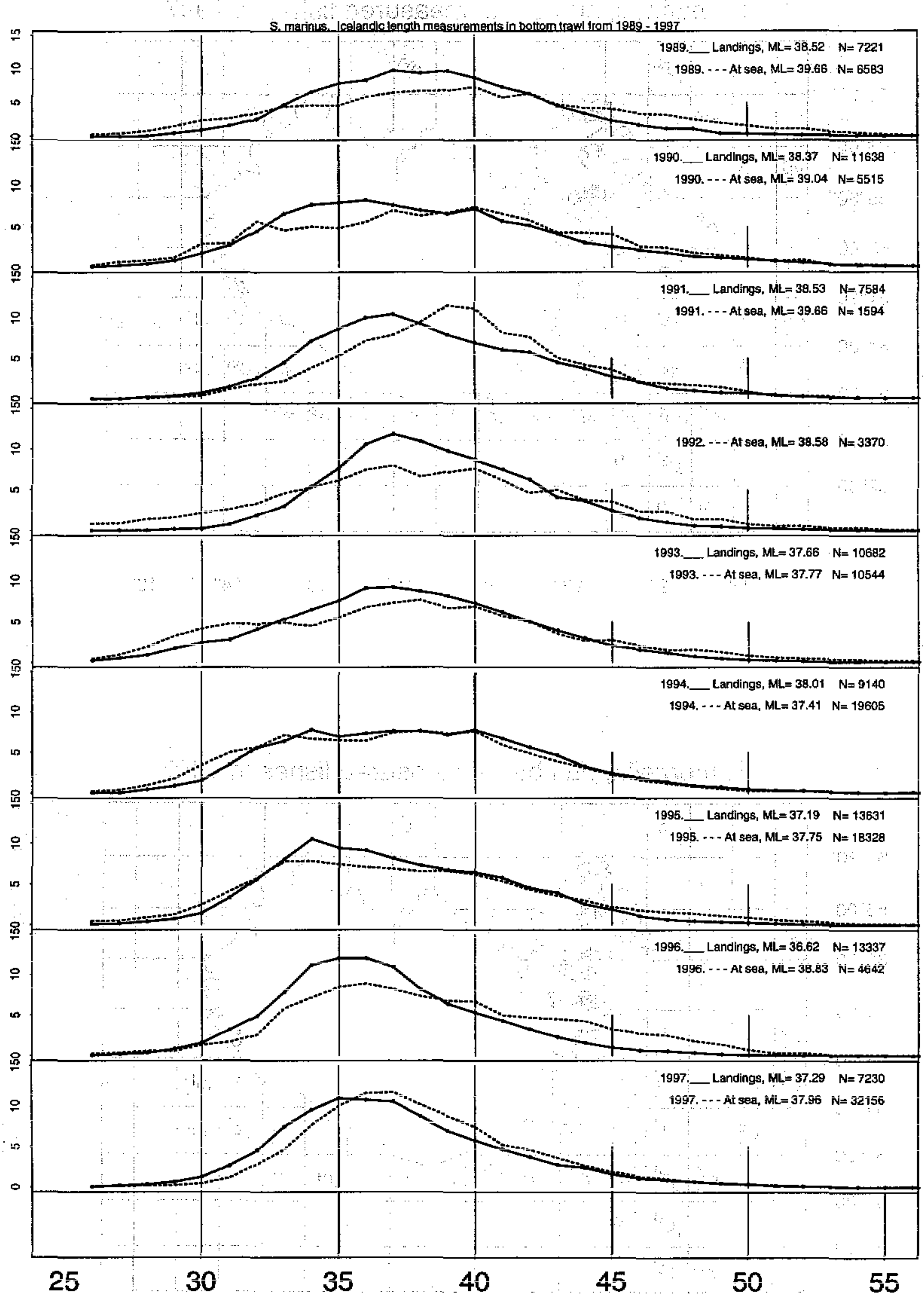
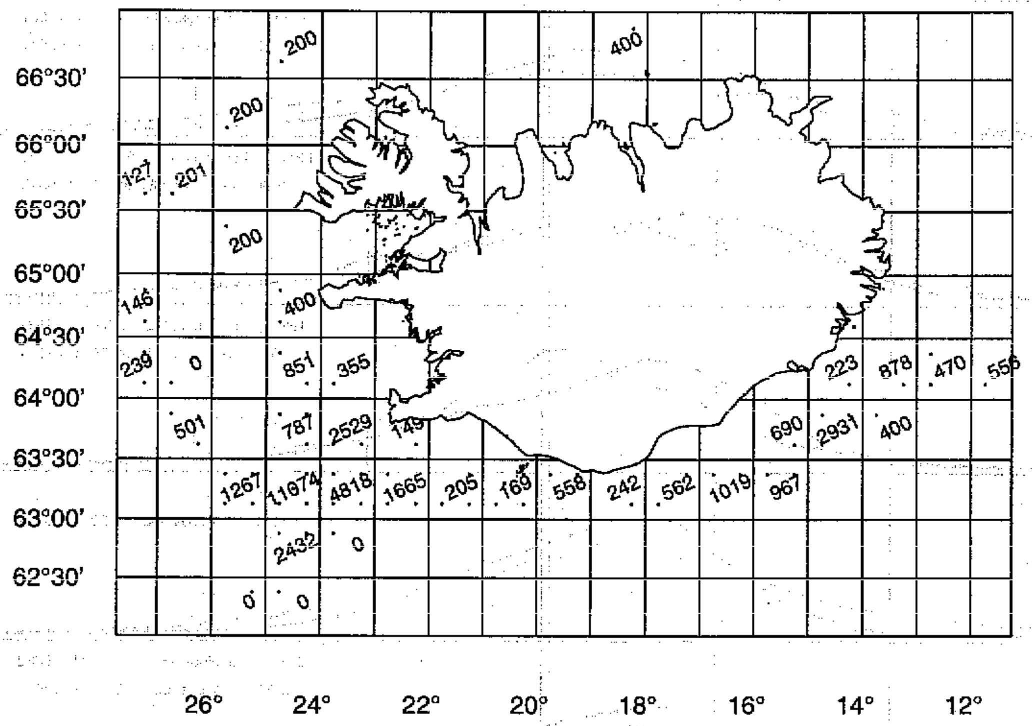


Figure 8.1.1. *S. MARINUS.* Length distribution from icelandic landings and from samples taken at sea from the trawler fleet 1989 - 1997.

S. marinus, number of measured fishes in 1997



S. mentella, number of measured fishes in 1997

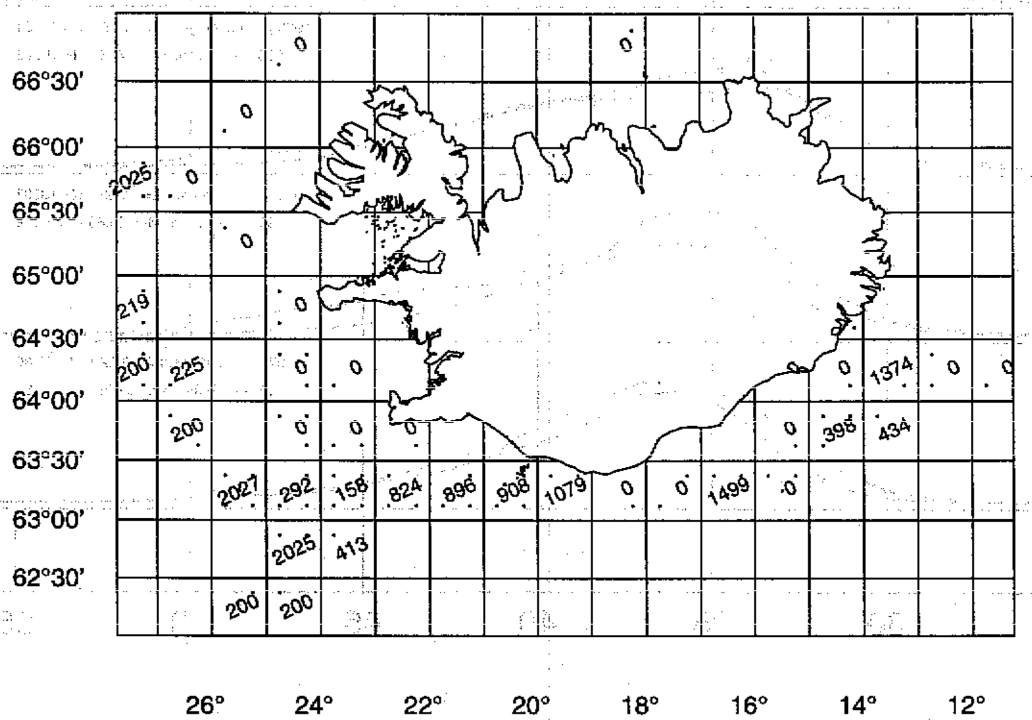


Figure 8.1.2. Sampling of *s.marinus* and *s.mentella* in 1997. Number of fishes in each square and location of samples.

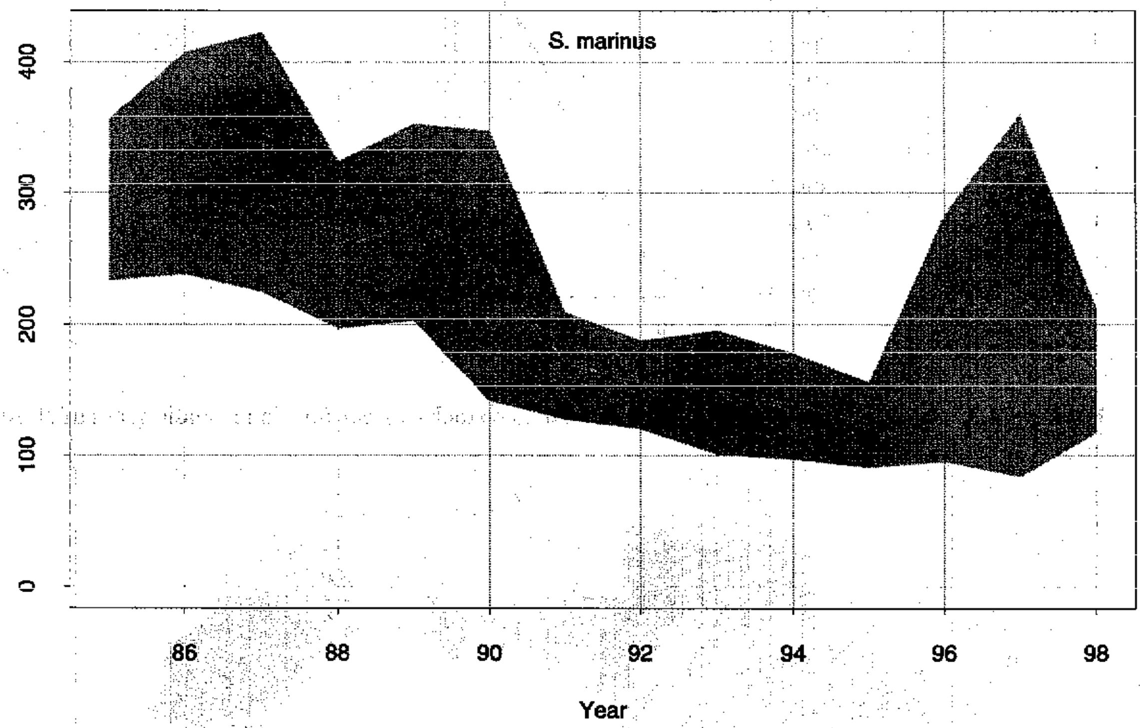


FIgure 8.2.1. Index on fishable stock of s. Marinus from icelandic groundfish survey and 95% confidence intervals. . The index is based all strata on depth from 0-500 m.

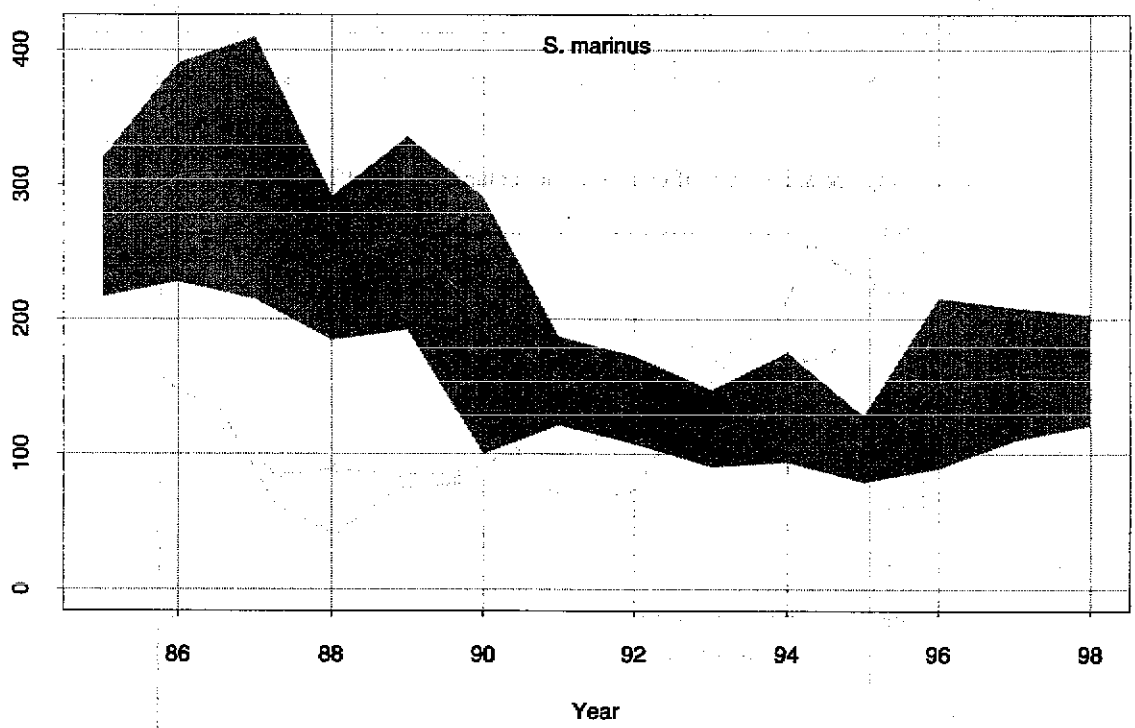


Figure 8.2.2. Index on fishable stock of s. Marinus from icelandic groundfish survey and 95% confidence intervals. The index is based all strata on depth from 0-400 m.

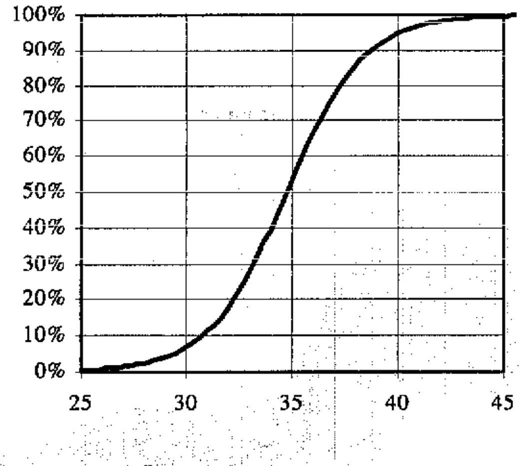


Figure 8.2.3. Selection curve for estimating the fishable stock of *s.marinus* in icelandic groundfish survey.

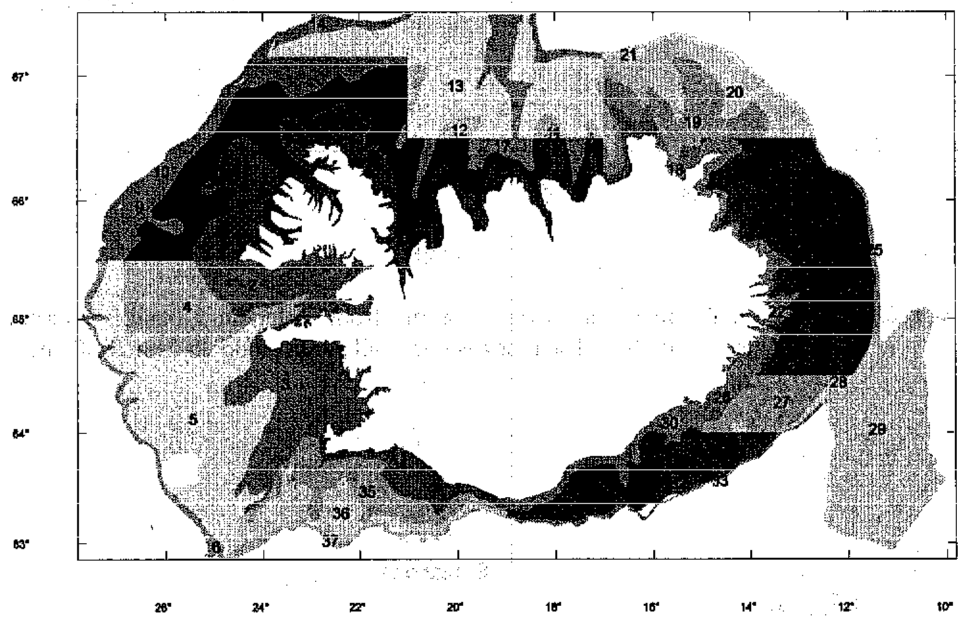


Figure 8.2.4. Stratification in the icelandic groundfish survey.

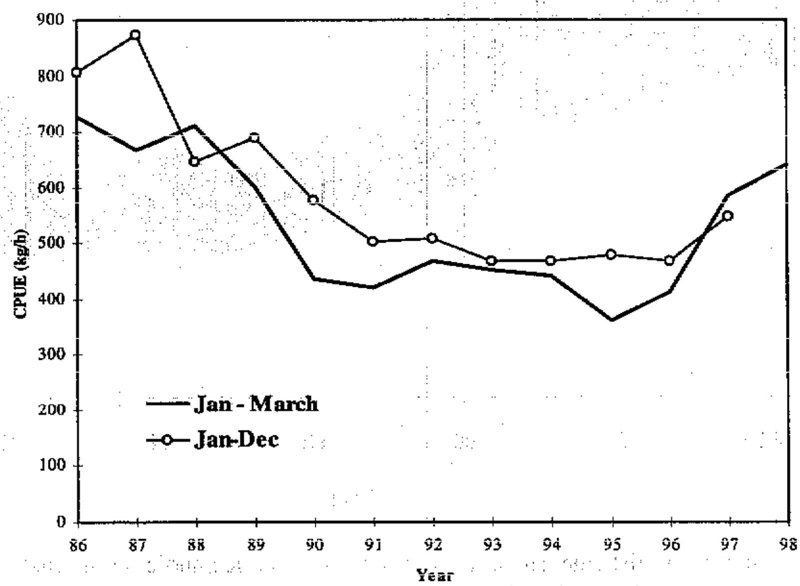


Figure 8.2.5. CPUE in *s.marinus* from icelandic trawles 1996-1998.

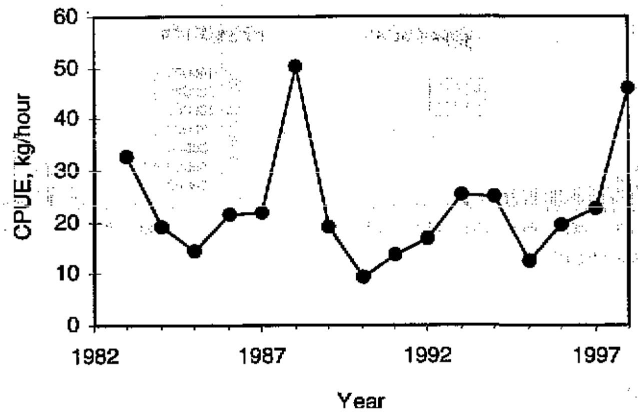


Figure 8.2.6. CPUE of *S. marinus* in the Faroese groundfish survey 1983-1998.

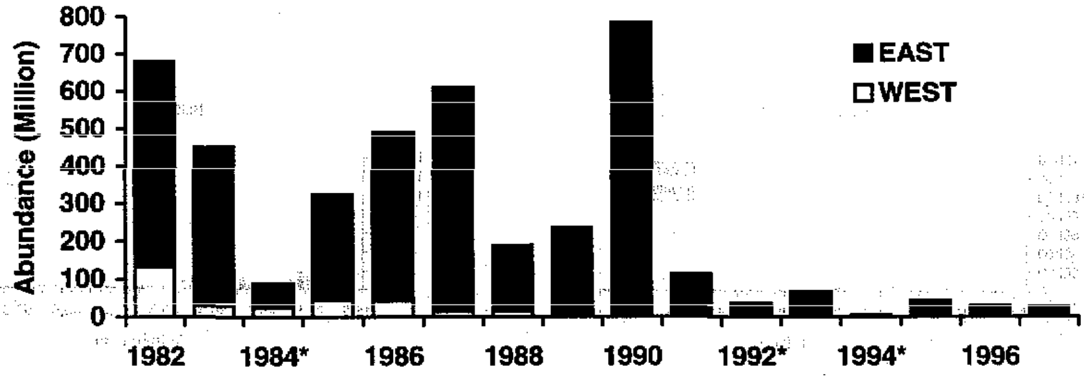


Figure 8.2.7 *S. marinus* (≥17 cm). Survey abundance indices for East and West Greenland as derived from the German groundfish survey, 1982-97. *) incomplete survey coverage.

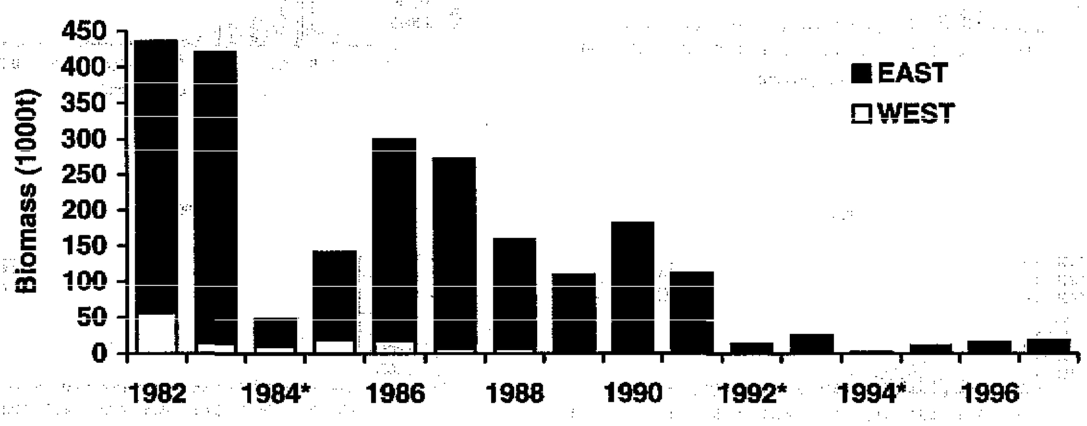


Figure 8.2.8 *S. marinus* (≥17 cm). Survey biomass indices for East and West Greenland as derived from the German groundfish survey, 1982-97. *) incomplete survey coverage.

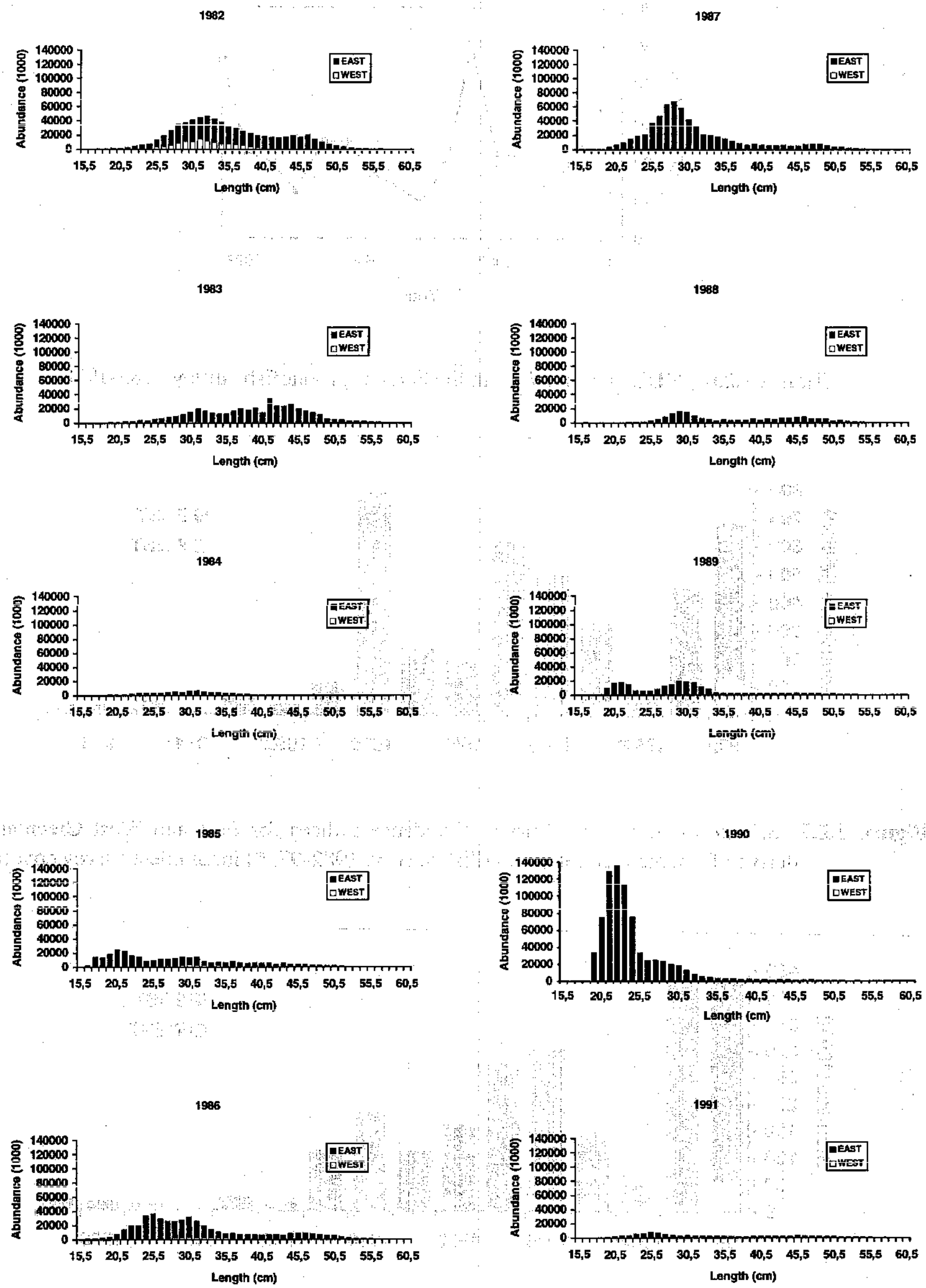


Figure 8.2.9 *S. marinus* (≥17 cm). Length frequencies for East and West Greenland as derived from the German groundfish survey, 1982-91

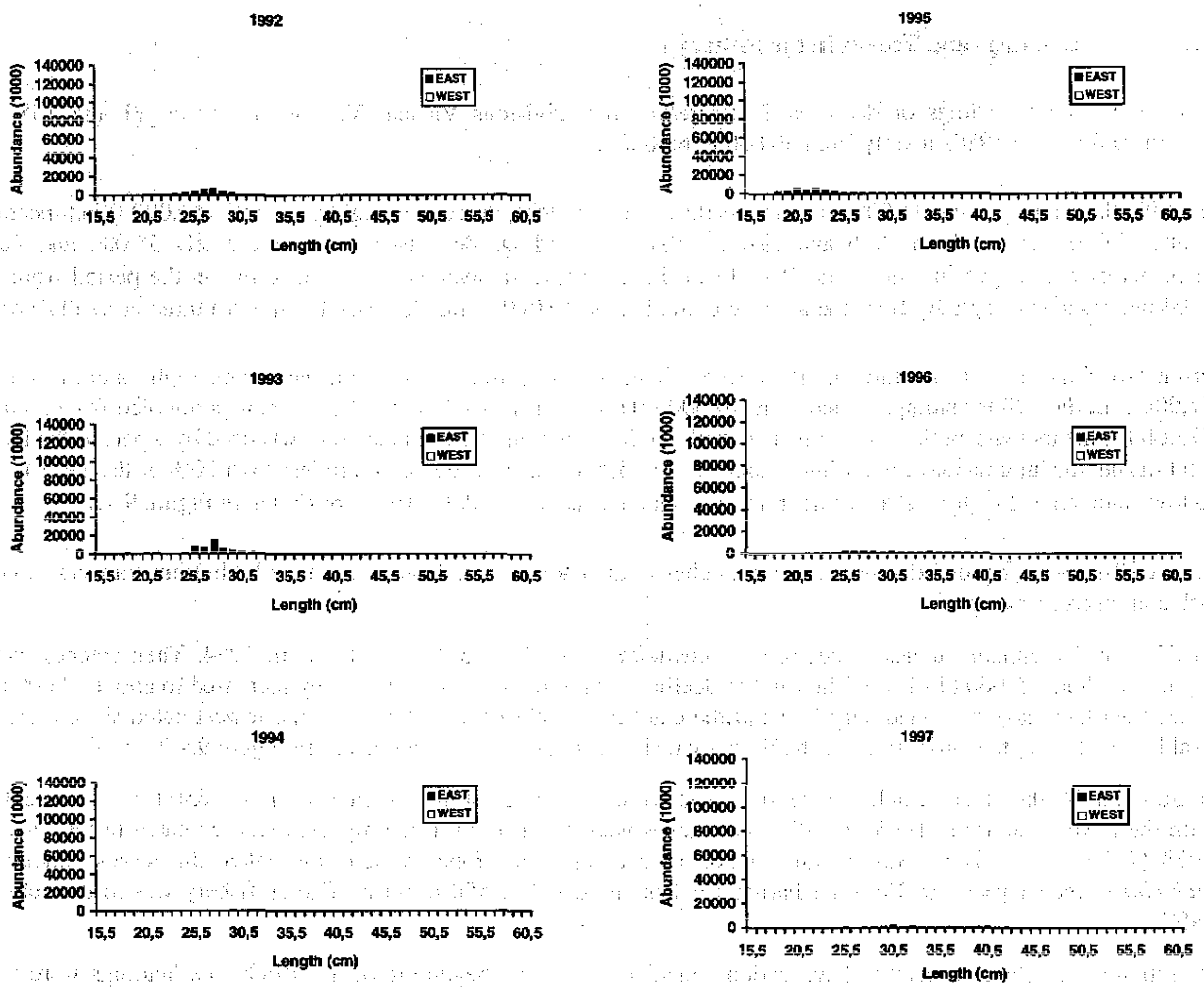


Figure 8.2.10 *S. marinus* (≥17 cm). Length frequencies for East and West Greenland as derived from the German groundfish survey, 1992-97.

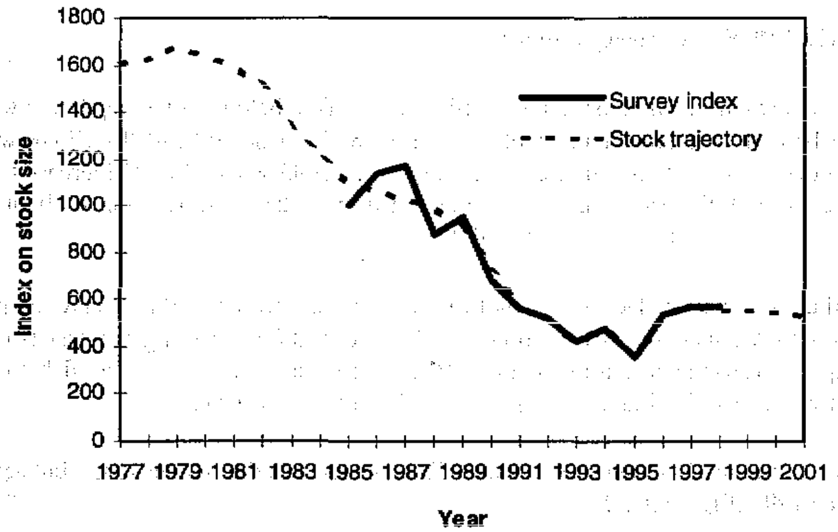


Figure 8.2.11. Survey index from Icelandic groundfish survey and stock trajectory based on age based production model.

9 DEEP-SEA *Sebastes mentella*

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 (62,000 t) but increased to about 83,000 t in 1994. In 1995 and also in 1996, the landings decreased to approximately 55,000 and 42,000 t respectively and stayed in 1997 a the 1996 level. In summary, the average annual landings in the period from 1991–1994 increased substantially from the average in the 1980s (42,000 t), but decreased in the last three years (Table 9.1.1).

From Division Va, total landings in 1997 were about 37 000 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 less than 10% of the 1994 level due to low catch rates. Length distributions from the Icelandic catches in 1989–1997 are shown in Figure 9.1.1.

About 90-95% of the total deep-sea redfish catches in area Va in 1997 have been taken by bottom trawlers (both fresh fish and freezer trawlers).

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 1997 of only 4,500 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 9.1.2.

In Sub-area VI the annual catches were highest in 1980 (1,000 t), but have varied from 10 - 650 t during recent years, with the lowest catches in 1995. In 1996, the catches were about 1,100 t, the highest recorded catch in the series since 1978 (Table 9.1.1). There was no information of catches from France which have taken the largest amount of *S. mentella* in recent years. In 1996 the Faroes catches amounted to 550 t, but no Faroes fishery was in the sub-area in 1997.

In Sub-area XIV, annual catches have varied considerably. In the beginning of the 1980s, the landings were between 10,000–15,000t, 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. After low catches in 1995 and in 1996 of only 900 t and 500 t, respectively (Table 9.1.1), the catches in 1997 decreased further to only 200 t. The decline in 1995–1996 was due to a reduction in effort and in 1997 there was no direct fishery of *S. mentella* in Sub-area XIV and all the catches were taken as bycatch in the shrimp fishery.

9.2 Assessment

9.2.1 Trends in CPUE and survey indices

CPUE for deep-sea *S. mentella* in Division Va is based on tows taken below 500 m depth and where the total catches of redfish is more than 10% of the total catch in each tow. In the period from 1986–1989 CPUE was stable. From 1990 to 1996 CPUE has declined about 45 % (Figure 9.2.1), except in 1995 where CPUE increased by 5% from 1994. The decline in the period from 1990 corresponds to a reduction from a stable effort level of about 950 before 1990 to the current level of below 500, i.e. a reduction of about 45%.

It should be noted that these data reflect only a part of the stock, i.e. Division Va. During the period from 1986–1994, the landings in Division Va increased from about 20,000 t to 57,000 t. During the last two years, the catches has decreased due to quota restrictions. Although the CPUE from the Icelandic trawler fishery increased in 1997 this increase has not continued in 1998 (Figure 9.2.1) and is still at a very low level.

Regarding Division Vb the CPUE of deep-sea *S. mentella* have decreased in recent years, but seems to have stabilised at a very low level since 1995 (Figure 9.2.2).

Survey abundance and biomass indices from the German groundfish survey for deep sea *S. mentella* (>=17 cm) are presented in Tables 9.2.1 and 9.2.2, broken down by stratum at West and East Greenland, and illustrated in Figures

9.2.3 and 9.2.4. An increasing trend was evident for both abundance and biomass indices. In 1991, 1993 and 1995-96, when the survey area was completely covered, this species was found to be very abundant. Due to the successful recruitment of one or two individual year classes, last year's (1997) estimates revealed a continued increase by more than 50 % to the record high values of the time series amounting to 6,900 million individuals and 1.5 million t. The recent stock was composed of recruiting juveniles only while mature deep sea *S. mentella* were almost absent. However, the origin of the very abundant recruits and their recruitment to the stock of deep sea *S. mentella* is uncertain. Comparing the proportions between West and East Greenland, deep sea redfish was almost exclusively distributed off East Greenland. West Greenland shares were negligible and varied without a clear trend. The high confidence intervals indicated a low precision of these estimates.

Length disaggregated abundance was shown for West, East Greenland and total in Figures 9.2.5 and 9.2.6. Since 1985, juveniles (<25 cm) contributed significant portions and have dominated the stock structure since 1989. In 1991 and 1993, most of the deep sea *S. mentella* were smaller than 20 cm or varied between 25-27 cm. Comparing the 1995-97 length measurements, the annual growth increments of the most dominant year class amounted to 3 and 2 cm. Further growth indications for single cohorts between successive years were hardly derivable from the length distributions, except 1990-91 with pronounced peaks at 21.5-23.5 cm and 25.5-26.5 cm, respectively.

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 50 % of that level.

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 time series of CPUE indices, catches in area Va and deduced effort index are given in the following text table.

Year	CPUE 10%	Catch Va	Effort10%
85			
86	943	18898	20
87	974	19293	20
88	886	14290	16
89	974	40248	41
90	804	28429	35
91	770	47651	62
92	611	43414	71
93	547	51221	94
94	488	56720	116
95	514	48708	95
96	489	34741	71
97	562	37052	66
Average 86-90	916	24232	27

The effort in the time when the stock was considered in stable condition i.e. from 1989–1990 was below 40.

The working group was of the opinion that the effort should be further reduced in order to let the stock increase from the present low level. Using the CPUE data in the same way as the Iceland groundfish survey used for *S. marinus* indicates that a 25 % reduction would lead to catches of 28,000 t whereas a reduction in effort down to 40 would lead to catches of 22,000 t in 1999.

Although the two types of Oceanic redfish in Irminger Sea in the present context are treated as one unit, **it can 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 redfish resembling deep-sea *S. mentella* in the Irminger Sea and this should be keep in mind in the management of this stock.

9.3 Biological reference points

The fishable stock seems to be at a very low level, and knowledge about recruitment is scare. Therefore, it is difficult do define any biological reference points for the stock.

Table 9.1.1 Deep-sea *S. mentella*: 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	40,248	10,928	424	0	2,284	53,884
1990	28,429	9,330	348	0	6,097	44,204
1991	47,651	12,897	273	0	7,057	67,878
1992	43,414	12,533	134	0	7,022	63,102
1993	51,221	7,801	346	0	14,828	74,195
1994	56,720	6,229	642	0	19,305	82,896
1995	48,708	5,196	607	0	908	55,419
1996	34,741	5,337	1,117	0	730	41,925
1997 [1]	37,074	4,500	1	0	169	41,744

1) Provisional data.

Table 9.2.1 Deep sea *S. mentella* (≥17 cm). Abundance indices (n*1000) for West, East Greenland and total by stratum as derived from the German groundfish survey, 1982-97. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling.

YEAR	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2	7.1	7.2	WEST	EAST	TOTAL	CI
1982	0	390	17	348	0	2360	0			9275		19370		58822	3115	87467	90582	65
1983	40	1011	70	2528	0	5236	0			15820	0	42393		28378	8885	86591	95476	42
1984	41	2967	7	1276	0	1115	0		18			34633		76541	5406	(111192)	(116598)	93
1985	0	369	31	27	55	328	0		34904	16909	105	38689		81487	810	172094	172904	47
1986	2141	414	38	292	5	444	0			6932	27	76655		67172	3334	150786	154120	36
1987	987	13679	42		56		0		0	18340	64	7182		62458	14764	88044	102808	45
1988	150	3187	25	777	60	4619	0		22025	28158	74	176639		25344	8818	252240	261058	58
1989	0	186	9	102	0		8		847	3067		72046		222281	305	298241	298546	60
1990	0	10	4	705	50		0	3881	329	12453	2354	13513		16046	4650	44695	49345	43
1991	0	0	0	0	0	652	0	1773	0	10707	46	724504		234748	2425	970005	972430	81
1992	0	35	0	15	0	106	0	0						60064	156	(60064)	(60220)	165
1993	0	24	0	159	7	0	0		62	3528	140	1258376		121927	190	1384033	1384223	86
1994	0	271	20	95	94	162	0	36						77891	678	(77891)	(78569)	168
1995					29	234	96	1468	265	24463	1173	2394064		83314	1827	2503279	2505106	55
1996	1527	619	0	236	0	1921	29	7135	396	176448	1215	4246101		75011	11467	4499171	4510638	64
1997	252	1759	0	381	37	3204	144	30742	165	22270		6257093		628353	36518	6907882	6944399	62

Table 9.2.2 Deep sea *S. mentella* (≥17 cm). Biomass indices (tons) for West, East Greenland and total by stratum as derived from the German groundfish survey, 1982-97. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling.

YEAR	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2	7.1	7.2	WEST	EAST	TOTAL	CI
1982	0	96	6	114	0	893	0			5178		4843		22795	1109	32816	33925	68
1983	16	213	26	1158	0	2857	0			8701	0	21047		12747	4270	42495	46765	47
1984	6	798	4	490	0	472	0		2			12786		35202	1770	(47990)	(49760)	97
1985	0	96	15	11	27	110	0		2960	7169	40	17011		38533	259	65713	65972	35
1986	223	39	20	110	3	179	0		0	3943	15	29277		31333	574	64568	65142	36
1987	84	1184	9		31		0		0	4891	17	2328		23264	1308	30500	31808	46
1988	20	425	21	159	45	1878	0		3542	10166	9	55838		11607	2548	81162	83710	56
1989	0	23	7	15	0		1		90	655	0	21151		45452	46	67348	67394	63
1990	0	5	2	87	7		0	542	62	2741	329	1961		3275	643	8368	9011	44
1991	0	0	0	0	0	153	0	445	0	2959	30	211468		69454	598	283911	284509	80
1992	0	3	0	2	0	28	0	0						19856	33	(19856)	(19889)	160
1993	0	5	0	23	2	0	0		34	493	19	194675		34102	30	229323	229353	61
1994	0	31	3	10	12	25	0	3						7122	84	(7122)	(7206)	128
1995					5	25	10	159	29	2659	207	355946		16505	199	375546	375745	52
1996	5	55	0	19	0	235	4	689	13	24445	124	837222		14503	1007	876307	877314	59
1997	20	141	0	38	2	320	18	2973	20	3445		1323965		162744	3512	1490174	1493686	59

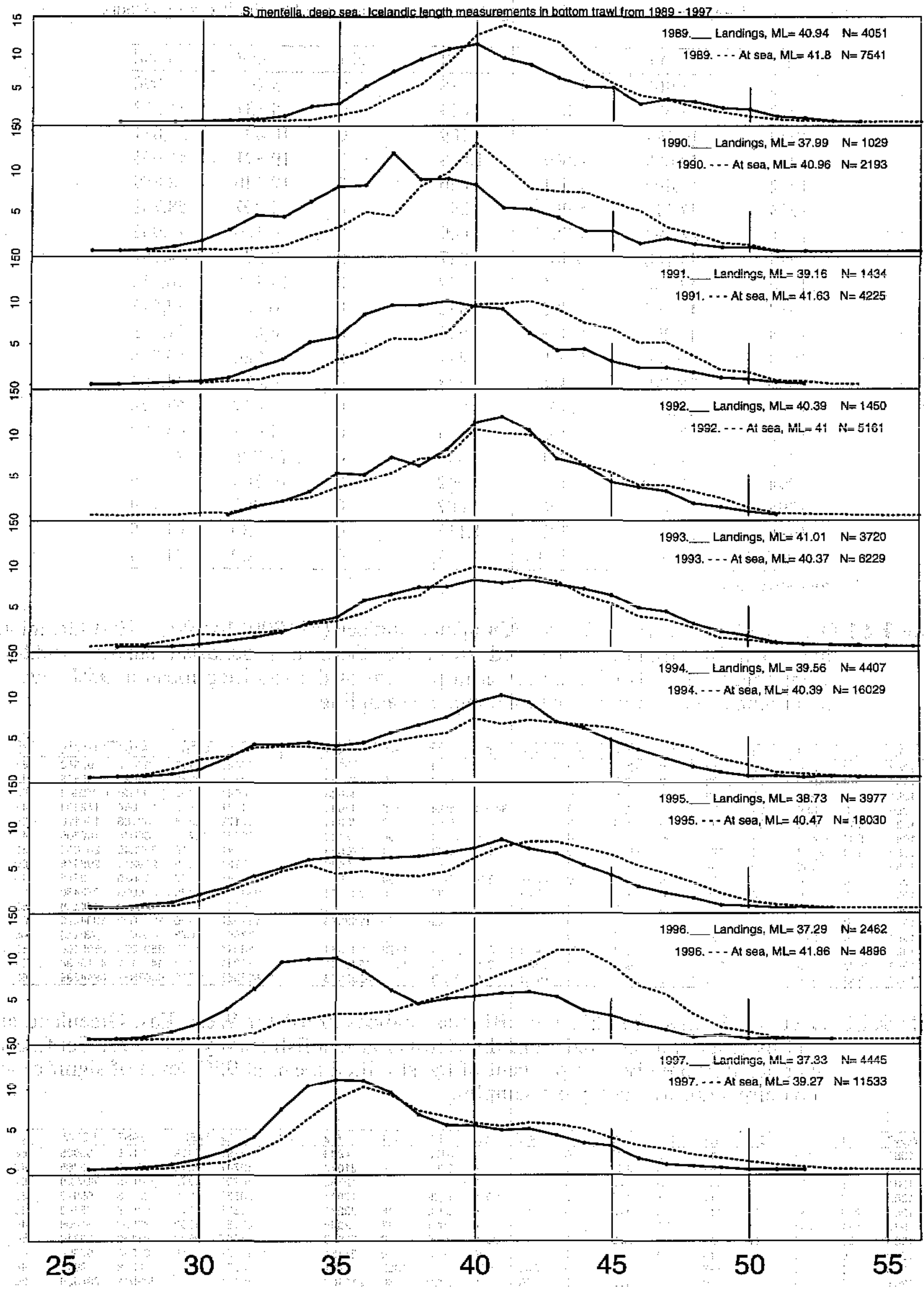


Figure 9.1.1. *S. Mentella.* Length distribuion from icelandic landings and from samples taken at sea from the trawler fleet 1989-1997.

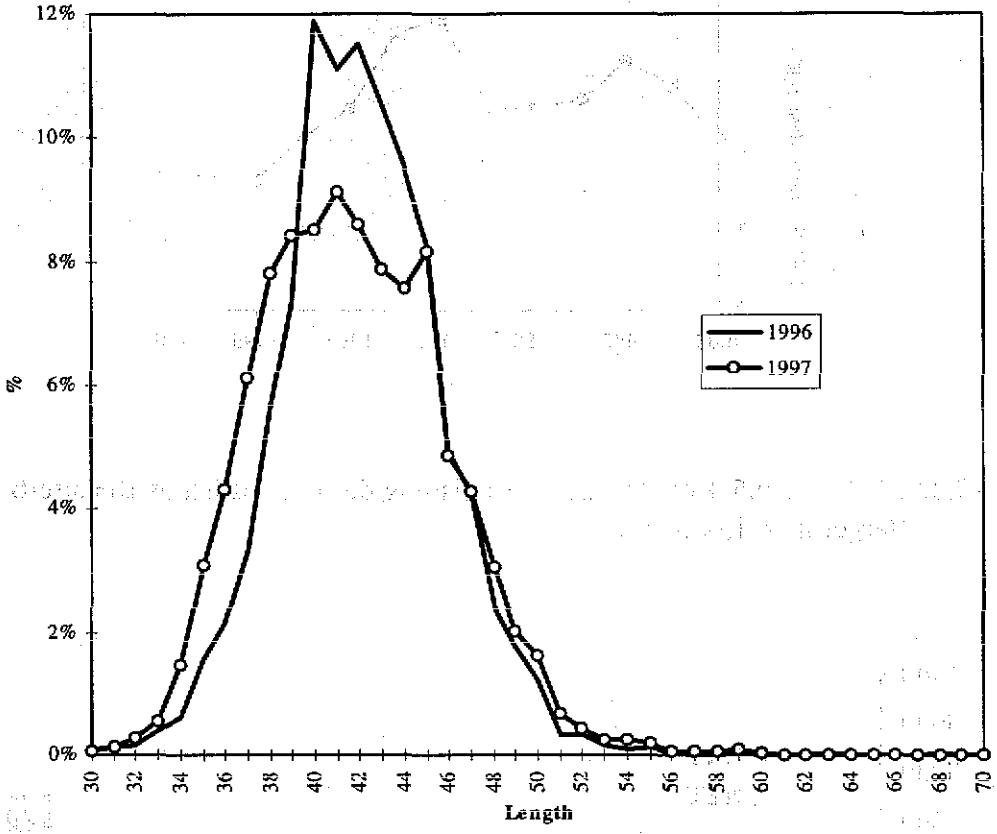


Figure 9.1.2. Length distribution of *s.mentella* in the faroese otterboard trawlers larger than 1,000 hp in 1996 and 1997.

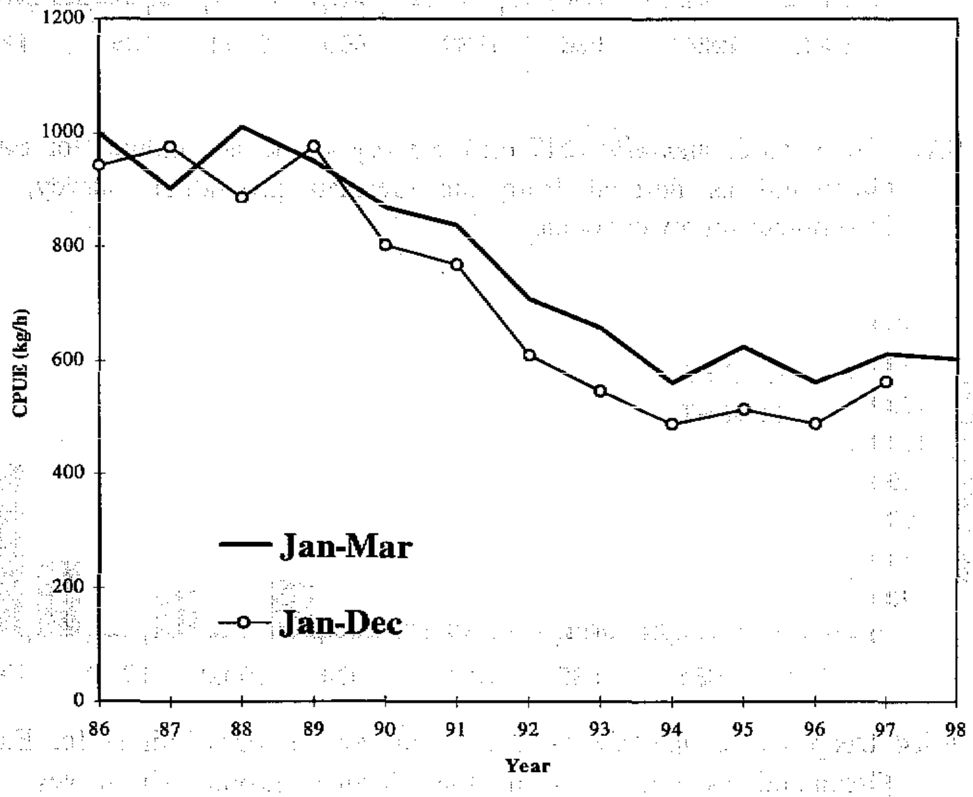


Figure 9.2.1. Cpue in s.*mentella* from icelandic trawles 1996-1998.

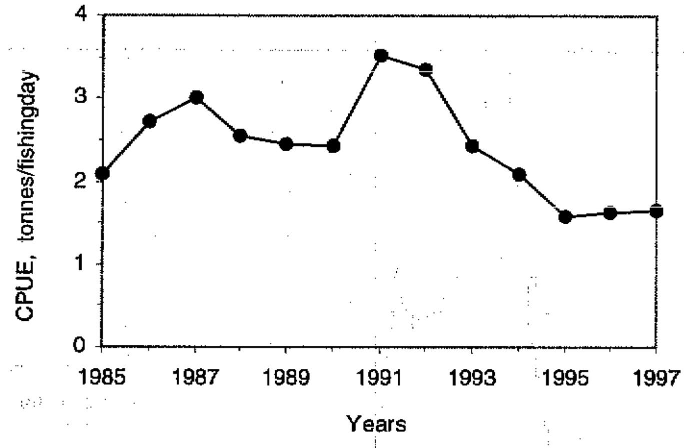


Figure 9.2.2. CPUE 1985-1997 (catch (t) per fishing day) of redfish by the otterboard trawlers larger than 1,000 HP.

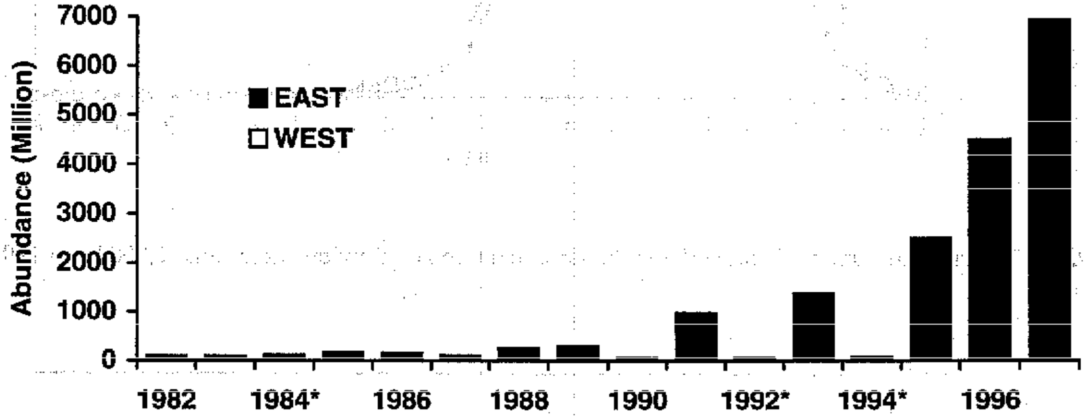


Figure 9.2.3 Deep sea *S. mentella* (≥17 cm). Survey abundance indices for East and West Greenland as derived from the German groundfish survey, 1982-97. *) incomplete survey coverage.

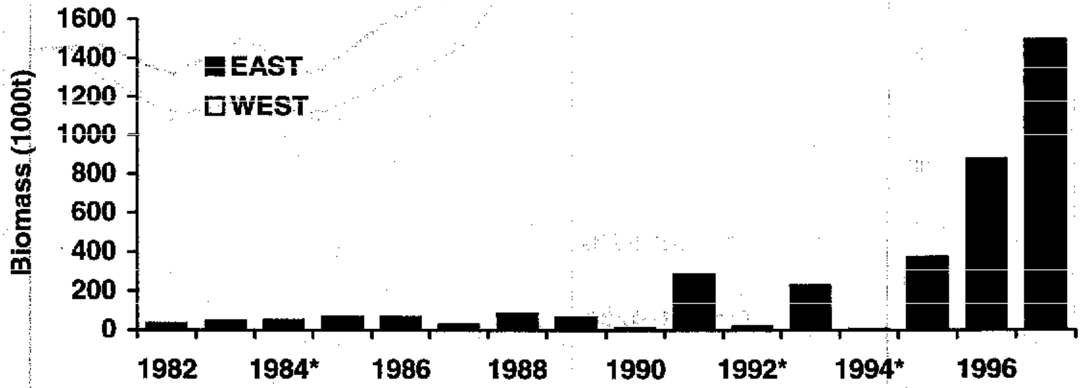


Figure 9.2.4 Deep sea *S. mentella* (≥17 cm). Survey biomass indices for East and West Greenland as derived from the German groundfish survey, 1982-97. *) incomplete survey coverage.

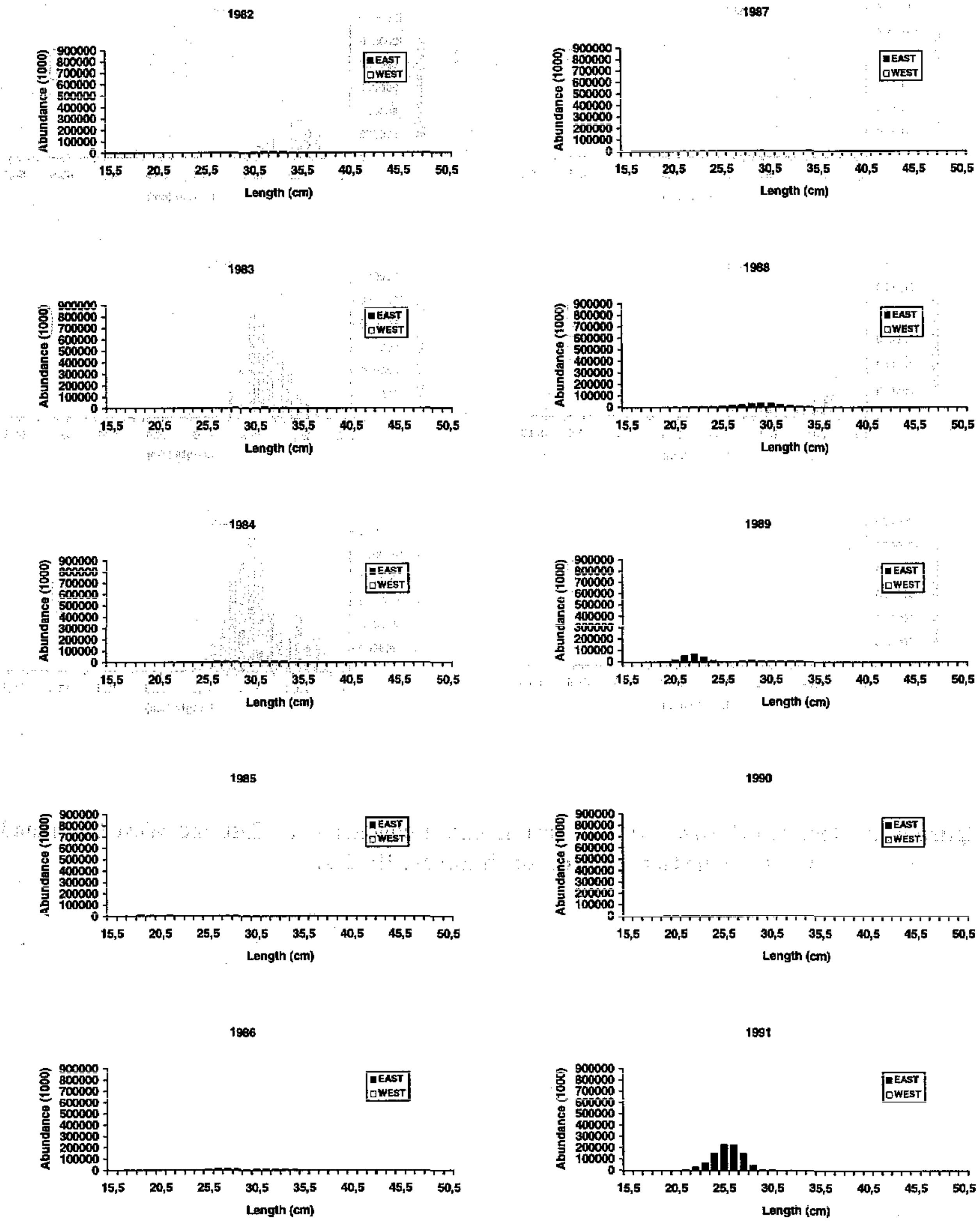


Figure 9.2.5 Deep sea *S. mentella* (≥17 cm). Length frequencies for East and West Greenland as derived from the German groundfish survey, 1982-91.

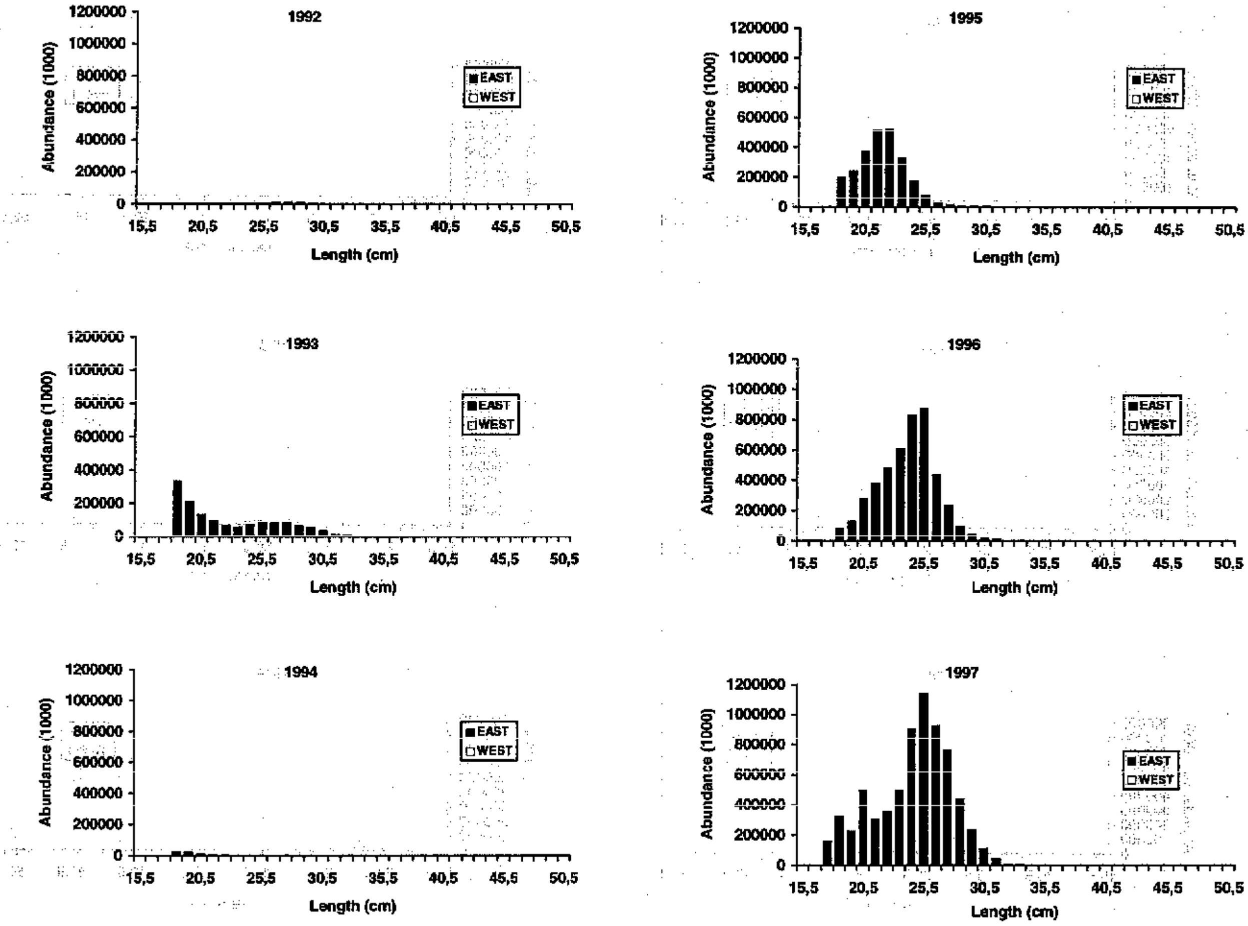


Figure 9.2.6 Deep sea *S. mentella* (≥17 cm). Length frequencies for East and West Greenland as derived from the German groundfish survey, 1992-97.

10 OCEANIC *Sebastes mentella*

10.1 Fishery on oceanic *S. mentella*

10.1.1 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 176,000 t (Tables 10.1.1–10.1.2). In 1997 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 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 1997 at a depth range of 180 to 950 m, but mainly deeper than 600 m. Icelandic trawlers fished mainly on depth 600-800 m during the period 1995–1997 (Table 10.1.3 Figure 10.1.1).

10.1.2 Description of the various fleets in 1997.

Trawlers from at least 19 countries participated in the fishery in 1997. 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 some fleets fishing in the Irminger Sea in 1997:

Russia	40 factory trawlers of eight types , ranged from 2000 to 4500 hp
Iceland	25 factory trawlers and 2 freshfish trawlers
Norway	3 factory trawlers
Spain	4 freezing trawlers
Germany	9 factory trawlers and 1 freshfish trawler
Faroes	1 factory trawler and 6 freshfish trawlers

Information about the other fleets is not available.

10.1.3 Trends in landings and fisheries on oceanic S. *mentella*

Catch data for 1995 are estimated at 173,000 t (Table 10.1.1–10.1.2) and for 1996 at 176,000 t, the highest recorded in this fishery. A preliminary estimate of a total catches in 1997 is 120,000 t but may reach 140,000 t due to the lack of reportings from Bulgaria, Latvia, Lithuania and Ukraine.

Iceland presented the discard rate of 10 % (see section 7.6.2 and Table 7.6.2). Norway used the discard rate of 3 %.

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 conversion factors used by Iceland, Norway and Russia were presented at the meeting. A report from a co-financed EU-project on the currently used conversion factors (for many species and product categories) is also available on the Internet (http://www.ifremer.fr/cofrepeche).

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]
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.

At the beginning of the fishery in 1982, catches of oceanic 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 1996–1997 the main part of the total catch were taken from Sub-area XIV - 134,000 t and 85,000 t (Table 10.1.1).

The landings of oceanic *S. mentella* from Division Va has amounted about 2,000 t since the fishery started in 1992, except in 1994 when more than 15 000 t were caught in this area. In 1996 5,000 t were caught there. In 1997 about 15,000 t of oceanic were taken in Va area (Table 10.1.1).

In Table 10.1.4 the CPUE series for Bulgarian, German, Icelandic, Norwegian, Russian, and Spanish fleets are given. Table 10.1.5. shows catches, effort and CPUE by depth for the Icelandic fleet during the period 1989–1996. As can be seen from the table more than 90 % of the Icelandic catches were taken below 500 m. In Figure 10.1.2. the development of CPUE in three depth intervals is illustrated graphically. Figure 10.1.3 shows the CPUE from different fleets in recent years. Greenland presented a catch rate index for 1993–1997 of the fishery within the Greenland EEZ based on log-book data from selected vessels reporting to Greenland authorities (WD 14). After a possible learning period in the fishery the estimated indices show a rather stable situation since 1994.

Length distributions of oceanic *S. mentella* from German, Icelandic, Russian and Spanish commercial catches were reported for 1997 and are given in Figure 10.1.4.

10.2 Assessment

10.2.1 Acoustic assessment

The trawl-acoustic survey on oceanic *S. mentella* in the Irminger Sea and adjacent waters was carried out by Russia in June-July 1997 (WD 22). Approximately 159,000 sq. nm were covered in the traditional area of oceanic redfish distribution on depth between 0-500 m. The acoustic assessment yielded a stock size of about 1.24 million t or 2.4 billion individuals, i.e. 400 000t less than previous acoustic estimates (see text table below).

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

It should be noted that the area covered in 1997 survey was smaller than the previous year and made with only one vessel. The acoustic estimate, which is considered to be an absolute measure of the fishable stock, covers only the pelagic redfish shallower than 500 metres. More and more of the catches, however, are taken deeper than 500 metres.

10.2.2 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 10.2.1.

10.2.3 State of the stock

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

Both survey estimates and CPUE of four fleets have decreased in a similar manner during the last 3 years. 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 decreased by approx. 45 %. During 1995-97, the survey estimates decreased by 50 % from 2.5 million t to 1.2 million t.

There have been observed changes in the environmental conditions in the Irminger Sea during the last years (WD22), which could affect the behaviour of the redfish in the area. At 200-500 m depth, the sea water temperature has 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 the 1997 survey design.

10.3 Management considerations

For the oceanic redfish there have been some discussion in the past about MBAL (previous NWWG reports), and it has been measured 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 due to an unsustainable catch level.

It is, however, not clear so far, to which degree the environmental changes have contributed to the sudden decrease in the stock indices.

10.4 Special comments

It should be underlined that since no reliable information is available on the recruitment processes for this stock, it will at present be impossible to detect a reduction in the recruitment before the fish enter the fishable part of the stock at an age of at least 10–15 years. The stock could therefore suffer from recruitment failure in years before it is possible to observe it.

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.

Due to the low acoustic estimate from the 1997 survey and signs of a decrease in the commercial CPUEs, the Working Group suggests the need for an international acoustic survey within the next year.

Table 10.1.1 Oceanic *S. mentella*. Landings (in tonnes) by area as used by the Working Group. Due to incomplete area reportings, the of exact shere 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	16,666	21,551	38,217
1990	0	0	0	7,039	24,477	31,516
1991	0	0	0	10,061	17,088	27,149
1992	1,968	0	0	23,249	40,745	65,962
1993	2,603	0	0	71,512	39,639	113,754
1994	15,472	0	0	93,741	39,028	148,241
1995	1,543	0	0	128,982	42,172	172,698
1996 [1]	4,610	0	0	38,828	133,163	176,601
1997 [1]	15,253	0	0	16,354	87,706	119,313

Table 10.1.2 Oceanic *S. mentella*.catches (in tonnes) by countries used by the Working Group.

Year	Bulgaria	Canada	Estonia	Faroes	France	FRG [3]	Greenland	Iceland	Japan	Latvia	Lithuania	Netherlands	Norway	Poland	Portugal	Russia [2]	Spain	Ukraine	UK	Total
1981	0		0	0	0	0	0	0					0	0		0				0
1982	0		0	0	0	0	0	0					0	581		60,000				60,581
1983	0		0	0	0	155	0	0					0	0		60,079				60,234
1984	2,961		0	0	0	989	0	0					0	239		60,643				64,832
1985	5,825		0	0	0	5,438	0	0					0	135		60,273				71,671
1986	11,385		0	5	0	8,574	0	0					0	149		84,994				105,107
1987	12,270		0	382	0	7,023	0	0					0	25		71,469				91,169
1988	8,455		0	1,090	0	16,848	0	0					0	0		65,026				91,419
1989	4,546		0	226	0	6,797	0	3,816					0	112		22,720				38,217
1990	2,690		0	0	0	7,957	0	4,537					7,085	0		9,247				31,516
1991	0		2,195	115	0	571	0	8,783					6,198	0		9,289				27,150
1992	628		1,810	3,765	2	6,447	9	15,478		780	6,656		14,654	0		15,733				65,962
1993	3,216		6,365	7,121	0	17,498	8	22,908		6,803	7,899		14,990	0		24,165		2,782		113,754
1994	3,600		17,875	2,896	606	17,152	0	53,332		13,205	7,404		6,909	0	1,887	17,814		5,561		148,241
1995	3,800	602 [4]	16,854	5,239	226	18,985	156	34,631	1,148	5,003	22,893	13	8,101	0	5,125	42,182	4,555	3,185		172,698
1996 [1]	3,500	650	7,092	6,271	0	21,245	0	62,903	415	1,084	10,649	0	6,658	0	2,379	45,748	7,229	518	260	176,601
1997 [1]	0	111	1,985	3,420	0	20,447	0	41,272	31	0	0	0	3,179	776	3,644	36,930	7,500	0	0	119,295

1) Provisional data.
2) USSR 1981-1991; Russia since 1992.
3) Includes former GDR.
4) Taken in NAFO area 1F.

Table 10.1.3. Oceanic *S. mentella* landings (in tonnes) in 1997 by countries and depth (A), and in 1996-1997 by depth (B). (Working Group figures and/or as reported to NEAFC).

A.	Total	not splitted	shallower than 600 m	deeper than 600 m
Canada	111	111		
Estonia	1,985	1,985		
Faroes	3,420			3,420
Germany	20,447		14,202	6,245
Iceland	41,272		7,397	33,875
Japan	31	31		
Norway	3,179		732	2,447
Poland	776	776		
Portugal	3,644	3,644		
Russia	36,930	36,930		
Spain	7,500		1,814	5,686
	119,295	43,477	24,145	51,673

B.	Total	not splitted	shallower than 600 m	deeper than 600 m
1996	176,655	76,554	24,618	75,483
1997	119,295	43,477	24,145	51,673

Table 10.1.4 Oceanic *S. mentella*. Catch per unit effort in Sub-areas XII and XIV.

Year	CPUE (t/h)					
	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	1.22	-	1.00	-
1990	-	0.89	1.02	1.09	0.99	-
1991	-	-	1.51	1.42	0.80	-
1992	-	-	1.66	1.79	0.63	-
1993	-	-	3.28	2.02	0.63	-
1994	-	-	2.64	2.83	1.70	-
1995	-	2.06	2.02	2.05	1.00	-
1996	-	1.45	1.76	1.20	1.30	-
1997[1]	-	1.31	1.07	0.72	-	0.83

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

Table 10.1.5. CPUE, trawling time and catch of "oceanic" redfish by depth intervals since 1989 as reported in log-books from the Icelandic fleet.

CPUE

Depth	89	90	91	92	93	94	95	96	97
100-199	0.75	0.99	1.30	1.07		1.31		0.08	1.53
200-299	1.83	1.17	1.32	1.46		1.89	1.42	2.31	1.63
300-399	1.69	0.96	1.91	2.50	5.61	3.21	2.40	0.96	1.56
400-499	1.33	0.53	2.38	1.69	4.03	3.41	2.58	1.08	0.86
500-599			0.95	1.18	2.70	2.90	2.06	1.32	0.99
600-699				1.90	2.69	2.53	2.10	1.46	1.15
700-799				3.14	1.75	2.21	2.16	2.01	1.08
800-899						3.49	2.00	2.53	0.92
900+							1.93	1.02	

Sum of Hours

Depth	89	90	91	92	93	94	95	96	97
100-199	300	844	1564	847		9		16	61
200-299	152	352	1009	1447		315	2019	925	224
300-399	99	333	738	1208	428	269	656	78	1049
400-499	5	13	371	228	480	291	347	392	814
500-599			97	765	1110	2865	1432	2669	2261
600-699				403	1107	5087	4253	7289	10721
700-799				36	41	829	2993	10746	9553
800-899						76	25	807	485
900+							46	318	

Sum of Catch(tonnes)

Depth	89	90	91	92	93	94	95	96	97
100-199	226.0	839.2	2034.7	908.0		12.0		1.2	94.0
200-299	278.5	410.6	1335.5	2115.0		595.8	2873.9	2133.1	365.6
300-399	167.5	318.5	1408.2	3016.1	2401.5	863.0	1571.9	74.8	1635.1
400-499	6.0	7.1	882.0	385.0	1934.5	990.0	895.0	423.3	698.2
500-599			92.5	903.3	2998.1	8310.9	2955.1	3521.5	2246.1
600-699				765.0	2975.0	12855.7	8915.3	10678.1	12360.5
700-799				113.0	71.0	1836.0	6461.5	21560.0	10270.3
800-899						267.0	50.0	2038.3	446.2
900+							88.0	325.5	

Table 10.2.1. Oceanic *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

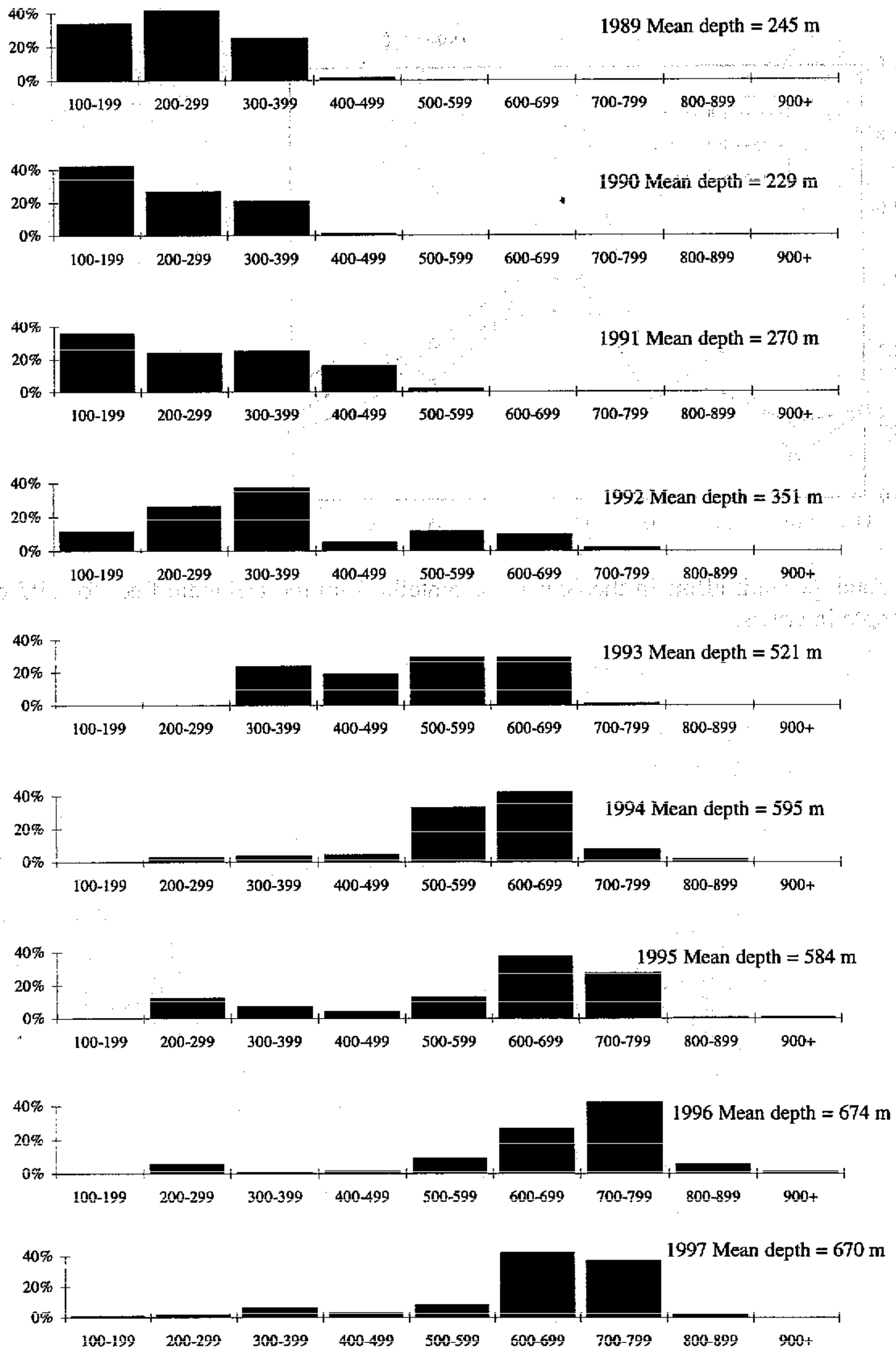


Figure 10.1.1. Depth distribution of trawl hauls of the icelandic fleet in the irminger sea since 1989 from trawler log-books. Indicated depth as depth of the headline of the trawl.

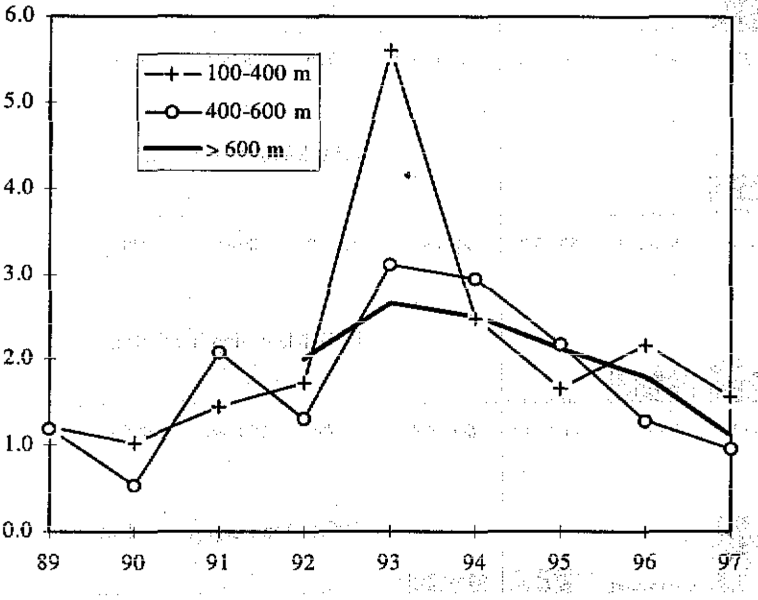


Figure 10.1.2. Catch per unit effort in the oceanic s.mentella from the icelandic fleet for different depth intervals.

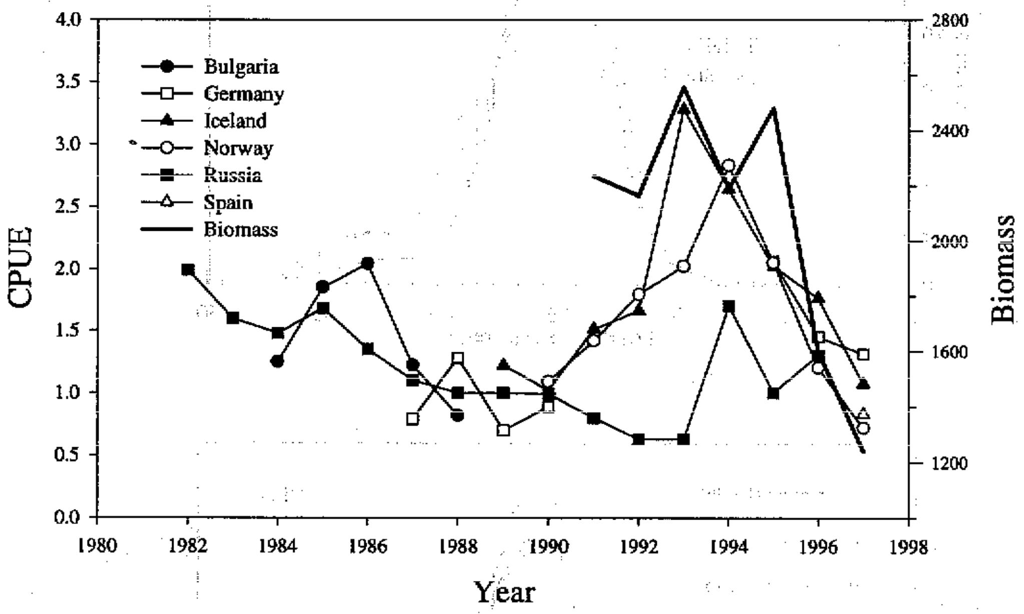


Figure 10.1.3 Trends in CPUE of oceanic *S. mentella* inthe Irminger Sea and estimated acoustic biomass.

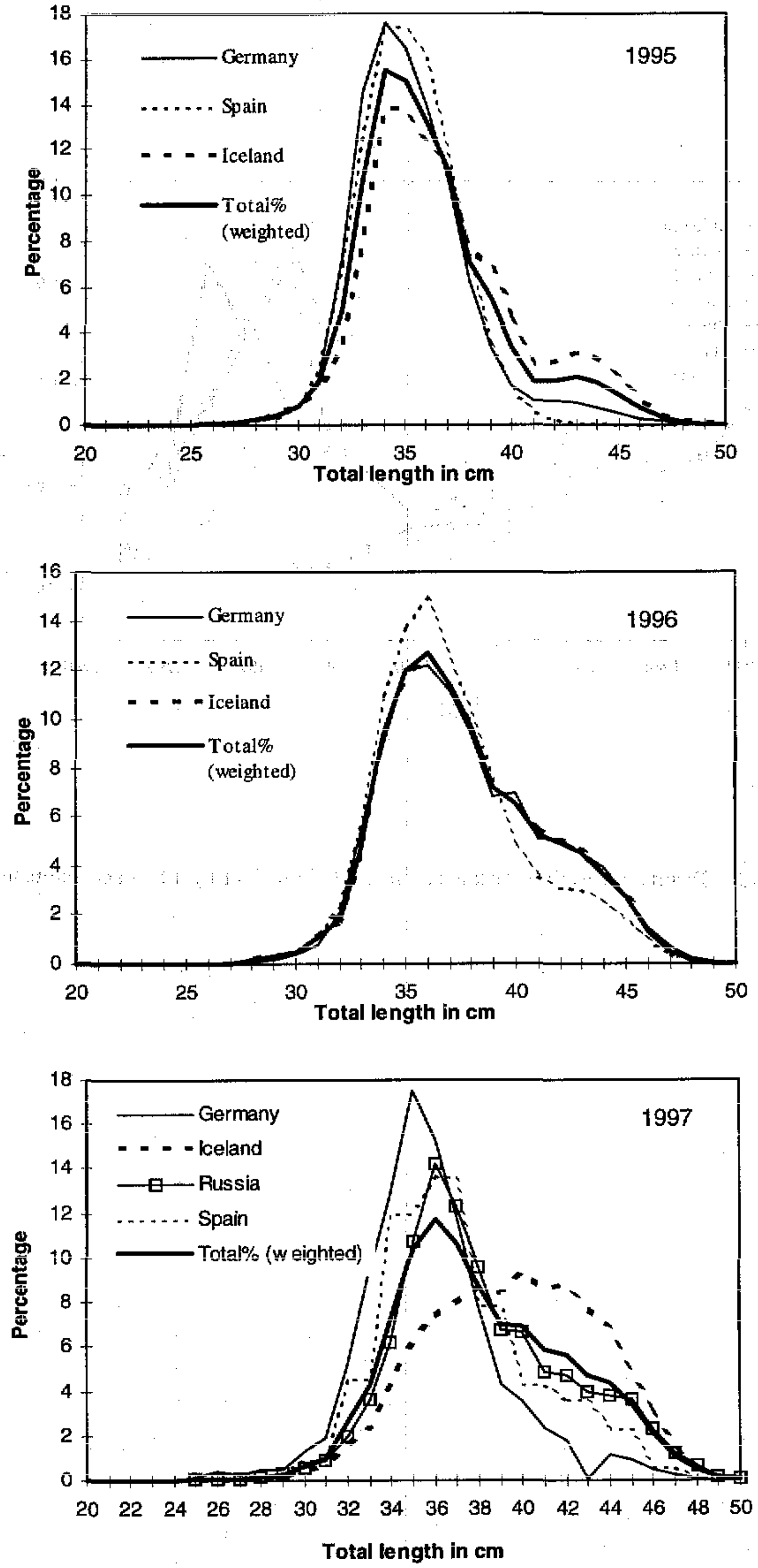


Figure 10.1.4. Length distributions from landings of oceanic *s.mentella* in 1995-1997

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26 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. 1998/G:3, Ref.H); b) Report of the Study Group on the Precautionary Approach to Fisheries Management (ICES C.M.1998/ACFM:10, Ref.D); c) Selectivity in longline fishery for Greenland halibut (J.Boje, R.Holst and A.Woll; ICES FTFB WG Meeting).

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25) Torhild Johansen, Anna Kristin Danielsdottir and Gunnar Naevdal,1998. Regarding *S. mentella* types at Iceland and in the Irminger Sea; preliminary results.

26) Hoskuldur Bjornsson, 1998. Description of the use of a multispecies model for cod assessment.

ANNEX 1

NORTH-WESTERN WORKING GROUP

ICES, Headquarters, 28 April - 6 May 1998

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