Advisory Committee on Fishery Management **ICES CM 1997/Assess:13**

REPORT OF THE

NORTH-WESTERN WORKING GROUP

ICES, Headquarters
29 April - 7 May 1997

Part 2 of 2

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International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

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, standardized, 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 summarized 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 analyzed 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 a 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 limit. 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 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 continued in 1995 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, fisheries for all fleet categories have been increasing.

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. This lead to a slight increase in effort by the gillnet fleet, effort of the longliners declined compared to 1995 and effort of the trawlers was unchanged between these years.

Trends in fishing mortality by fleet (Figure 3.3.1.) 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.

Fishing mortality by age (Figure 3.3.2.) for the gillnetters and the Danish seiners show that these fleet exploit mainly the oldest age-groups (8-12) whereas the longliners and especially the handliners exploit the younger ages.

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, handline lines 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 10-15 000 cod otoliths have been read. The age-length keys have then been used to convert about 100-150 000 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 of samples of otoliths and lengths along with length distributions and length-weight relationships.

The mean weights at age are computed for the same categories as the catch numbers at age and are then weighted together across the 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 1996, 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 was a marked increase in the proportion of mature fish at age during the period 1992-1995 (Figure 3.3.3). However in 1996 a decrease was noted both in the Groundfish survey and in the catches. The latest information available from the 1997 Groundfish survey and also supported with data collected from the commercial fleet show an upward trend in 1997 spawning season. 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 analyzed 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 1991-1996.

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. southwestern areas, and northern areas (Table 3.3.8).

The same method was applied for the gillnet fleet. Logbooks for this fleet have been analyzed for the years 1991-1996 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 1997 survey abundance indices were moved back in time of approximately three months i.e. to December 1996. The same applies to abundance indices for the other survey years. 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):

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

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

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:

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

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.= 0.6 is given in Figure 3.3.4. This run was adopted by the Working Group as it resulted in a slightly better fit than using the standard default settings 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 1996 (see Table 3.3.15).

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 1992-1994 as 3-year-olds in 1995-1997) was estimated using RCT3 as described in Section 3.3.8.4.

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 landings and 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).

It has been illustrated that not only may cetaceans have a considerable impact on future yields from Va cod (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. The medium-term predictions are therefore based on the model given in Stefánsson *et al* (1997), with modifications as described in 3.3.8.2.

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 1992-1996. 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 and a selection pattern which averaged to 1 over ages 5-10. The selection patterns were averaged in time to produce a single selection pattern for each fleet. The results are given as average fishing mortalities at age and trends with time in Figures 3.3.2 and 3.3.1, respectively.

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 3.3.16 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 1997-1999. For 1997 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 1994-1996 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. First observations in 1997 both from the commercial landings as from the Icelandic Groundfish survey show an upwards trend again. For the short-term predictions the average for the years 1992-1996 has been used for the years 1997-1999.

The exploitation pattern used for the short-term predictions was taken as the average of the years 1994-1996 from the VPA.

3.3.8.2 Assumptions and input data for the medium-term prediction

The principle of the medium-term simulation is as in previous assessments for this stock. Thus, the cod stock and catches are projected forward in time with the usual catch and stock equations. The capelin and shrimp stocks are projected forward in the same model, using simple biomass-based models (Stefánsson *et al.*, 1994). The mean weights at age of the cod depend to some extent on the size of the capelin stock and this is used in all projections, as described elsewhere in this report. The cod stock affects the natural mortality of the modelled capelin and shrimp stocks and this affects the modelled yields of those stocks.

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, not only as is reflected in the Ricker function but also through the negative relationship between recruitment and older, immature fish (Bogstad *et al.* 1997). 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. In order to accommodate this effect, the medium-term predictions are undertaken by taking the cod dynamics back to age 1, by backcalculating with an average mortality. The simulated recruitment at age 1 is then projected forwards by including the effects of the various predators and fishery.

Earlier work has considered in some detail the possible effects of different strategies for the management of marine mammals. This is not of primary interest here. Rather, the emphasis is to simulate a likely harvesting strategy for all species in the model. Thus, simulations are undertaken with the assumption that whaling operations will not commence and that seals will be harvested in a sustainable fashion at present stock levels.

Since there is an adopted strategy for harvesting the cod stock off Iceland, and this strategy appears sustainable, there is no reason to consider a large number of alternatives. Thus, only the base case scenario where the cod quota is set to 25% of the 4+ biomass will be considered.

The input data to the prediction is the same as that of the short-term prediction.

3.3.8.3 Input data to the long-term prediction

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

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

Mean weight and maturity at age have been predicted as the average over the years 1976-1996.

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

3.3.8.4 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 3.3.17. As an input to the RCT3 program age groups 1-4 from the survey were chosen.

The size of the year classes 1992-1996 has been estimated using RCT3, with the output as given in Table 3.3.18. The revised recruitment estimates are then discounted with natural and fishing mortalities for use in the predictions.

3.3.8.5 Short term prediction results

Input to the projections is given in Table 3.3.19. Results from projections up to the year 1999 with different fishing mortalities are given in Table 3.3.20.

Landings in 1997 are expected to be 200 000 t due an increase in the quota established. This will however mean a further decrease in fishing mortality to F=0.45 compared to F=0.57 in 1996.

Continuing fishing in 1998 at the expected 1997 level of fishing mortality (F=0.45) 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.

3.3.8.6 Medium term prediction results

The adopted harvesting strategy is simulated, taking into account some of the variations in food supply (through capelin) and some of the variations in natural mortality (through cannibalism and predation by marine mammals). The resulting projected trajectories of yield and biomass are given in Figures 3.3.5 and 3.3.6. It is seen that there is about 50% probability that the yields will decrease again in the next few years, but also that this is not expected to be a major decline and in fact the probability that the current harvesting strategy will lead to a stock collapse seems to be very close to 0.

3.3.8.7 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 3.3.7 (Tables 3.3.20-21).

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 3.3.8. When using the period 1955-1994, the reference points F_{med} and F_{high} are about 0.48 and 0.77, respectively. Also shown in the same figure is the a fitted curve used in the medium-term simulations. It is seen that an F_{high} equilibrium does seem to be available if the stock-recruitment curve is assumed, but the existence of such an equilibrium is highly data-dependent.

It is seen that the predicted recruitment from the S-R curve at current spawning stock biomass levels of about 190 million individuals is much higher than the average recruitment obtained in recent years.

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 Figure 3.3.9) and hence in fishing mortality. Fishing mortality was at the level of F=0.80-0.90 in 1992-1993 but dropped considerably in 1994 to F=0.68 and again in 1995 to F=0.51. In 1996, it increased to F=0.57. In 1997, it is expected that the present restriction on cod catches will result in F=0.45 which is at the F_{med} level.

The inclusion of the stock recruitment relationship has a major effect on long-term predictions. From Figure 3.3.7 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 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.

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.

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, 1983- 1996 as officially reported to ICES.

Country	1983	1984	1985	1986	1987	1988	1989
Belgium	188	254	207	226	597	365	309
Faroe Islands	5,626	2,041	2,203	2,554	1,848	1,966	2,012
Iceland	293,890	281,481	322,810	365,852	389,808	375,741	353,985
Norway	109	90	46	1	4	4	3
UK (Engl. and Wales)	-	2	1	-	-	-	-
Total	299,813	283,868	325,267	368,633	392,257	378,076	356,309
WG estimate	-	-	-	-	-	-	-

Country	1990	1991	1992	1993	1994	1995	1996 [1]
Belgium	260	548	222	145	135	-	-
Faroe Islands	1,782	1,323	883	664	754	739	722
Iceland	333,348	306,697	266,662	251,170	175,296	168,685	180,676
Norway	-	-	-	-	-	4	7
UK (Engl. and Wales)	-	-	-	+	-	-	-
Total	335,390	308,568	267,767	251,979	178,808	169,428	181,405
WG estimate	-	-	-	-	-	-	181,532 [2]

1) Provisional.
2) Additional catch by Iceland of 127 t included.

Table 3.3.2. Cod at Iceland. Division Va. Landings (tonnes), effort, cpue and percentage changes in effort and cpue in the period 1991-1996 (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

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

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

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

Marine Research Institute Sat May 03 08:54:31 1997
Virtual Population Analysis : Catch in numbers, millions
Run12 FINAL-VPA

Age	1977	1978	1979	1980	1981	1982	1983
3	2.614	5.999	7.186	4.348	2.118	3.285	3.554
4	42.659	16.287	28.427	28.530	13.297	20.812	10.910
5	32.465	43.931	13.772	32.500	39.195	24.462	24.305
6	12.162	17.626	34.443	15.119	23.247	28.351	18.944
7	13.017	8.729	14.130	27.090	12.710	14.012	17.382
8	2.809	4.119	4.426	7.847	26.455	7.666	8.381
9	1.773	0.978	1.432	2.228	4.804	11.517	2.054
10	0.421	0.348	0.350	0.646	1.677	1.912	2.733
11	0.086	0.119	0.168	0.246	0.582	0.327	0.514
12	0.024	0.048	0.043	0.099	0.228	0.094	0.215
13	0.006	0.015	0.024	0.025	0.053	0.043	0.064
14	0.002	0.027	0.004	0.004	0.068	0.011	0.037
Juvenile	77.549	66.317	66.657	74.804	79.027	73.043	58.426
Adult	30.489	31.909	37.748	43.878	45.407	39.449	30.667
Sum 3- 3	2.614	5.999	7.186	4.348	2.118	3.285	3.554
Sum 4-14	105.424	92.227	97.219	114.334	122.316	109.207	85.539
Total	108.038	98.226	104.405	118.682	124.434	112.492	89.093

Age	1984	1985	1986	1987	1988	1989	1990
3	6.750	6.457	20.642	11.002	6.713	2.605	5.785
4	31.553	24.552	20.330	62.130	39.323	27.983	12.313
5	19.420	35.392	26.644	27.192	55.895	50.059	27.179
6	15.326	18.267	30.839	15.127	18.663	31.455	44.534
7	8.082	8.711	11.413	15.695	6.399	6.010	17.037
8	7.336	4.201	4.441	4.159	5.877	1.915	2.573
9	2.680	2.264	1.771	1.463	1.345	0.881	0.609
10	0.512	1.063	0.805	0.592	0.455	0.225	0.322
11	0.538	0.217	0.392	0.253	0.305	0.107	0.118
12	0.195	0.233	0.103	0.142	0.157	0.086	0.050
13	0.090	0.102	0.076	0.046	0.114	0.038	0.015
14	0.036	0.038	0.040	0.058	0.025	0.005	0.020
Juvenile	65.651	69.001	80.654	107.928	103.170	82.565	65.114
Adult	26.867	32.496	36.842	29.931	32.101	38.804	45.441
Sum 3- 3	6.750	6.457	20.642	11.002	6.713	2.605	5.785
Sum 4-14	85.768	95.040	96.854	126.857	128.558	118.764	104.770
Total	92.518	101.497	117.496	137.859	135.271	121.369	110.555

Age	1991	1992	1993	1994	1995	1996
3	8.554	12.217	20.500	6.160	10.768	5.352
4	25.131	21.708	33.078	24.142	9.102	14.874
5	15.491	26.524	15.195	19.666	16.827	7.366
6	21.514	11.413	13.281	6.968	13.064	12.297
7	25.038	10.073	3.583	4.393	4.115	9.422
8	6.364	8.304	2.785	1.257	1.596	2.155
9	0.903	2.006	2.707	0.599	0.313	0.836
10	0.243	0.257	1.181	0.508	0.184	0.208
11	0.125	0.046	0.180	0.283	0.156	0.076
12	0.063	0.032	0.034	0.049	0.141	0.065
13	0.011	0.012	0.011	0.018	0.029	0.055
14	0.012	0.008	0.013	0.006	0.008	0.005
Juvenile	60.283	48.743	45.914	26.361	21.950	31.777
Adult	43.166	43.857	46.634	37.688	34.353	20.934
Sum 3- 3	8.554	12.217	20.500	6.160	10.768	5.352
Sum 4-14	94.895	80.383	72.048	57.889	45.535	47.359
Total	103.449	92.600	92.548	64.049	56.303	52.711

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 03 08:54:31 1997
Virtual Population Analysis : Weight at age in the catches, in grams
Run12 FINAL-VPA

Age	1977	1978	1979	1980	1981	1982	1983
3	1259	1289	1408	1392	1180	1006	1095
4	1911	1833	1956	1862	1651	1550	1599
5	2856	2929	2642	2733	2260	2246	2275
6	4069	3955	3999	3768	3293	3104	3021
7	5777	5726	5548	5259	4483	4258	4096
8	6636	6806	6754	6981	5821	5386	5481
9	7685	9041	8299	8037	7739	6682	7049
10	9730	10865	9312	10731	9422	9141	8128
11	11703	13068	13130	12301	11374	11963	11009
12	14394	11982	13418	17281	12784	14226	13972
13	17456	19062	13540	14893	12514	17287	15882
14	24116	21284	20072	19069	19069	16590	18498

Age	1984	1985	1986	1987	1988	1989	1990
3	1288	1407	1459	1316	1438	1186	1290
4	1725	1971	1961	1956	1805	1813	1704
5	2596	2576	2844	2686	2576	2590	2383
6	3581	3650	3593	3894	3519	3915	3034
7	4371	4976	4635	4716	4930	5210	4624
8	5798	6372	6155	6257	6001	6892	6521
9	7456	8207	7503	7368	7144	8035	8888
10	9851	10320	9084	9243	8822	9831	10592
11	11052	12197	10356	10697	9977	11986	10993
12	14338	14683	15283	10622	11732	10003	14570
13	15273	16175	14540	15894	14156	12611	15732
14	16660	19050	15017	12592	13042	16045	17290

Age	1991	1992	1993	1994	1995	1996	1997
3	1309	1289	1392	1443	1348	1457	1416
4	1899	1768	1887	2063	1959	1930	2062
5	2475	2469	2772	2562	2920	3132	2839
6	3159	3292	3762	3659	3625	4141	4206
7	3792	4394	4930	5117	5176	4922	5536
8	5680	5582	6054	6262	6416	6009	6375
9	7242	6830	7450	7719	7916	7406	7680
10	9804	8127	8641	8896	10273	9772	9647
11	9754	12679	10901	10847	11022	10539	10803
12	14344	13410	12517	12874	11407	13503	12595
13	14172	15715	14742	14742	13098	13689	13843
14	20200	11267	16874	17470	15182	16194	16282

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

Marine Research Institute Sat May 03 08:54:31 1997
Virtual Population Analysis : Weight at age in the SSB, in grams
Run12 FINAL-VPA

Age	1977	1978	1979	1980	1981	1982	1983
3	960	1031	1141	1333	967	996	891
4	1723	1671	1647	1680	1513	1626	1472
5	2729	2863	2532	2708	2101	2095	2139
6	4108	3920	4027	3875	3225	3006	2918
7	5957	5976	5664	5446	4520	4339	4130
8	6696	6946	6951	7106	5851	5571	5553
9	7618	9204	8234	8120	7661	6801	7007
10	9669	10833	9500	10737	9084	9259	7770
11	12578	12920	12921	12628	10833	11550	10817
12	13884	12863	13028	17528	12401	13445	13176
13	17026	19104	13308	15939	11724	17138	14175
14	24652	21183	18930	25212	14326	16554	18543

Age	1984	1985	1986	1987	1988	1989	1990
3	1002	1131	1182	1289	1218	1012	813
4	1479	1597	1762	1811	1604	1542	1330
5	2257	2285	2681	2735	2499	2423	2132
6	3476	3524	3562	4202	3566	3743	3187
7	4480	5010	4824	5110	5161	5298	4691
8	5887	6195	6457	6497	6238	6910	6627
9	7660	7800	7843	7802	7302	7725	8915
10	9920	9225	9419	10220	8647	9397	10362
11	11035	11336	10674	11197	10184	11953	12093
12	14531	13277	13660	10620	11504	9529	15453
13	15378	15325	13812	15893	14159	12195	15337
14	16394	18932	18479	16514	10952	14270	17257

Age	1991	1992	1993	1994	1995	1996	1997
3	1122	876	1037	1193	1066	1264	1174
4	1776	1389	1570	1748	1826	1627	1734
5	2233	2174	2518	2382	2735	2600	2563
6	3044	3185	3611	3684	3497	3829	3846
7	3891	4481	4872	5175	4741	4605	5142
8	5897	5587	6150	6210	6126	5792	6116
9	7657	6775	7538	7676	7582	7550	7603
10	10573	8225	8840	8814	9887	9433	9378
11	11230	11702	11088	10842	10829	11293	10988
12	14340	13474	12002	12595	11307	12984	12295
13	14172	15436	14402	14402	13098	13821	13774
14	20200	11267	18383	17470	15182	16194	16282

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

Marine Research Institute Sat May 03 08:54:31 1997
Virtual Population Analysis : Sexual maturity at age in the stock
Run12 FINAL-VPA

Age	1977	1978	1979	1980	1981	1982	1983
3	0.000	0.049	0.000	0.056	0.000	0.023	0.000
4	0.047	0.050	0.019	0.023	0.029	0.051	0.087
5	0.213	0.185	0.189	0.165	0.085	0.129	0.167
6	0.611	0.443	0.531	0.478	0.289	0.226	0.338
7	0.881	0.877	0.793	0.807	0.659	0.544	0.515
8	0.960	0.962	0.929	0.915	0.890	0.849	0.717
9	0.990	0.982	0.982	0.979	0.952	0.956	0.857
10	1.000	1.000	0.919	0.977	0.962	0.967	0.979
11	1.000	1.000	1.000	1.000	0.988	1.000	0.985
12	1.000	1.000	1.000	0.964	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Age	1984	1985	1986	1987	1988	1989	1990
3	0.000	0.027	0.005	0.020	0.039	0.000	0.000
4	0.043	0.058	0.054	0.046	0.020	0.048	0.075
5	0.189	0.202	0.244	0.238	0.206	0.226	0.303
6	0.416	0.548	0.543	0.585	0.477	0.550	0.633
7	0.656	0.774	0.762	0.808	0.690	0.820	0.819
8	0.782	0.903	0.891	0.942	0.831	0.858	0.912
9	0.858	0.938	0.981	0.952	0.929	0.887	0.953
10	0.949	1.000	0.962	1.000	0.946	0.991	0.986
11	0.969	1.000	0.988	0.979	0.974	1.000	1.000
12	0.948	1.000	1.000	1.000	0.821	0.903	1.000
13	1.000	1.000	1.000	1.000	1.000	0.859	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Age	1991	1992	1993	1994	1995	1996	1997
3	0.000	0.072	0.078	0.096	0.043	0.078	0.073
4	0.063	0.225	0.246	0.281	0.394	0.097	0.249
5	0.214	0.562	0.470	0.570	0.729	0.512	0.569
6	0.543	0.706	0.714	0.796	0.849	0.742	0.761
7	0.781	0.906	0.939	0.895	0.853	0.862	0.891
8	0.887	0.961	0.984	0.919	0.954	0.911	0.946
9	0.945	0.977	0.973	1.000	1.000	0.841	0.958
10	0.842	1.000	0.968	0.852	1.000	1.000	0.964
11	1.000	1.000	1.000	0.985	1.000	1.000	0.997
12	1.000	1.000	1.000	1.000	1.000	0.986	0.979
13	1.000	1.000	1.000	1.000	1.000	0.971	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 1991-1996 used in XSA tuning.

Trawl Jun-Dec. N

Age/year	5	6	7	8
1991	653	793	624	88
1992	772	336	257	102
1993	458	349	137	60
1994	1113	229	105	27
1995	1417	1124	154	95
1996	911	1026	478	82

Trawl Jun-Dec. S

Age/year	6	7	8	9
1991	329	411	202	54
1992	115	220	277	70
1993	196	87	71	73
1994	150	69	35	0
1995	552	55	0	0
1996	597	331	29	22

Trawl-Jan-May-N

Age/year	5	6	7	8
1991	468	911	1306	188
1992	992	661	378	165
1993	813	667	105	44
1994	1376	503	343	51
1995	1961	1373	275	157
1996	760	1386	745	134

Trawl-Jan-May-S

Age/year	5	6	7	8	9
1991	155	401	1011	295	59
1992	265	328	373	489	79
1993	463	264	44	75	68
1994	1032	359	136	26	11
1995	557	802	330	51	0
1996	172	513	426	75	17

Table 3.3.9. Cod at Iceland. Division Va. Gillnet CPUE (GLM) indices 1991-1996 used in XSA tuning.

Gillnet Jan-May S

Age/year	6	7	8	9
1991	254	847	432	54
1992	142	359	669	212
1993	181	160	203	280
1994	242	292	134	63
1995	410	414	209	63
1996	480	506	230	115

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

IceGFS. N

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

IceGFS. SE

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

IceGFS.
SW.

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

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

Lowestoft VPA Version 3.1

30/04/1997 9:20

Extended Survivors Analysis

"ICELANDIC COD (Div. Va); data from 1970-96(4/97)"

CPUE data from file codvarnt.dat

Catch data for 13 years. 1984 to 1996. Ages 3 to 14.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
IceGFS. N.	1984	1996	3	8	0.99	1
IceGFS. SE	1984	1996	3	8	0.99	1
IceGFS. SW.	1984	1996	3	8	0.99	1
TRAWL-JUN-DEC-N	1991	1996	5	8	0.58	1
TRAWL-JUN-DEC-S	1991	1996	6	9	0.58	1
TRAWL-JAN-MAY-N	1991	1996	5	8	0	0.58
TRAWL-JAN-MAY-S	1991	1996	5	9	0	0.58
GILLNET-JAN-MAY-S	1991	1996	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 = .600

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	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
3	0.044	0.045	0.035	0.05	0.098	0.077	0.143	0.089	0.081	0.036
4	0.308	0.218	0.264	0.232	0.314	0.387	0.31	0.251	0.185	0.154
5	0.517	0.505	0.136	0.444	0.511	0.646	0.517	0.306	0.278	0.224
6	0.784	0.839	0.601	0.638	0.776	0.918	0.811	0.477	0.343	0.337
7	0.974	0.955	0.727	0.787	0.949	1.111	0.861	0.703	0.581	0.448
8	0.995	1.4	0.879	0.818	0.79	1.026	1.164	0.879	0.603	0.7
9	0.974	1.12	0.82	0.792	0.783	0.622	1.246	0.863	0.56	0.754
10	0.705	0.984	0.548	0.836	0.888	0.533	0.968	0.839	0.723	0.939
11	0.578	1.035	0.656	0.63	0.968	0.401	0.92	0.649	0.678	0.765

12	0.653	0.9	0.981	0.752	0.851	0.715	0.59	0.697	0.813	0.681
13	0.746	2.336	0.564	0.439	0.359	0.267	0.577	0.733	1.304	0.91
14	0.677	1.33	0.694	0.668	0.774	0.484	0.774	0.733	0.885	0.834

1

XSA population numbers (Thousands)

	AGE									
YEAR	3	4	5	6	7	8	9	10	11	12
1987	2.83E+05	2.59E+05	7.44E+04	3.08E+04	2.79E+04	7.29E+03	2.60E+03	1.29E+03	6.37E+02	3.27E+02
1988	1.70E+05	2.22E+05	1.56E+05	3.63E+04	1.15E+04	8.62E+03	2.21E+03	8.03E+02	5.23E+02	2.92E+02
1989	8.33E+04	1.33E+05	1.46E+05	7.70E+04	1.29E+04	3.62E+03	1.74E+03	5.89E+02	2.46E+02	1.52E+02
1990	1.32E+05	6.58E+04	8.38E+04	1.04E+05	3.46E+04	5.09E+03	1.23E+03	6.28E+02	2.79E+02	1.05E+02
1991	1.01E+05	1.03E+05	4.28E+04	4.41E+04	4.51E+04	1.29E+04	1.84E+03	4.56E+02	2.23E+02	1.22E+02
1992	1.81E+05	7.48E+04	6.16E+04	2.10E+04	1.66E+04	1.43E+04	4.79E+03	6.88E+02	1.54E+02	6.93E+01
1993	1.70E+05	1.37E+05	4.16E+04	2.64E+04	6.86E+03	4.48E+03	4.20E+03	2.11E+03	3.31E+02	8.43E+01
1994	7.96E+04	1.20E+05	8.24E+04	2.03E+04	9.61E+03	2.37E+03	1.14E+03	9.89E+02	6.55E+02	1.08E+02
1995	1.53E+05	5.96E+04	7.67E+04	4.97E+04	1.03E+04	3.89E+03	8.07E+02	3.95E+02	3.50E+02	2.80E+02
1996	1.69E+05	1.15E+05	4.05E+04	4.75E+04	2.88E+04	4.73E+03	1.74E+03	3.77E+02	1.57E+02	1.45E+02

Estimated population abundance at 1st Jan 1997

0.00E+00	1.27E+05	8.29E+04	2.47E+04	2.78E+04	1.51E+04	1.91E+03	6.72E+02	1.21E+02	5.99E+01

Taper weighted geometric mean of the VPA populations:

1.48E+05	1.15E+05	7.30E+04	4.15E+04	1.74E+04	6.20E+03	2.18E+03	8.13E+02	3.57E+02	1.67E+02

Standard error of the weighted Log(VPA populations) :

0.4115	0.4379	0.4523	0.5086	0.5889	0.5766	0.6144	0.6071	0.6194	0.6393

	AGE	
YEAR	13	14
1987	9.67E+01	1.30E+02
1988	1.39E+02	3.76E+01
1989	9.74E+01	1.10E+01
1990	4.66E+01	4.53E+01
1991	4.03E+01	2.46E+01
1992	4.25E+01	2.31E+01
1993	2.77E+01	2.67E+01
1994	3.83E+01	1.28E+01
1995	4.40E+01	1.51E+01
1996	1.02E+02	9.77E+00

Estimated population abundance at 1st Jan 1997

6.04E+01	3.36E+01

Taper weighted geometric mean of the VPA populations:

7.10E+01	2.87E+01

Standard error of the weighted Log(VPA populations) :

0.725	0.8603

1

Log catchability residuals.

Fleet : IceGFS. N.

Age	1984	1985	1986
3	0.86	-0.08	0.33
4	0.62	0.26	-0.03
5	0.45	0.34	0.31
6	0.54	0.2	0.35
7	0.42	0.16	0.31
8	0.7	0.11	0.33
9	No data for this fleet at this age		

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
3	0.67	0.74	-0.53	0.01	-0.16	0.07	-0.35	-1.09	-0.25	0.52
4	0.41	0.41	-0.12	-0.11	-0.31	0.07	-0.26	-0.36	-0.34	0.31
5	-0.16	0.3	-0.01	0.1	-0.41	0.08	-0.31	-0.23	-0.21	0.22
6	0.31	-0.36	0.01	0.11	-0.29	-0.15	-0.14	-0.36	0.21	0.05
7	0.6	0.03	-0.49	-0.42	-0.44	0.02	-0.28	-0.31	0.52	0.31
8	0.23	0.63	0.16	-0.49	-1.15	-0.23	0.43	-0.37	0.32	-0.07
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	-1.7217	-1.6887	-1.9265	-2.3595
S.E(Log q)	0.2711	0.2715	0.3909	0.5157

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.51	2.901	6.58	0.8	13	0.22	-1.54
4	0.7	2.127	4.55	0.85	13	0.19	-1.56

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	0.81	1.322	3.57	0.84	13	0.21	-1.72
6	0.8	1.585	3.47	0.88	13	0.2	-1.69
7	0.98	0.1	2.1	0.7	13	0.4	-1.93
8	1.11	-0.347	1.63	0.5	13	0.6	-2.36
1							

Fleet : IceGFS. SE

Age	1984	1985	1986
3	-0.9	-0.27	-0.56
4	-0.79	0.02	-0.62
5	-0.53	0	-0.3
6	-0.26	-0.21	-0.15
7	-0.18	-0.32	-0.24
8	0.4	-0.26	-0.23
9	No data for this fleet at this age		

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
3	1.39	1.01	-1.4	-1.56	-0.12	0.47	0.55	0.11	0.27	0.49
4	0.7	1.11	-0.7	-1.33	-0.19	-0.07	0.36	0.92	0.12	0.05
5	-0.18	1.07	-0.07	-0.85	-0.15	-0.23	0.02	0.89	0.26	-0.24
6	-0.19	0.32	0.38	-0.36	0.27	-0.5	-0.05	0.54	0.49	-0.51
7	-0.11	0.42	0.04	-0.48	0.42	-0.32	-0.41	0.43	0.76	-0.29
8	-0.59	0.99	0.28	-0.05	-0.18	-0.6	-0.02	0.53	0.47	-0.67
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	-4.0675	-3.3554	-3.0025	-2.9846

S.E(Log q)	0.5309	0.3921	0.4186	0.5118

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.52	1.459	8.47	0.5	13	0.43	-5.25
4	0.56	1.683	7.71	0.62	13	0.36	-4.6

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	0.7	1.183	6.21	0.63	13	0.36	-4.07
6	1.06	-0.225	2.91	0.6	13	0.44	-3.36
7	1.21	-0.745	1.61	0.59	13	0.52	-3
8	1.45	-1.118	0.41	0.41	13	0.73	-2.98
1							

Fleet : IceGFS. SW.

Age	1984	1985	1986
3	-0.43	-0.67	-0.46
4	-0.19	-0.29	-0.95
5	-0.03	-0.27	-0.39
6	0.16	-0.31	-0.34
7	-0.01	-0.33	-0.49
8	0.3	-0.04	-0.53
9	No data for this fleet at this age		

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
3	-0.32	0.59	0.06	0.19	-0.52	0.2	0.4	-0.11	0.31	0.15
4	-0.14	0.38	0.51	0.31	-0.29	0.06	-0.02	0.27	0.1	-0.16
5	-0.6	0.28	0.4	0.61	-0.17	0.1	-0.31	0.22	0.14	-0.25
6	-0.11	-0.28	0.37	0.69	0.21	-0.31	-0.34	0.01	0.45	-0.33
7	0.1	-0.12	-0.13	0.27	0.5	-0.14	-0.65	-0.01	0.62	0.11
8	-0.39	0.63	0.3	0.43	0.17	-0.12	-0.17	-0.92	0.42	-0.04
9	No data for this fleet at this age									

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

Age	5	6	7	8
Mean Log q	-2.8648	-2.4892	-2.3912	-2.691
S.E(Log q)	0.349	0.3649	0.3732	0.4481

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	0.99	0.017	3.76	0.54	13	0.4	-3.71
4	1.03	-0.092	2.91	0.58	13	0.39	-3.13

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	0.71	1.914	5.31	0.83	13	0.22	-2.86

6	0.7	2.209	4.92	0.86	13	0.22	-2.49
7	0.78	1.516	4.03	0.84	13	0.27	-2.39
8	0.83	0.825	3.72	0.72	13	0.38	-2.69
1							

Fleet : TRAWL-JUN-DEC-N

Age		1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
	3	No data for this fleet at this age									
	4	No data for this fleet at this age									
	5	99.99	99.99	99.99	99.99	0.09	0	-0.23	-0.19	0.1	0.25
	6	99.99	99.99	99.99	99.99	0.21	0.2	-0.07	-0.49	0.1	0.05
	7	99.99	99.99	99.99	99.99	0.05	0.29	0.35	-0.37	-0.16	-0.16
	8	99.99	99.99	99.99	99.99	-0.63	-0.41	0.33	-0.05	0.5	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	-3.7117	-3.4652	-3.4363	-3.5796
S.E(Log q)	0.1868	0.2631	0.2837	0.4401

Regression statistics :

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

Age		Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
	5	1.18	-0.548	2.4	0.7	6	0.24	-3.71
	6	0.75	1.201	5.17	0.86	6	0.19	-3.47
	7	1.03	-0.131	3.27	0.86	6	0.33	-3.44
	8	1.84	-2.128	-0.66	0.62	6	0.62	-3.58
	1							

Fleet : TRAWL-JUN-DEC-S

Age		1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
	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	0.03	-0.17	0.05	-0.21	0.09	0.21
	7	99.99	99.99	99.99	99.99	0.11	0.61	0.37	-0.32	-0.71	-0.05
	8	99.99	99.99	99.99	99.99	0.07	0.46	0.37	0.07	99.99	-0.94
	9	99.99	99.99	99.99	99.99	0.47	-0.35	0.3	99.99	99.99	-0.4

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	-4.1635	-3.9121	-3.4457	-3.2267
S.E(Log q)	0.1616	0.4779	0.5621	0.4463

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
6	0.75	3.438	5.72	0.98	6	0.07	-4.16
7	0.91	0.312	4.45	0.74	6	0.48	-3.91
8	0.82	0.517	4.37	0.75	5	0.51	-3.45
9	1.08	-0.127	2.84	0.55	4	0.59	-3.23
1							

Fleet : TRAWL-JAN-MAY-N

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	99.99	99.99	99.99	99.99	-0.44	-0.02	0.14	-0.07	0.35	0.02
6	99.99	99.99	99.99	99.99	-0.19	0.26	0.01	-0.09	-0.02	0.03
7	99.99	99.99	99.99	99.99	0.19	-0.01	-0.47	0.34	0.01	-0.06
8	99.99	99.99	99.99	99.99	-0.26	-0.44	-0.56	0.15	0.7	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	-3.8767	-3.4141	-3.4186	-3.6922
S.E(Log q)	0.2589	0.1523	0.2737	0.4988

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	0.78	0.736	5.41	0.74	6	0.21	-3.88
6	1.17	-0.856	2.24	0.87	6	0.18	-3.41
7	0.87	0.829	4.22	0.91	6	0.25	-3.42
8	1.61	-1.254	0.69	0.52	6	0.76	-3.69
1							

Fleet : TRAWL-JAN-MAY-S

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	99.99	99.99	99.99	99.99	-0.54	-0.33	0.58	0.64	0.09	-0.46
6	99.99	99.99	99.99	99.99	-0.3	0.28	-0.19	0.29	0.16	-0.24
7	99.99	99.99	99.99	99.99	0.34	0.39	-0.93	-0.18	0.6	-0.21
8	99.99	99.99	99.99	99.99	0.25	0.71	0.03	-0.47	-0.36	-0.14
9	99.99	99.99	99.99	99.99	0.74	0.03	0.17	-0.45	99.99	-0.46

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

Age	5	6	7	8	9
Mean Log q	-4.8791	-4.1327	-3.8271	-3.7526	-3.9062
S.E(Log q)	0.5254	0.2728	0.5619	0.4323	0.4956

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	0.59	0.951	7.37	0.58	6	0.31	-4.88
6	1.61	-1.409	0.34	0.58	6	0.4	-4.13
7	0.75	0.926	5.28	0.78	6	0.43	-3.83
8	0.64	4.883	5.52	0.98	6	0.12	-3.75
9	0.79	0.614	4.73	0.74	5	0.42	-3.91
1							

Fleet : GILLNET-JAN-MAY-S

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
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	-0.29	-0.09	-0.11	0.36	-0.04	0.15
7	99.99	99.99	99.99	99.99	-0.21	-0.03	-0.02	0.21	0.45	-0.41
8	99.99	99.99	99.99	99.99	-0.35	0.04	0.05	0.19	0.07	-0.01
9	99.99	99.99	99.99	99.99	-0.62	-0.25	0.32	0.03	0.3	0.18

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	-4.5987	-3.4498	-2.7688	-2.6386
S.E(Log q)	0.2263	0.3055	0.1823	0.364

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	1.21	-0.679	3.37	0.72	6	0.29	-4.6
7	1.41	-1.875	0.88	0.84	6	0.35	-3.45
8	1.22	-1.907	1.49	0.95	6	0.18	-2.77
9	1.11	-0.388	2.09	0.76	6	0.44	-2.64
1							

Terminal year survivor and F summaries :

Age 3 Catchability dependent on age and year class strength

Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	224807	0.584	0	0	1	0.157	0.021
IceGFS. SE	217357	0.919	0	0	1	0.064	0.022
IceGFS. SW.	154988	0.4	0	0	1	0.335	0.031
TRAWL-JUN-DEC-N	1	0	0	0	0	0	0
TRAWL-JUN-DEC-S	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	114897	0.44				0.29	0.041
F shrinkage mean	43744	0.6				0.155	0.105

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
126595	0.23	0.31	5	1.322	0.036

1

Age 4 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
IceGFS. N.	97200	0.29	0.237	0.82	2	0.323	0.13
IceGFS. SE	92577	0.577	0.105	0.18	2	0.08	0.136
IceGFS. SW.	85098	0.275	0.233	0.85	2	0.351	0.147
TRAWL-JUN-DEC-N	1	0	0	0	0	0	0
TRAWL-JUN-DEC-S	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	72970	0.45				0.157	0.169
F shrinkage mean	47434	0.6				0.089	0.25

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
82863	0.17	0.11	8	0.663	0.154

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

Year class = 1991

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	23444	0.209	0.298	1.42	3	0.284	0.25
IceGFS. SE	24295	0.402	0.125	0.31	3	0.077	0.242
IceGFS. SW.	23933	0.221	0.104	0.47	3	0.246	0.246
TRAWL-JUN-DEC-N	34060	0.3	0	0	1	0.151	0.179
TRAWL-JUN-DEC-S	1	0	0	0	0	0	0
TRAWL-JAN-MAY-N	27074	0.3	0	0	1	0.151	0.22
TRAWL-JAN-MAY-S	16696	0.568	0	0	1	0.042	0.336
GILLNET-JAN-MAY-S	1	0	0	0	0	0	0
F shrinkage mean	14917	0.6				0.047	0.369

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
24657	0.11	0.09	13	0.782	0.224

1

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

Year class = 1990

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	24271	0.176	0.098	0.56	4	0.195	0.377
IceGFS. SE	24915	0.293	0.299	1.02	4	0.075	0.369
IceGFS. SW.	29021	0.197	0.166	0.84	4	0.147	0.325
TRAWL-JUN-DEC-N	29835	0.214	0.023	0.11	2	0.145	0.317
TRAWL-JUN-DEC-S	34220	0.3	0	0	1	0.082	0.282
TRAWL-JAN-MAY-N	32833	0.214	0.156	0.73	2	0.145	0.292
TRAWL-JAN-MAY-S	23070	0.267	0.127	0.48	2	0.1	0.394
GILLNET-JAN-MAY-S	32449	0.3	0	0	1	0.082	0.295
F shrinkage mean	15241	0.6				0.029	0.548

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
27796	0.08	0.06	21	0.737	0.337

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

Year class = 1989

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	15976	0.167	0.12	0.72	5	0.16	0.428
IceGFS. SE	18521	0.252	0.226	0.9	5	0.081	0.379
IceGFS. SW.	18575	0.184	0.078	0.42	5	0.134	0.378
TRAWL-JUN-DEC-N	13924	0.181	0.091	0.5	3	0.161	0.478
TRAWL-JUN-DEC-S	15812	0.263	0.064	0.25	2	0.077	0.431
TRAWL-JAN-MAY-N	14377	0.179	0.014	0.08	3	0.164	0.466
TRAWL-JAN-MAY-S	17405	0.248	0.174	0.7	3	0.081	0.399
GILLNET-JAN-MAY-S	11849	0.225	0.183	0.81	2	0.113	0.542
F shrinkage mean	8057	0.6				0.029	0.722

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
15126	0.07	0.05	29	0.702	0.448

1

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

Year class = 1988

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	1850	0.187	0.15	0.8	6	0.126	0.72
IceGFS. SE	2126	0.257	0.28	1.09	6	0.083	0.651
IceGFS. SW.	2109	0.204	0.154	0.75	6	0.121	0.655
TRAWL-JUN-DEC-N	1669	0.187	0.149	0.79	4	0.143	0.774
TRAWL-JUN-DEC-S	1100	0.264	0.229	0.86	3	0.075	1.02
TRAWL-JAN-MAY-N	2092	0.187	0.099	0.53	4	0.137	0.659
TRAWL-JAN-MAY-S	2266	0.248	0.167	0.67	4	0.092	0.621
GILLNET-JAN-MAY-S	2305	0.195	0.148	0.76	3	0.175	0.613
F shrinkage mean	1355	0.6				0.049	0.891

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1911	0.08	0.06	37	0.815	0.7

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

Year class = 1987

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	654	0.216	0.117	0.54	6	0.089	0.769
IceGFS. SE	912	0.284	0.136	0.48	6	0.065	0.604
IceGFS. SW.	761	0.231	0.125	0.54	6	0.091	0.69
TRAWL-JUN-DEC-N	675	0.208	0.214	1.03	4	0.108	0.752
TRAWL-JUN-DEC-S	502	0.332	0.126	0.38	3	0.094	0.919
TRAWL-JAN-MAY-N	944	0.208	0.152	0.73	4	0.102	0.589
TRAWL-JAN-MAY-S	470	0.278	0.054	0.19	5	0.121	0.959
GILLNET-JAN-MAY-S	758	0.199	0.051	0.26	4	0.242	0.692
F shrinkage mean	519	0.6				0.088	0.899

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
672	0.1	0.05	39	0.532	0.754

1

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

Year class = 1986

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	90	0.23	0.047	0.21	6	0.077	1.128
IceGFS. SE	123	0.299	0.236	0.79	6	0.057	0.927
IceGFS. SW.	65	0.243	0.161	0.66	6	0.08	1.359
TRAWL-JUN-DEC-N	141	0.22	0.103	0.47	4	0.093	0.848
TRAWL-JUN-DEC-S	131	0.315	0.144	0.46	3	0.048	0.892
TRAWL-JAN-MAY-N	104	0.22	0.189	0.86	4	0.087	1.034
TRAWL-JAN-MAY-S	84	0.296	0.224	0.76	4	0.062	1.174
GILLNET-JAN-MAY-S	148	0.22	0.071	0.32	4	0.257	0.82
F shrinkage mean	140	0.6				0.238	0.852

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
121	0.16	0.06	38	0.358	0.939

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

Year class = 1985

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	69	0.242	0.129	0.53	6	0.045	0.693
IceGFS. SE	54	0.315	0.125	0.4	6	0.033	0.819
IceGFS. SW.	60	0.257	0.125	0.49	6	0.047	0.764
TRAWL-JUN-DEC-N	80	0.255	0.03	0.12	3	0.048	0.618
TRAWL-JUN-DEC-S	82	0.333	0.15	0.45	3	0.028	0.606
TRAWL-JAN-MAY-N	46	0.256	0.178	0.69	3	0.044	0.913
TRAWL-JAN-MAY-S	46	0.354	0.145	0.41	4	0.091	0.918
GILLNET-JAN-MAY-S	61	0.245	0.039	0.16	4	0.185	0.756
F shrinkage mean	61	0.6				0.479	0.757

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
60	0.29	0.03	36	0.114	0.765

1

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

Year class = 1984

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	55	0.211	0.127	0.6	6	0.031	0.723
IceGFS. SE	51	0.291	0.234	0.8	6	0.021	0.771
IceGFS. SW.	74	0.228	0.15	0.66	6	0.031	0.587
TRAWL-JUN-DEC-N	50	0.293	0.23	0.78	2	0.024	0.778
TRAWL-JUN-DEC-S	82	0.388	0.061	0.16	3	0.043	0.539
TRAWL-JAN-MAY-N	55	0.298	0.312	1.05	2	0.021	0.727
TRAWL-JAN-MAY-S	85	0.375	0.172	0.46	3	0.042	0.525
GILLNET-JAN-MAY-S	71	0.245	0.13	0.53	3	0.092	0.601
F shrinkage mean	57	0.6				0.695	0.707

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F

60	0.42	0.04	32	0.098	0.681

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

Year class = 1983

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	23	0.219	0.259	1.18	6	0.026	1.153
IceGFS. SE	31	0.292	0.187	0.64	6	0.018	0.966
IceGFS. SW.	41	0.236	0.078	0.33	6	0.026	0.799
TRAWL-JUN-DEC-N	18	0.487	0	0	1	0.01	1.333
TRAWL-JUN-DEC-S	26	0.417	0.175	0.42	2	0.027	1.073
TRAWL-JAN-MAY-N	26	0.552	0	0	1	0.008	1.074
TRAWL-JAN-MAY-S	38	0.388	0.106	0.27	2	0.029	0.844
GILLNET-JAN-MAY-S	25	0.262	0.051	0.2	2	0.061	1.096
F shrinkage mean	35	0.6				0.794	0.881

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
34	0.48	0.05	27	0.106	0.91

1

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

Year class = 1982

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IceGFS. N.	2	0.237	0.067	0.28	6	0.009	1.073
IceGFS. SE	4	0.307	0.071	0.23	6	0.007	0.824
IceGFS. SW.	3	0.252	0.19	0.75	6	0.009	0.833
TRAWL-JUN-DEC-N	1	0	0	0	0	0	0
TRAWL-JUN-DEC-S	6	0.512	0	0	1	0.008	0.596
TRAWL-JAN-MAY-N	1	0	0	0	0	0	0
TRAWL-JAN-MAY-S	7	0.557	0	0	1	0.007	0.484
GILLNET-JAN-MAY-S	2	0.403	0	0	1	0.013	1.228
F shrinkage mean	3	0.6				0.947	0.832

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3	0.57	0.03	22	0.049	0.834

Table 3.3.12. Cod at Iceland. Fishing mortality

Virtual Population Analysis : Fishing mortality
Run12 FINAL-VPA

Age	1977	1978	1979	1980	1981	1982	1983
3	0.020	0.030	0.033	0.034	0.016	0.027	0.017
4	0.212	0.169	0.195	0.176	0.137	0.221	0.120
5	0.355	0.351	0.211	0.358	0.388	0.400	0.433
6	0.368	0.333	0.513	0.378	0.470	0.541	0.622
7	0.810	0.494	0.487	0.442	0.635	0.581	0.767
8	0.657	0.660	0.503	0.554	0.839	1.046	0.852
9	0.995	0.505	0.507	0.514	0.802	1.187	0.930
10	0.608	0.530	0.339	0.453	0.950	0.910	1.082
11	0.562	0.343	0.531	0.425	0.982	0.479	0.671
12	0.547	0.719	0.200	0.700	0.904	0.404	0.678
13	0.078	0.806	1.020	0.171	1.076	0.417	0.533
14	0.558	0.580	0.519	0.453	0.943	0.679	0.779
W.Av 5-10	0.438	0.372	0.403	0.404	0.529	0.582	0.609
Ave 5-10	0.632	0.479	0.427	0.450	0.681	0.777	0.781

Age	1984	1985	1986	1987	1988	1989	1990
3	0.055	0.051	0.070	0.045	0.045	0.036	0.050
4	0.211	0.288	0.222	0.309	0.222	0.266	0.233
5	0.323	0.388	0.581	0.519	0.506	0.485	0.446
6	0.539	0.572	0.697	0.785	0.838	0.602	0.641
7	0.598	0.683	0.883	0.976	0.954	0.727	0.787
8	0.900	0.731	0.936	0.994	1.394	0.877	0.818
9	0.746	0.802	0.806	0.975	1.113	0.820	0.789
10	0.634	0.770	0.764	0.707	0.987	0.547	0.838
11	0.639	0.613	0.740	0.582	1.033	0.666	0.626
12	0.587	0.641	0.672	0.665	0.906	0.976	0.775
13	0.685	0.711	0.445	0.739	2.335	0.576	0.439
14	0.658	0.707	0.686	0.734	1.275	0.717	0.693
W.Av 5-10	0.479	0.486	0.689	0.698	0.629	0.544	0.597
Ave 5-10	0.623	0.658	0.778	0.826	0.965	0.676	0.720

Age	1991	1992	1993	1994	1995	1996	1993-1996
3	0.099	0.078	0.144	0.090	0.081	0.036	0.088
4	0.316	0.388	0.310	0.251	0.185	0.154	0.225
5	0.514	0.647	0.517	0.307	0.278	0.224	0.332
6	0.779	0.918	0.810	0.478	0.344	0.337	0.492
7	0.950	1.110	0.861	0.703	0.581	0.448	0.648
8	0.789	1.026	1.160	0.878	0.604	0.700	0.836
9	0.782	0.624	1.241	0.862	0.562	0.754	0.855
10	0.879	0.535	0.966	0.837	0.723	0.939	0.866
11	0.968	0.398	0.919	0.651	0.678	0.765	0.753
12	0.833	0.719	0.579	0.698	0.814	0.681	0.693
13	0.380	0.364	0.585	0.706	1.285	0.910	0.872
14	0.769	0.528	0.858	0.751	0.813	0.810	0.808
W.Av 5-10	0.755	0.803	0.715	0.390	0.335	0.347	0.483
Ave 5-10	0.782	0.810	0.926	0.678	0.516	0.567	0.671

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

Marine Research Institute Sat May 03 08:54:31 1997
Virtual Population Analysis : Stock in numbers, millions
Run12 FINAL-VPA

Age	1977	1978	1979	1980	1981	1982	1983
3	143.292	221.657	245.520	144.032	143.272	133.572	226.320
4	245.879	114.957	176.061	194.527	113.998	115.389	106.394
5	119.035	162.909	79.448	118.551	133.568	81.349	75.741
6	43.280	68.303	93.924	52.650	67.877	74.178	44.652
7	25.539	24.515	40.087	83.048	29.534	34.736	35.349
8	6.364	9.306	12.250	20.159	50.701	12.818	15.903
9	3.055	2.700	3.939	6.065	9.481	17.940	3.687
10	1.009	0.925	1.335	1.942	2.970	3.480	4.482
11	0.219	0.450	0.446	0.778	1.011	0.940	1.147
12	0.062	0.102	0.261	0.214	0.417	0.310	0.476
13	0.088	0.030	0.041	0.175	0.087	0.138	0.170
14	0.005	0.067	0.011	0.012	0.121	0.024	0.075
Juvenile	499.602	491.742	526.237	477.617	450.101	383.305	444.537
Adult	88.225	114.179	127.086	144.536	102.936	91.570	69.859
Sum 3- 3	143.292	221.657	245.520	144.032	143.272	133.572	226.320
Sum 4-14	444.535	384.264	407.803	478.122	409.765	341.302	288.075
Total	587.827	605.921	653.323	622.154	553.037	474.874	514.396

Age	1984	1985	1986	1987	1988	1989	1990
3	138.994	144.011	335.704	277.468	168.288	82.318	130.723
4	182.086	107.707	112.078	256.226	217.240	131.723	65.045
5	77.272	120.677	66.110	73.465	153.944	142.470	82.679
6	40.213	45.816	67.036	30.288	35.795	75.968	102.787
7	19.620	19.202	21.165	27.344	11.308	12.677	34.064
8	13.437	8.834	7.941	7.167	8.434	3.567	5.015
9	5.554	4.471	3.483	2.550	2.171	1.714	1.215
10	1.191	2.156	1.642	1.273	0.787	0.584	0.618
11	1.244	0.517	0.817	0.626	0.514	0.240	0.277
12	0.480	0.537	0.230	0.319	0.286	0.150	0.101
13	0.198	0.219	0.232	0.096	0.134	0.095	0.046
14	0.081	0.082	0.088	0.122	0.038	0.011	0.044
Juvenile	405.950	361.240	531.323	607.779	515.767	344.357	309.871
Adult	74.421	92.989	85.202	69.165	83.172	107.160	112.742
Sum 3- 3	138.994	144.011	335.704	277.468	168.288	82.318	130.723
Sum 4-14	341.377	310.218	280.822	399.476	430.651	369.199	291.890
Total	480.371	454.229	616.526	676.944	598.939	451.517	422.613

Age	1991	1992	1993	1994	1995	1996	1997
3	99.884	179.726	168.463	79.205	125.000	195.000	90.000
4	101.806	74.064	136.126	119.451	59.291	94.350	154.007
5	42.174	60.769	41.154	81.724	76.081	40.346	66.222
6	43.321	20.654	26.048	20.085	49.235	47.160	26.404
7	44.349	16.281	6.754	9.487	10.200	28.576	27.565
8	12.697	14.040	4.393	2.339	3.845	4.669	14.948
9	1.813	4.721	4.118	1.128	0.795	1.720	1.898
10	0.452	0.679	2.071	0.975	0.390	0.371	0.663
11	0.219	0.154	0.326	0.646	0.346	0.155	0.119
12	0.121	0.068	0.084	0.106	0.276	0.144	0.059
13	0.038	0.043	0.027	0.039	0.043	0.100	0.059
14	0.024	0.021	0.025	0.012	0.016	0.010	0.033
Juvenile	244.370	263.536	231.583	155.040	172.507	322.693	288.654
Adult	102.528	107.684	158.006	160.156	153.010	89.908	93.323
Sum 3- 3	99.884	179.726	168.463	79.205	125.000	195.000	90.000
Sum 4-14	247.014	191.493	221.126	235.992	200.517	217.601	291.977
Total	346.898	371.220	389.589	315.197	325.517	412.601	381.977

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

Marine Research Institute Sat May 03 08:54:31 1997
Virtual Population Analysis : SSB in 1000 x tons
Run12 FINAL-VPA

Age	1977	1978	1979	1980	1981	1982	1983
3	0.000	10.689	0.000	10.271	0.000	2.916	0.000
4	18.155	8.826	5.033	6.867	4.674	8.747	12.670
5	60.349	75.078	34.390	46.055	20.608	18.924	23.101
6	92.719	102.240	164.296	82.993	52.345	40.894	34.833
7	93.539	101.232	142.177	293.391	65.636	62.439	53.318
8	29.197	44.333	60.423	97.901	174.043	36.502	41.484
9	13.639	18.244	23.793	35.895	44.874	62.993	13.516
10	6.946	7.402	9.432	15.614	15.691	19.197	19.365
11	2.002	4.695	4.251	7.633	6.445	8.215	8.439
12	0.634	0.887	2.946	2.469	3.193	3.271	4.321
13	1.381	0.365	0.317	2.450	0.582	1.845	1.773
14	0.092	1.024	0.152	0.233	1.052	0.277	0.906
Total	318.652	375.015	447.211	601.773	389.142	266.221	213.728

Age	1984	1985	1986	1987	1988	1989	1990
3	0.000	4.165	1.876	6.778	7.575	0.000	0.000
4	10.555	9.010	9.746	19.204	6.370	8.841	5.918
5	28.989	48.125	35.621	39.994	66.489	65.794	45.482
6	47.188	71.048	100.351	56.133	45.194	124.481	163.178
7	43.623	54.563	52.819	73.965	26.609	39.679	92.169
8	39.716	34.161	28.870	27.020	22.618	13.714	20.168
9	24.329	21.229	17.354	11.316	8.240	7.552	6.740
10	7.881	13.102	9.832	8.833	3.825	3.988	4.026
11	9.325	4.166	5.759	4.947	2.963	1.988	2.364
12	4.754	4.999	2.165	2.348	1.671	0.770	1.026
13	2.089	2.271	2.463	1.019	0.594	0.718	0.547
14	0.928	1.050	1.115	1.346	0.213	0.103	0.514
Total	219.377	267.890	267.970	252.905	192.361	267.627	342.133

Age	1991	1992	1993	1994	1995	1996
3	0.000	10.712	12.804	8.563	5.413	18.232
4	10.236	20.534	47.294	53.345	39.248	13.777
5	16.877	60.153	40.751	97.816	134.672	48.329
6	54.092	33.669	50.264	48.640	125.585	115.352
7	89.176	41.145	21.157	31.952	31.422	90.929
8	44.741	45.788	15.233	8.648	16.415	17.259
9	8.590	22.073	15.897	5.457	4.387	7.252
10	2.516	4.115	10.637	4.672	2.597	2.128
11	1.473	1.414	2.215	4.809	2.576	1.155
12	1.112	0.619	0.732	0.913	2.012	1.264
13	0.429	0.533	0.281	0.379	0.292	0.828
14	0.325	0.178	0.285	0.144	0.153	0.103
Total	229.566	240.933	217.551	265.338	364.770	317.606

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	Recruitment	SSB
1955	0,31	260	1261
1956	0,26	307	1199
1957	0,32	153	1145
1958	0,32	191	1034
1959	0,33	143	928
1960	0,38	163	825
1961	0,33	292	760
1962	0,4	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. 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	3953
Average	**2981**

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

Yearclass	VPA	Surv 4	Surv 3	Surv 2	Surv 1
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	277	92490	99294	52943	16492
1985	168	60113	68604	25874	13903
1986	82	8272	17511	5820	2605
1987	131	22262	19408	14921	1711
1988	100	13601	15633	11786	2048
1989	180	31684	30540	14473	3509
1990	168	18211	26030	16407	1712
1991	79	4301	5556	2237	223
1992	-11	19228	17477	10539	1312
1993	-11	48173	37466	28480	8920
1994	-11	-11	11969	3869	487
1995	-11	-11	-11	18566	2454
1996	-11	-11	-11	-11	530

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

Analysis by RCT3 ver3.1 of data from file :

recsas.dat

Iceland Cod: VPA and groundfish survey data

Data for 4 surveys over 22 years : 1975 - 1996

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 = 1990

	I-----------Regression----------I				I-----------Prediction---------I				
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4	.60	-1.21	.24	.797	9	9.81	4.72	.302	.262
Surv3	.71	-2.37	.25	.807	8	10.17	4.85	.313	.243
Surv2	.73	-2.04	.23	.855	7	9.71	5.00	.292	.279
Surv1	.58	.12	.41	.580	6	7.45	4.43	.590	.069
						VPA Mean =	5.09	.404	.147

Yearclass = 1991

	I-----------Regression----------I				I-----------Prediction---------I				
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4	.61	-1.24	.27	.737	10	8.37	3.88	.408	.232
Surv3	.72	-2.40	.26	.774	9	8.62	3.78	.415	.225
Surv2	.73	-2.05	.22	.846	8	7.71	3.57	.393	.250
Surv1	.65	-.32	.52	.412	7	5.41	3.17	1.006	.038
						VPA Mean =	5.09	.390	.254

Yearclass = 1992

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

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4	.52	-.29	.25	.790	11	9.86	4.87	.292	.279
Surv3	.60	-1.10	.25	.799	10	9.77	4.72	.303	.259
Surv2	.57	-.46	.26	.809	9	9.26	4.84	.313	.243
Surv1	.43	1.57	.41	.558	8	7.18	4.62	.517	.089
						VPA Mean =	5.02	.427	.130

Yearclass = 1993

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

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4	.52	-.26	.25	.795	11	10.78	5.36	.298	.280
Surv3	.59	-1.07	.25	.798	10	10.53	5.18	.304	.269
Surv2	.57	-.43	.26	.807	9	10.26	5.41	.325	.235
Surv1	.43	1.57	.41	.555	8	9.10	5.45	.543	.084
						VPA Mean =	5.01	.433	.133

Yearclass = 1994

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

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4									
Surv3	.59	-1.03	.25	.797	10	9.39	4.51	.320	.373
Surv2	.56	-.38	.26	.804	9	8.26	4.28	.350	.311
Surv1	.42	1.59	.42	.553	8	6.19	4.22	.571	.117
						VPA Mean =	5.00	.438	.199

Yearclass = 1995

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

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4									
Surv3									

Surv2	.56	-.33	.26	.801	9	9.83	5.16	.327	.519
Surv1	.42	1.61	.42	.550	8	7.81	4.91	.530	.197

VPA Mean = 4.98 .442 .283

Yearclass = 1996

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

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4									
Surv3									
Surv2									
Surv1	.42	1.63	.42	.548	8	6.27	4.28	.592	.363

VPA Mean = 4.97 .446 .637

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1990	129	4.87	.15	.09	.33	168	5.13
1991	57	4.06	.20	.31	2.48	80	4.38
1992	124	4.82	.15	.05	.13		
1993	196	5.28	.16	.07	.20		
1994	90	4.50	.20	.16	.65		
1995	157	5.06	.24	.08	.10		
1996	111	4.72	.36	.33	.87		

Table 3.3.19

Cod in the Iceland Grounds (Fishing Area Va)

Prediction with management option table: Input data

Year: 1997								
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	90000.000	0.2000	0.0730	0.0850	0.2500	1174.000	0.0660	1416.000
4	154007.00	0.2000	0.2490	0.1800	0.2500	1734.000	0.1900	2062.000
5	66222.000	0.2000	0.5690	0.2480	0.2500	2563.000	0.2600	2839.000
6	26404.000	0.2000	0.7610	0.2960	0.2500	3846.000	0.3730	4206.000
7	27565.000	0.2000	0.8910	0.3820	0.2500	5142.000	0.5580	5536.000
8	14948.000	0.2000	0.9460	0.4370	0.2500	6116.000	0.7030	6375.000
9	1898.000	0.2000	0.9580	0.4770	0.2500	7603.000	0.7020	7680.000
10	663.000	0.2000	0.9640	0.4770	0.2500	9738.000	0.8060	9647.000
11	119.000	0.2000	0.9970	0.4770	0.2500	10988.000	0.7830	10803.000
12	59.000	0.2000	0.9790	0.4770	0.2500	12295.000	0.7830	12595.000
13	59.000	0.2000	0.9940	0.4770	0.2500	13774.000	0.7830	13843.000
14	33.000	0.2000	1.0000	0.4770	0.2500	16282.000	0.7830	16282.000
Unit	Thousands	-	-	-	-	Grams	-	Grams

Year: 1998								
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	157000.00	0.2000	0.0730	0.0850	0.2500	1174.000	0.0660	1416.000
4	.	0.2000	0.2490	0.1800	0.2500	1734.000	0.1900	1941.000
5	.	0.2000	0.5690	0.2480	0.2500	2418.000	0.2600	2734.000
6	.	0.2000	0.7610	0.2960	0.2500	3641.000	0.3730	3805.000
7	.	0.2000	0.8910	0.3820	0.2500	5018.000	0.5580	5427.000
8	.	0.2000	0.9460	0.4370	0.2500	6416.000	0.7030	6621.000
9	.	0.2000	0.9580	0.4770	0.2500	7603.000	0.7020	7680.000
10	.	0.2000	0.9640	0.4770	0.2500	9738.000	0.8060	9647.000
11	.	0.2000	0.9970	0.4770	0.2500	10988.000	0.7830	10803.000
12	.	0.2000	0.9790	0.4770	0.2500	12295.000	0.7830	12595.000
13	.	0.2000	0.9940	0.4770	0.2500	13774.000	0.7830	13843.000
14	.	0.2000	1.0000	0.4770	0.2500	16282.000	0.7830	16282.000
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	110000.00	0.2000	0.0730	0.0850	0.2500	1174.000	0.0660	1416.000
4	.	0.2000	0.2490	0.1800	0.2500	1734.000	0.1900	1941.000
5	.	0.2000	0.5690	0.2480	0.2500	2418.000	0.2600	2667.000
6	.	0.2000	0.7610	0.2960	0.2500	3518.000	0.3730	3715.000
7	.	0.2000	0.8910	0.3820	0.2500	4866.000	0.5580	5019.000
8	.	0.2000	0.9460	0.4370	0.2500	6326.000	0.7030	6552.000
9	.	0.2000	0.9580	0.4770	0.2500	7603.000	0.7020	7680.000
10	.	0.2000	0.9640	0.4770	0.2500	9738.000	0.8060	9647.000
11	.	0.2000	0.9970	0.4770	0.2500	10988.000	0.7830	10803.000
12	.	0.2000	0.9790	0.4770	0.2500	12295.000	0.7830	12595.000
13	.	0.2000	0.9940	0.4770	0.2500	13774.000	0.7830	13843.000
14	.	0.2000	1.0000	0.4770	0.2500	16282.000	0.7830	16282.000
Unit	Thousands	-	-	-	-	Grams	-	Grams

Notes: Run name : MANSAS01
Date and time: 05MAY97:12:11

Table 3.3.20

Cod in the Iceland Grounds (Fishing Area Va) — The SAS System — 12:09 Monday, May 5, 1997

Prediction with management option table

Year: 1997					Year: 1998					Year: 1999	
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
0.7885	0.4471	901416	406533	200000	0.0000	0.0000	969734	513465	0	1220962	732313
.	.	.	.	.	0.1000	0.0567	.	505120	30600	1187041	692295
.	.	.	.	.	0.2000	0.1134	.	496973	59880	1154611	655112
.	.	.	.	.	0.3000	0.1701	.	489018	87910	1123592	620530
.	.	.	.	.	0.4000	0.2268	.	481250	114756	1093910	588338
.	.	.	.	.	0.5000	0.2835	.	473663	140479	1065495	558342
.	.	.	.	.	0.6000	0.3402	.	466252	165138	1038280	530367
.	.	.	.	.	0.7000	0.3969	.	459013	188788	1012203	504253
.	.	.	.	.	0.8000	0.4536	.	451941	211481	987206	479852
.	.	.	.	.	0.9000	0.5103	.	445030	233264	963232	457031
.	.	.	.	.	1.0000	0.5670	.	438277	254184	940231	435668
.	.	.	.	.	1.1000	0.6237	.	431678	274284	918154	415652
.	.	.	.	.	1.2000	0.6804	.	425227	293606	896953	396880
.	.	.	.	.	1.3000	0.7371	.	418922	312186	876586	379258
.	.	.	.	.	1.4000	0.7938	.	412757	330063	857012	362702
.	.	.	.	.	1.5000	0.8505	.	406730	347269	838191	347134
.	.	.	.	.	1.6000	0.9072	.	400836	363837	820087	332480
.	.	.	.	.	1.7000	0.9639	.	395072	379798	802665	318676
.	.	.	.	.	1.8000	1.0206	.	389434	395180	785894	305660
.	.	.	.	.	1.9000	1.0773	.	383919	410011	769741	293378
.	.	.	.	.	2.0000	1.1340	.	378524	424316	754179	281779
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANSAS01
Date and time : 05MAY97:12:11
Computation of ref. F: Simple mean, age 5 - 10
Basis for 1997 : TAC constraints

Table 3.3.21

Cod in the Iceland Grounds (Fishing Area Va) — The SAS System — 23:36 Monday, May 5, 1997

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	0.0283	0.0850	0.2500	1073.231	0.0600	1261.154
4	.	0.2000	0.0932	0.1800	0.2500	1636.846	0.3300	1789.308
5	.	0.2000	0.3047	0.2480	0.2500	2538.115	0.6100	2590.385
6	.	0.2000	0.5569	0.2960	0.2500	3701.577	0.8600	3591.462
7	.	0.2000	0.7864	0.3820	0.2500	5051.885	1.0500	4880.769
8	.	0.2000	0.9075	0.4370	0.2500	6401.692	1.1600	6193.731
9	.	0.2000	0.9541	0.4770	0.2500	7754.346	1.1600	7505.192
10	.	0.2000	0.9753	0.4770	0.2500	9318.038	1.1600	9083.346
11	.	0.2000	0.9953	0.4770	0.2500	11090.692	1.1600	10750.731
12	.	0.2000	0.9995	0.4770	0.2500	12529.923	1.1600	12654.038
13	.	0.2000	0.9989	0.4770	0.2500	14379.769	1.1600	14552.462
14	.	0.2000	1.0000	0.4770	0.2500	14928.413	1.1600	15132.766
Unit	Numbers	-	-	-	-	Grams	-	Grams

Notes: Run name : YLDSAS01
Date and time: 05MAY97:23:37

Table 3.3.22

Cod in the Iceland Grounds (Fishing Area Va)

Yield per recruit: Summary table

F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
0.0000	0.0000	0.000	0.000	5.016	23315.118	2.442	18093.326	2.323	17210.904
0.0500	0.0500	0.131	790.313	4.574	19104.901	2.040	14062.861	1.901	13055.659
0.1000	0.1000	0.225	1244.517	4.232	16027.886	1.735	11147.376	1.587	10113.617
0.1500	0.1500	0.293	1501.861	3.962	13740.226	1.501	9005.723	1.349	7996.253
0.2000	0.2000	0.345	1643.917	3.746	12009.229	1.316	7407.417	1.165	6446.531
0.2500	0.2500	0.386	1718.543	3.568	10675.965	1.169	6195.343	1.020	5292.734
0.3000	0.3000	0.419	1753.851	3.421	9630.803	1.050	5261.371	0.905	4418.944
0.3500	0.3500	0.446	1766.378	3.296	8797.313	0.952	4530.329	0.811	3746.037
0.4000	0.4000	0.468	1765.864	3.189	8121.619	0.871	3949.390	0.734	3219.369
0.4500	0.4500	0.488	1758.044	3.096	7565.292	0.802	3481.016	0.669	2800.739
0.5000	0.5000	0.505	1746.293	3.014	7100.590	0.743	3098.219	0.615	2463.101
0.5500	0.5500	0.520	1732.596	2.942	6707.233	0.692	2781.366	0.568	2187.062
0.6000	0.6000	0.533	1718.108	2.877	6370.210	0.648	2516.001	0.528	1958.530
0.6500	0.6500	0.545	1703.499	2.818	6078.267	0.609	2291.348	0.493	1767.132
0.7000	0.7000	0.556	1689.144	2.765	5822.857	0.575	2099.278	0.462	1605.135
0.7500	0.7500	0.566	1675.251	2.717	5597.412	0.544	1933.585	0.435	1466.696
0.8000	0.8000	0.575	1661.921	2.672	5396.820	0.517	1789.477	0.411	1347.351
0.8500	0.8500	0.584	1649.199	2.631	5217.056	0.492	1663.210	0.389	1243.644
0.9000	0.9000	0.592	1637.091	2.593	5054.916	0.470	1551.827	0.370	1152.872
0.9500	0.9500	0.599	1625.586	2.557	4907.820	0.449	1452.969	0.352	1072.895
1.0000	1.0000	0.606	1614.662	2.524	4773.674	0.431	1364.738	0.336	1002.005
1.0500	1.0500	0.613	1604.289	2.492	4650.755	0.414	1285.587	0.322	938.823
1.1000	1.1000	0.619	1594.438	2.463	4537.640	0.398	1214.251	0.308	882.226
1.1500	1.1500	0.625	1585.076	2.435	4433.137	0.383	1149.680	0.296	831.293
1.2000	1.2000	0.630	1576.173	2.409	4336.247	0.370	1091.003	0.285	785.260
1.2500	1.2500	0.635	1567.701	2.384	4246.119	0.358	1037.487	0.274	743.493
1.3000	1.3000	0.640	1559.631	2.361	4162.031	0.346	988.512	0.264	705.456
1.3500	1.3500	0.645	1551.937	2.338	4083.358	0.335	943.552	0.255	670.700
1.4000	1.4000	0.649	1544.596	2.317	4009.563	0.325	902.158	0.247	638.841
1.4500	1.4500	0.654	1537.584	2.297	3940.180	0.316	863.943	0.239	609.551
1.5000	1.5000	0.658	1530.881	2.277	3874.800	0.307	828.573	0.231	582.549
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YLDSAS01
Date and time : 05MAY97:23:37
Computation of ref. F: Simple mean, age 5 - 10
F-0.1 factor : 0.1998
F-max factor : 0.3712
F-0.1 reference F : 0.1998
F-max reference F : 0.3712
Recruitment : Single recruit

Fig. 3.3.1 Iceland cod. Trends in average fishing mortality, F(5-10,u) by gear.

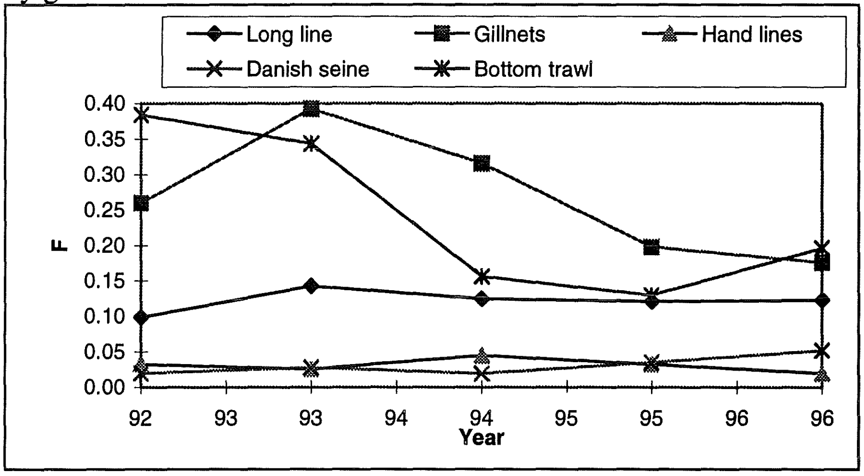


Fig. 3.3.2. Fishing mortality by gear and age. Average over the years 1992-1996.

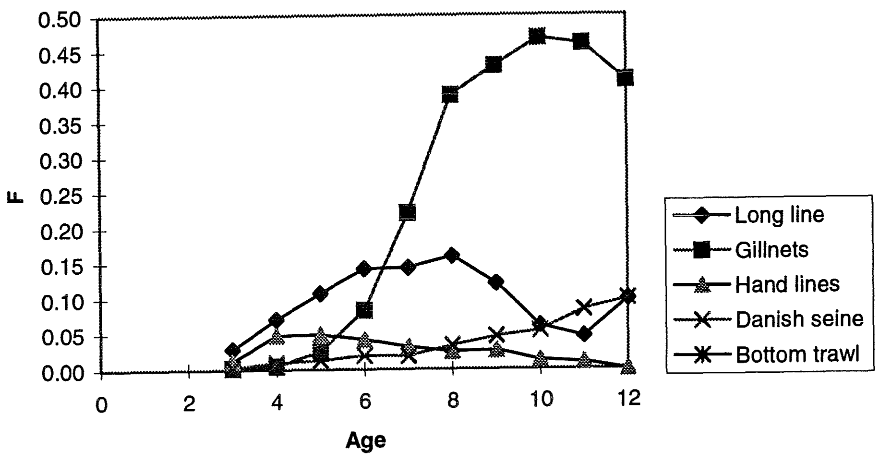


Figure 3.3.3 Cod at Iceland. Division Va. Proportion mature at the spawning time.

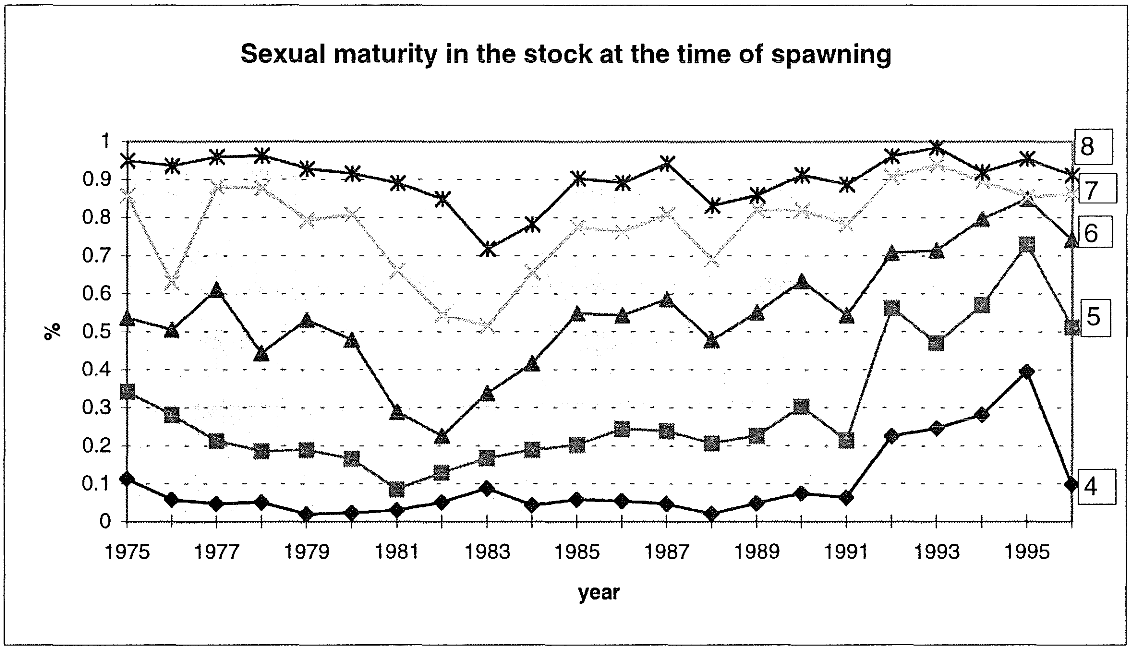
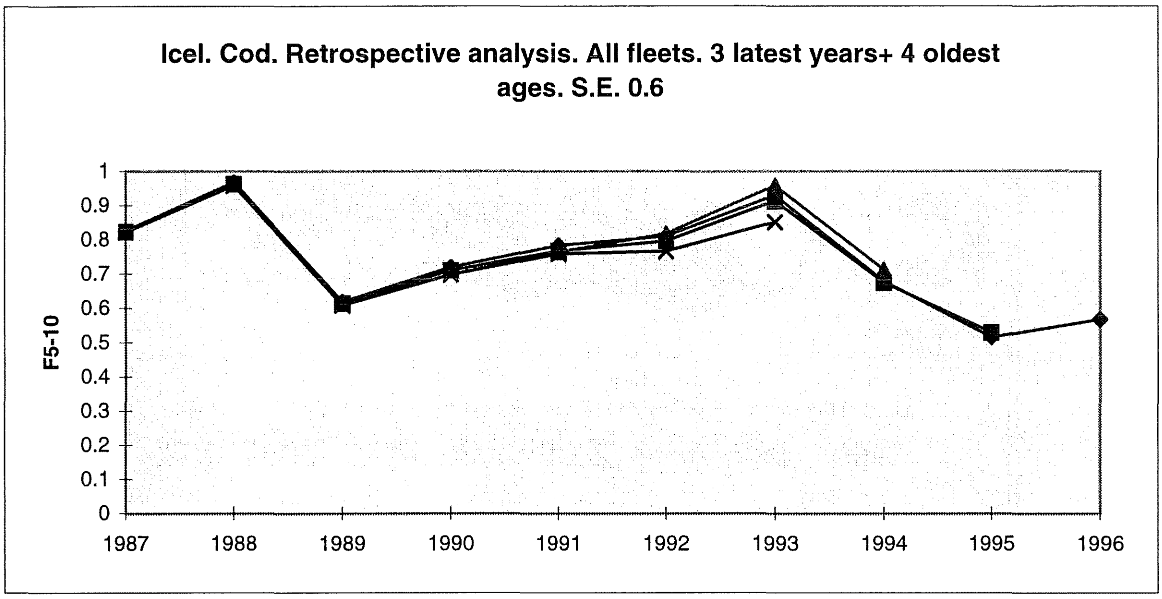


Figure 3.3.4. Cod at Iceland. Division Va. Retrospective analysis of the XSA.



e:\acfm\nwwg97\F-334.xls

Figure 3.3.5 Iceland cod. Medium term simulations. Deveopment of yield in '000 t using the adopted harvesting strategy of catching 25% of the 4+ biomass.

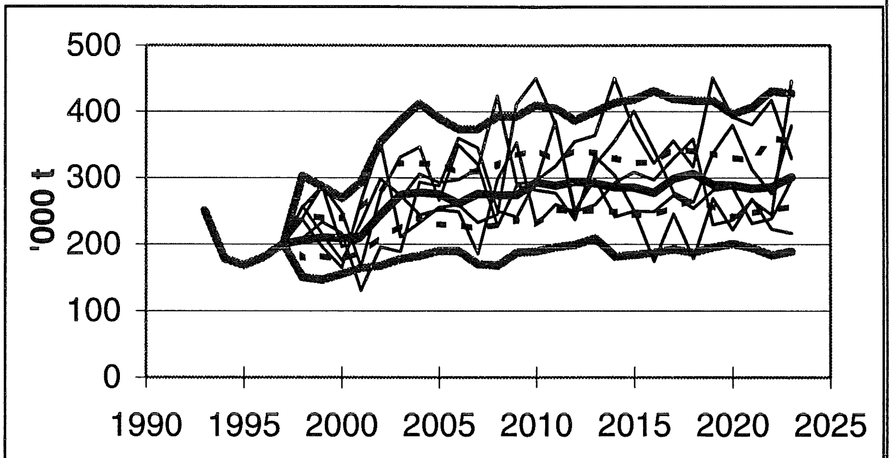


Figure 3.3.6 . Iceland cod. Medium term simulations. Deveopment of 4+biomass in '000 t when using the adopted harvesting strategy of catching 25% of the 4+ biomass.

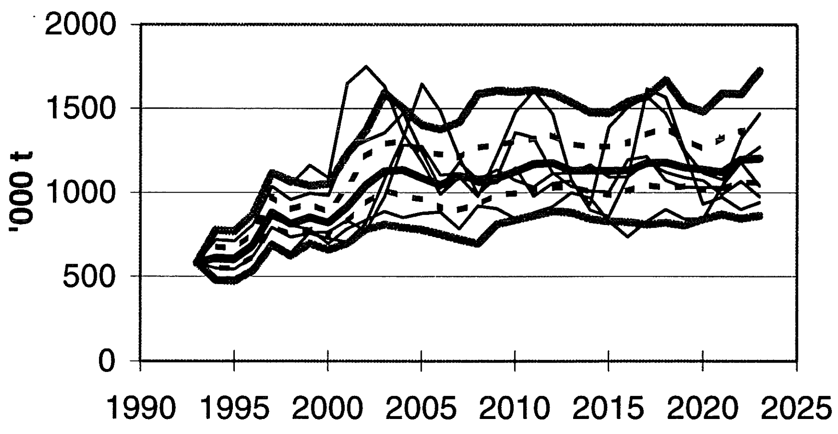
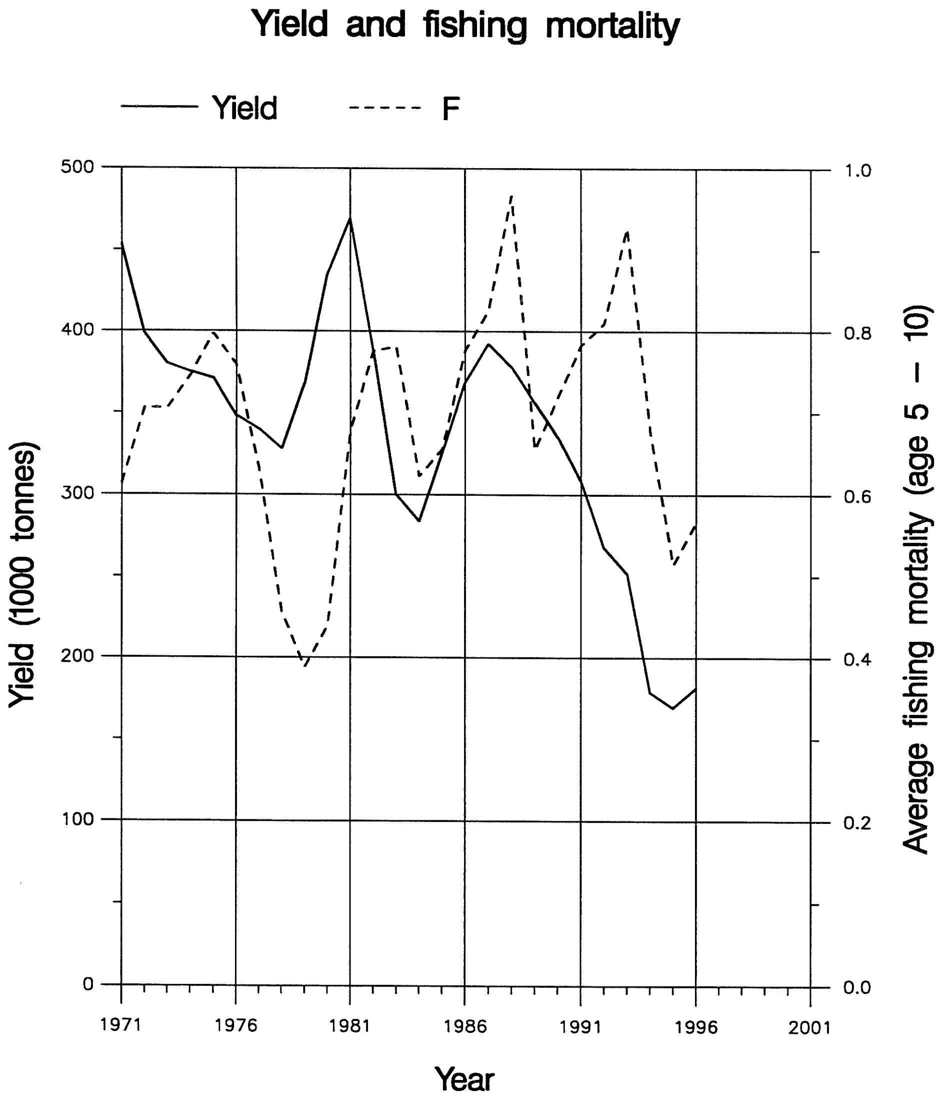
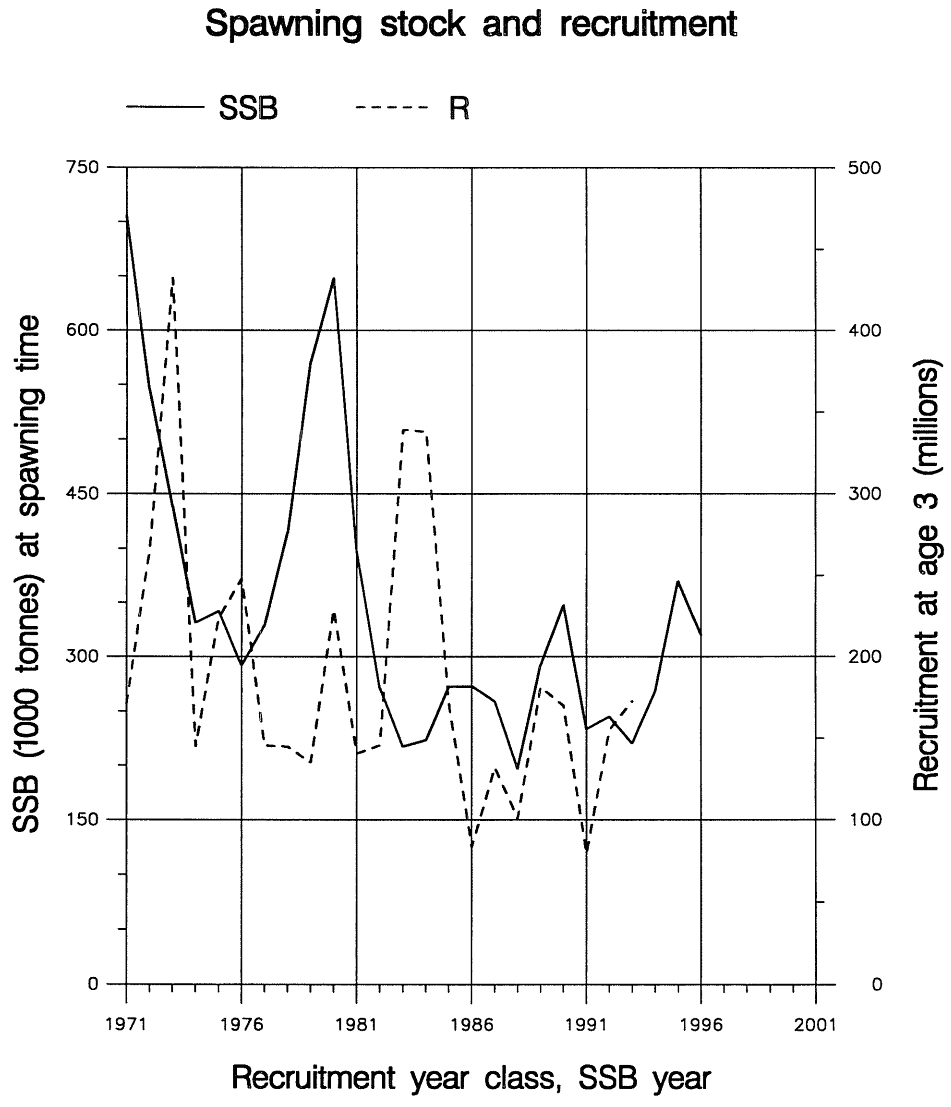


Figure 3.3.7

Fish Stock Summary
Cod in the Iceland Grounds (Fishing Area Va)
6 – 5 – 1997



(run: XSASAS03) **A**

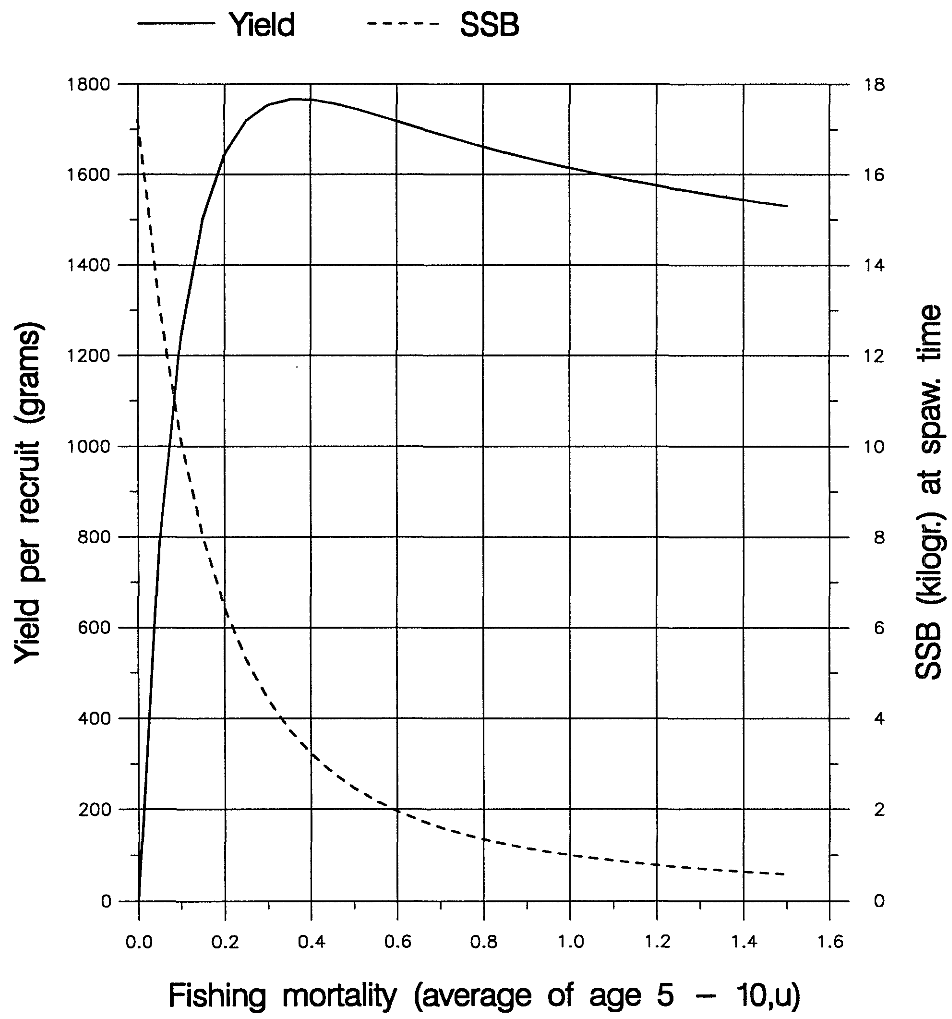


(run: XSASAS03) **B**

Figure 3.3.7 (Cont'd)

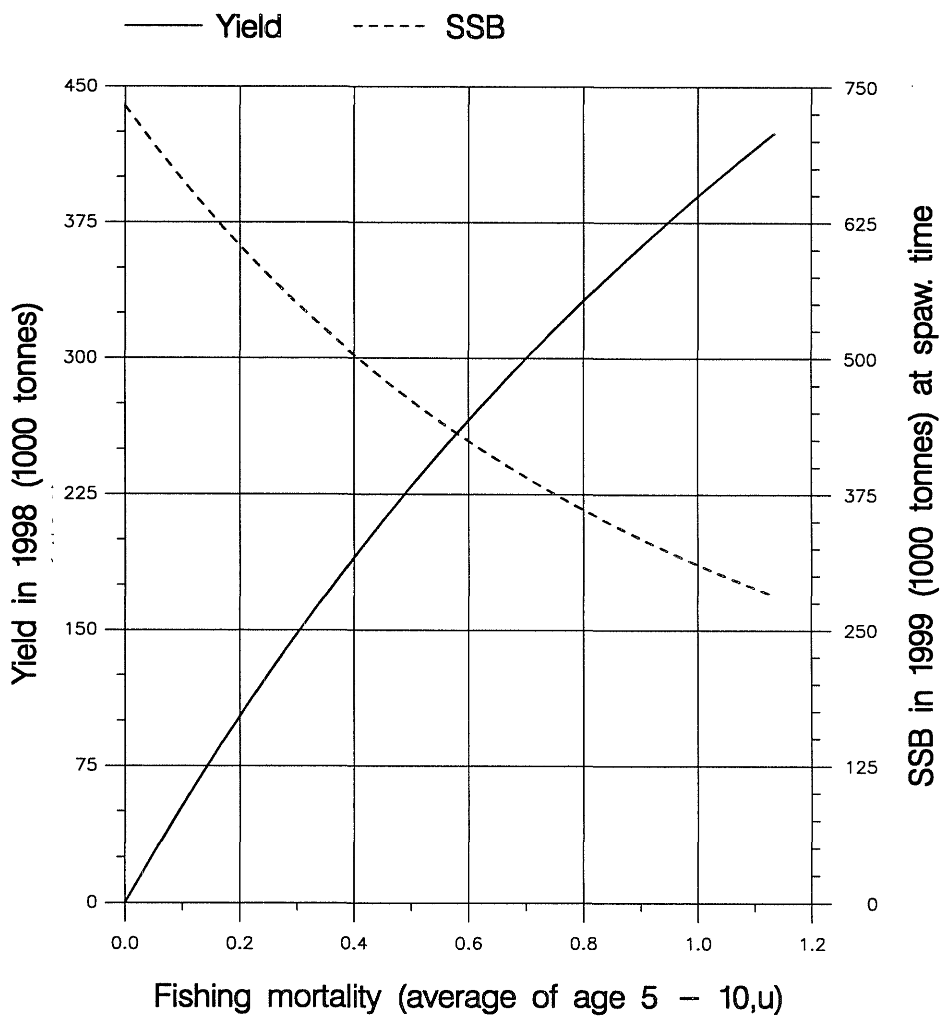
Fish Stock Summary
Cod in the Iceland Grounds (Fishing Area Va)
6 – 5 – 1997

Long term yield and spawning stock biomass



(run: YLDSAS01) **C**

Short term yield and spawning stock biomass



(run: MANSAS01) **D**

Fig. 3.3.8 Iceland cod. Spawning stock biomass and recruitment. Historic data along with fitted stock-recruitment curve (Ricker curve, accounting for cannibalism by immatures) and replacement lines corresponding to F_{med} and F_{high}.

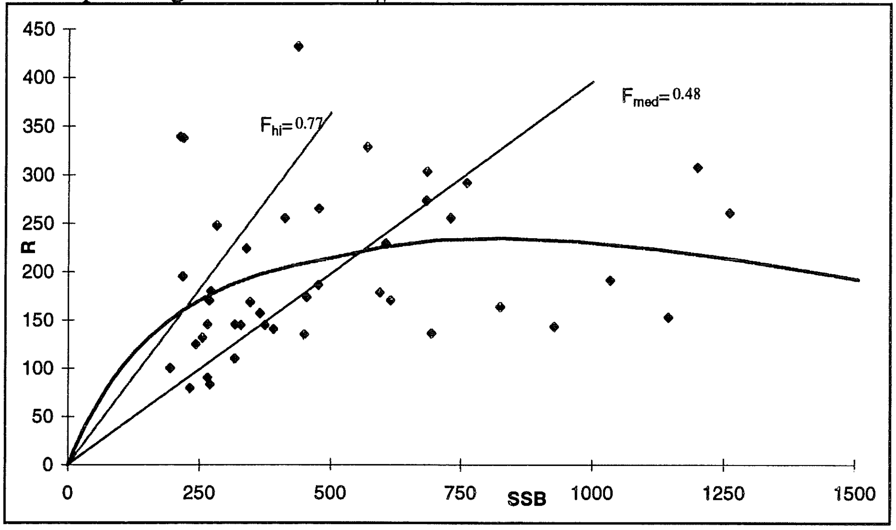


Figure 3.3.9. Cod at Iceland. Percentage changes in effort directed against cod since 1991.

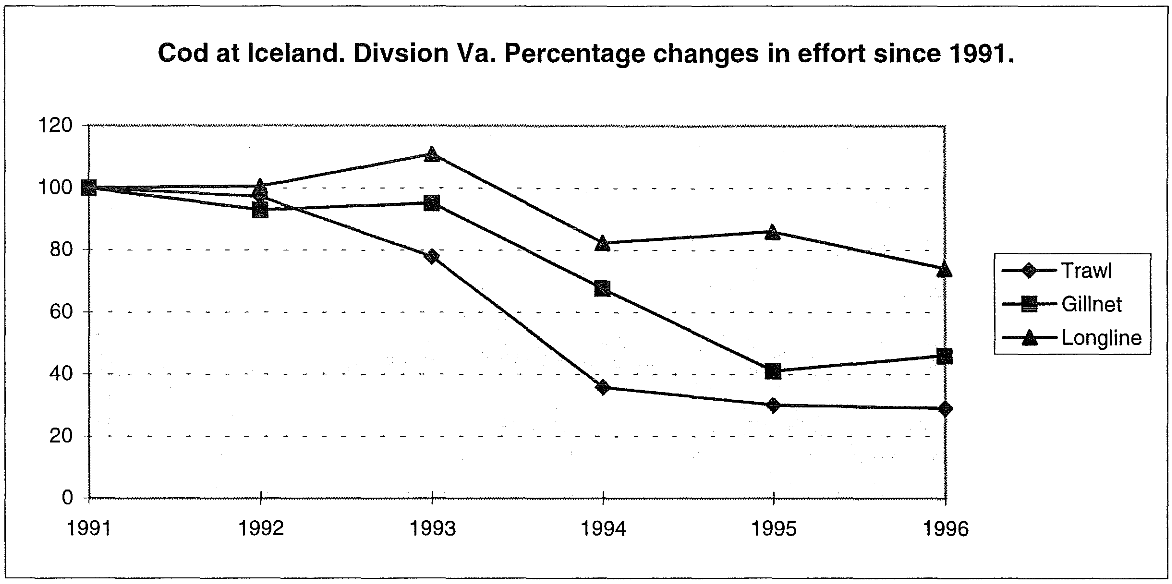


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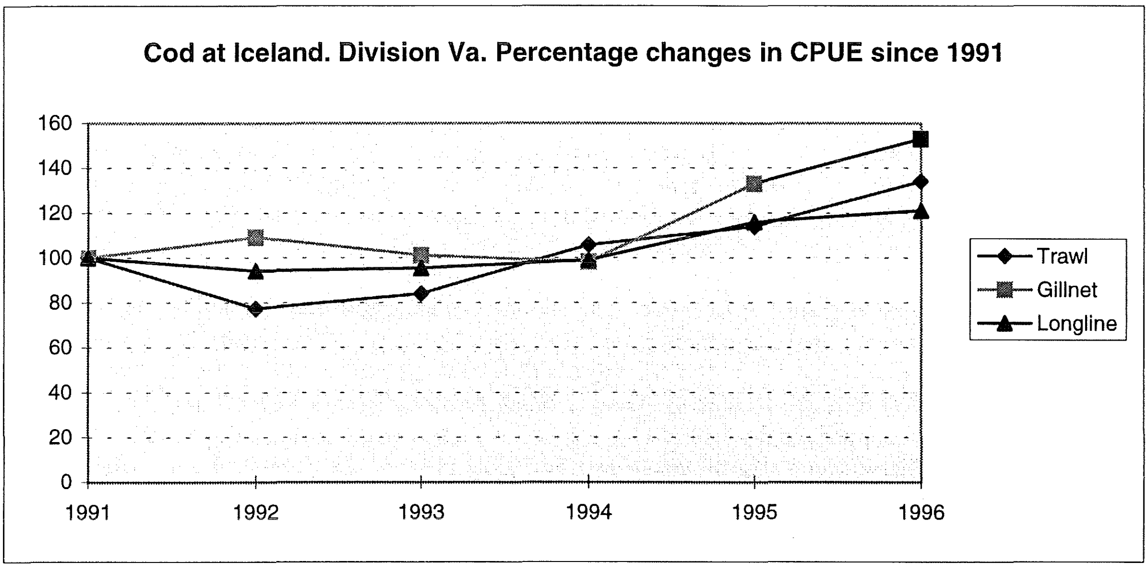
Figure 3.3.10 Cod at Iceland. Division Va. Percentage changes in CPUE for the main gears since 19!



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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).

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, 1971-94 (except 1972).

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

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 last year's 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 from the 1996 assessment appended only by the long term management considerations and updated the 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. Tables 5.1.2 and 5.1.3 listed 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 1982-96. Indices varied significantly between strata and years. Trends of the abundance and biomass estimates for West and East Greenland were shown in Figures 5.1.2 and 5.1.3, respectively. These figures illustrated 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. Since then, the depleted stock was mainly distributed off East Greenland. The 1996 survey results confirmed the severely depleted status of the stock. 1996 survey results indicated that 64 % of the stock abundance and 91 % 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 were listed in Tables 5.1.6-8, respectively. In 1996, the stock structure off West Greenland was found to be composed almost exclusively of the pre-recruiting age groups 1 and 3 years. The age composition off East Greenland was found to be more diverse and comprised mainly juveniles and few mature cod, the age groups 6 years and older amounted to 27 %. Recruitment was classified as 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 were 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 were illustrated in Figure 5.1.4 for the period 1982-96. 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. Off East Greenland, the mean weight for age groups 3-8 have been increasing from low values since 1991 while the cod off West Greenland remained to be small. The recent increase in weighted mean fish weight for age groups 3 to 8 of the total stock was due to their higher abundance off East Greenland where higher and increased growth rates were observed.

5.1.2 Trends in landings and fisheries

Officially reported catches were 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 were 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) were most important throughout the time series for offshore fisheries. Miscellaneous gears, mainly long lines and gill nets, contributed 30-40% until 1977 but have disappeared since then.

Annual landings taken offshore averaged about 300 000 t during the period 1955-60. Until 1968, figures increased to a higher level between 330 000 t and of 440 000 t in 1962. Landings decreased sharply by 90% to 46 000 t in 1973. Subsequently, the landings dropped below 40 000 t in 1977 and were very variable. The level of 40 000 t was only exceeded during the periods 1980-83 and 1988-1990. Since 1970, there have been large changes in effort which increased during exploitation of the strong year classes born in 1973 and 1984. The offshore fishery was closed in 1986 and for the first 10 months in 1987. During 1990-92, the landings decreased from 100 000 t by 90% to 11 000 t. Since then, no directed cod fishery has taken place offshore. The reported by-catches in the redfish fishery declined from 828 t to 187 t in 1993-96, respectively.

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 but no more recent information was available to the Working Group. This estimate was added to the catch figures used by the Working Group for the 1992-95 period.

5.1.3 Biological sampling of commercial catches

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

5.1.4 Results from the 1996 assessment

The historical stock status was assessed based on the terminal Fs derived from an XSA tuning run applying 1992 as the final year. The summary of the assessment was 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 1970s. Thereafter, the fishing mortality was highly variable and seemed to be dependent on the changes in effort directed to the exploitation of individual strong year classes. Periods when Fbar for ages 5-8 years exceeded 0.5 were 1974-1977, 1980-1984 and 1988-1992.

Trends in spawning stock biomass and recruitment were shown in Figure 5.1.7. During 1955 to 1973, the spawning biomass decreased almost continuously from 1.8 million t to 110 000 t, a decrease of 94%. Thereafter, the spawning stock biomass averaged 50 000 t. During the period 1955-73 before the spawning stock decreased below 100 000 t, the recruitment at age 3 varied enormously between 4 million and 700 million and averaged 220 million. Since 1974, the spawning stock varied around the mean of 50 000 t and produced an average recruitment of 41 million representing a mean reduction by 95% and 80%, respectively. The long term mean recruitment was not exceeded for 8 of 19 years from 1955 to 1973, while it has been below that value for 17 of 19 years since then. During the last 29 years, only two 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 spawing 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 F_{bar} 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 0.82 with the accompanied spawning stock biomass of 0.9 kg. There was a relationship between recruitment and the spawning stock biomass with stronger recruitment being produced when the spawning stock biomass was greater than about 1 000 000 t. However, neither the determined Beverton & Holt nor the Ricker model fit the observed recruitment-spawning stock biomass points well. The Beverton & Holt curve quickly reached the long term mean recruitment level affected by the strong 1973 and 1984 year classes. This was 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. For such ecological reasons as temperature and ocean current effects on migration, growth, spawning, larval survival and O-group drift from Iceland, the Working Group had difficulties in accepting the plotted recruitment-spawning stock biomass relation and, consequently, in identifying an appropriate time independent MBAL value and related target and limit reference points. It was recommended by the Working Group that temperature effects be analysed, i.e. to compare recruitment-spawning stock biomass relations under cold and average or warmer temperature regimes reflecting different production in terms of offsprings and growth.

5.1.6 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 1970s. 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.

5.1.7 Comments on the assessments

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 1993-96 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 south	north	east	west	depth (m)	area (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, 1982-96.

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

Table 5.1.4 Cod off Greenland (offshore component). Abundance indices (1000) for West, East Greenland and total by stratum, 1982-96. 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	5092	729	47957	1888	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

Table 5.1.5 Cod off Greenland (offshore component). Biomass indices (tons) for West, East Greenland and total by stratum, 1982-96. 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	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	46
1989	727	228	25829	441	231239		75386		40614	127865	34957	31324		4786	333850	239546	573395	46
1990	224	114	3552	190	5778		13185	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

Table 5.1.6 Cod off West Greenland (offshore component). Age disaggregate abundance indices (1000), 1982-1996. *) 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	2616	7184	375	600	18	19	0	59366
1986	0	10575	114823	4374	1033	7837	2250	4167	107	449	23	35	145673
1987	0	317	45474	692566	24230	5929	11813	1637	4006	0	366	30	786368
1988	434	254	3290	101820	511473	5435	616	1134	662	1310	34	39	626501
1989	12	204	2583	7618	170469	174532	2868	0	259	40	141	5	358731
1990	158	47	1014	2900	1272	22120	6964	47	0	0	0	5	34527
1991	0	245	208	435	1260	160	2102	356	6	0	0	0	4772
1992	0	189	1473	227	48	89	0	28	0	0	0	0	2054
1993	0	10	832	546	20	28	6	0	0	0	0	0	1442
1994	0	286	45	199	38	5	0	5	0	0	0	0	578
1995	0	0	241	16	22	0	0	0	0	0	0	0	279
1996	0	147	11	638	10	0	10	0	0	0	0	0	816

Table 5.1.7 Cod off East Greenland (offshore component). Age disaggregate abundance indices (1000), 1982-1996. *) 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	6605
1985	232	1932	559	117	2496	2035	1853	779	1989	284	53	79	12408
1986	0	1398	3346	1693	550	2419	1121	2187	566	1594	116	201	15191
1987	0	13	13785	17789	3890	1027	1767	452	1562	180	1023	131	41619
1988	12	25	160	6975	11092	2011	478	1410	150	653	94	501	23561
1989	0	8	177	494	17396	63169	2990	294	4746	396	1560	498	91728
1990	0	37	79	552	463	5132	17998	265	71	238	0	411	25246
1991	0	101	374	388	697	148	3524	5046	82	37	12	20	10429
(1992)	29	29	73	69	59	54	47	143	52	0	0	25	580
1993	0	17	45	1860	370	279	278	88	263	95	0	9	3304
(1994)	0	87	0	29	261	143	87	145	0	29	0	0	781
1995	0	7	2523	1125	370	1730	450	141	460	36	217	125	7184
1996	0	0	0	502	258	295	255	60	77	0	0	0	1447

Table 5.1.8 Cod off Greenland (offshore component). Age disaggregate abundance indices (1000), 1982-1996. *) 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	13580	2089	5568	180	1389	161	827987
1988	446	279	3450	108795	522565	7446	1094	2544	812	1963	128	540	650062
1989	12	212	2760	8112	187865	237701	5858	294	5005	436	1701	503	450459
1990	158	84	1093	3452	1735	27252	24962	312	71	238	0	416	59773
1991	0	346	582	823	1957	308	5626	5402	88	37	12	20	15201
(1992)	29	218	1546	296	107	143	47	171	52	0	0	25	2634
1993	0	27	877	2406	390	307	284	88	263	95	0	9	4746
(1994)	0	373	45	228	299	148	87	150	0	29	0	0	1359
1995	0	7	2764	1141	392	1730	450	141	460	36	217	125	7463
1996	0	147	11	1140	268	295	265	60	77	0	0	0	2263

Table 5.1.9 Cod off West Greenland (offshore component). Weighted mean weight (g., by stratum abundance) at age 1-10 years, 1982, 1984-1996.

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				

Table 5.1.10 Cod off East Greenland (offshore component). Weighted mean weight (g., by stratum abundance) at age 1-10 years, 1982, 1984-1996. () 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		

Table 5.1.11 Cod off Greenland (offshore component). Weighted mean weight (g., by stratum abundance) at age 1-10 years, 1982, 1984-1995. () Incomplete sampling.

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

Table 5.1.12 Nominal catch (tonnes) of Cod in NAFO Sub-area 1, 1982-1996 as officially reported to NAFO.

Country	1983	1984	1985	l1986	1987	1988	1989
Faroe Islands	1.339	-	-	-	-	-	-
Germany	10.158	8.941	2.170	41	55	6.574	12.892
Greenland	44.970	24.457	12.651	6.549	12.284	52.135	92.152
Japan	-	13	54	11	33	10	-
Norway	-	5	1	2	1	7	2
UK	1.174	-	-	-	-	927	3780
Total	57.641	33.416	14.876	6.603	12.373	59.653	108.826
WG estimate	-	-	-	-	-	62.653 [2]	111.567 [3]

Country	1990	1991	1992	1993	1994	1995	1996 [1]
Faroe Islands	51	1	-	-	-	-	-
Germany	7.515	96	-	-	-	-	-
Greenland	58.816	20.238	5.723	1.924	2.115	1.710	948
Japan	-	-	-	-	-	-	-
Norway	948	-	-	-	-	-	-
UK	1.631	-	-	-	-	-	-
Total	68.961	20.335	5.723	1.924	2.115	1.710	948
WG estimate	98.474 [4]	-	-	-	-	-	-

[1]) Provisional data
[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, 1982-1996 as officially reported to ICES.

Country	1983	1984	1985	1986	1987	1988	1989
Faroe Islands	368	-	-	86	-	12	40
Germany	8.238	7.035	2.006	4.063	5.358	12.049	10.613
Greenland	438	1.051	106	606	1.550	345	3.715
Iceland	-	-	-	-	1	9	-
Norway	-	794	-	-	-	-	-
Russia							-
UK (Engl. and Wales)	-	-	-	-	-	-	1.158
UK (Scotland)	-	-	-	-	-	-	135
United Kingdom	-	-	-	-	-	-	-
Total	9.044	8.880	2.112	4.755	6.909	12.415	15.661
WG estimate	13.378 [1]	8.914 [1]	-	-	-	9.457 [2]	14.669 [3]

Country	1990	1991	1992	1993	1994	1995	1996 [6]
Faroe Islands	-	-	-	-	1	-	-
Germany	26.419	8.434	5.893	164	24	22	5
Greenland	4.442	6.677	1.283	241	73	29	5
Iceland	-	-	22	-	-	1	-
Norway	17	828	1.035	183	43	+	1
Russia	-	-	126	-	-	-	-
UK (Engl. and Wales)	2.365	5.333	2.532	163	-	-	-
UK (Scotland)	93	528	463	46	-	-	-
United Kingdom	-	-	-	-	296	232	181
Total	33.336	21.800	11.354	797	437	284	192
WG estimate	33.513 [4]	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 miscellaneous	offshore OBT	offshore total	total
1955	19787	117238	136028	253266	273053
1956	21063	121876	193593	315469	336532
1957	24790	104632	151666	256298	281088
1958	26684	121636	182516	304152	330836
1959	28184	97457	128777	226234	254418
1960	28708	115273	122859	238132	266840
1961	35164	140110	192007	332117	367281
1962	36283	168092	273598	441690	477973
1963	24173	138451	289143	427594	451767
1964	23106	118495	243714	362209	385315
1965	25209	133855	225150	359005	384214
1966	29956	149234	200086	349320	379276
1967	28277	132415	293519	425934	454211
1968	21215	64286	323800	388086	409301
1969	22119	36276	174031	210307	232426
1970	16114	16101	102196	118297	134411
1971	14039	25450	113207	138657	152696
1972	14753	29765	94730	124495	139248
1973	9813	16740	46141	62881	72694
1974	8706	18086	27695	45781	54487
1975	6779	13363	33692	47055	53834
1976	5446	8710	32157	40867	46313
1977	14964	10081	21726	31807	46771
1978	20295	4	26059	26063	46358
1979	36785	36	20056	20092	56877
1980	40122	0	57584	57584	97706
1981	40021	0	40266	40266	80287
1982	26934	2020	49827	51847	78781
1983	26689	3339	40991	44330	71019
1984	19967	5	22358	22363	42330
1985	8488	1	8499	8500	16988
1986	5320	2	6036	6038	11358
1987	8445	1	10836	10837	19282
1988	22814	7	49089	49096	71910
1989	38788	2	85946	85948	124736
1990	29513	948	99535	100483	129996
1991	18950	0	22966	22966	41916
1992	5723	0	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

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

```
Run title : Greenland cod - (offshore component)

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

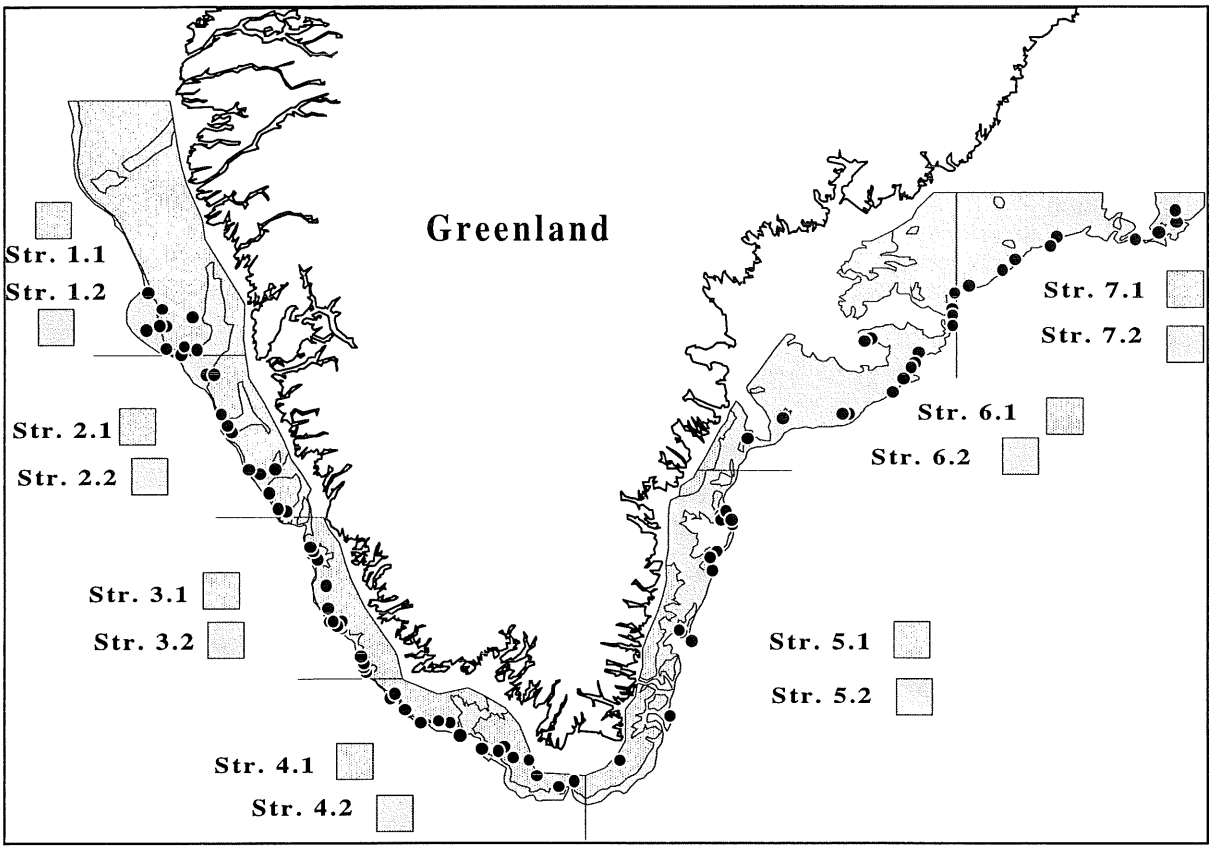

Figure. 5.1.1 Cod off Greenland (offshore component). Survey area, stratification and position of hauls carried out in 1996.

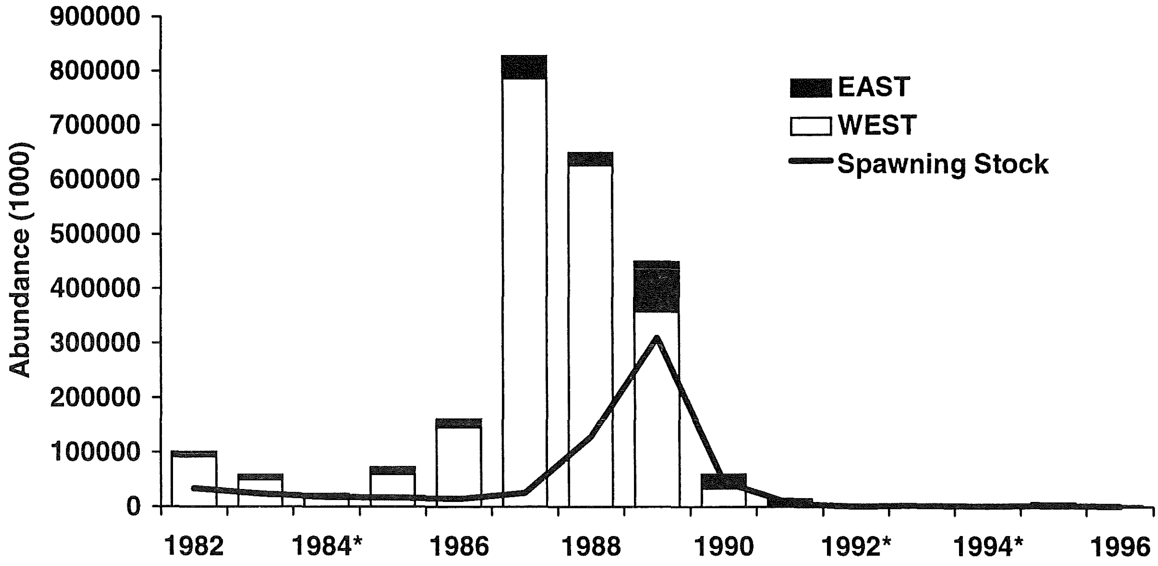

Figure 5.1.2 Cod off Greenland (offshore component). Aggregated survey abundance indices for West and East Greenland and spawning stock size, 1982-96. *) incomplete survey coverage.

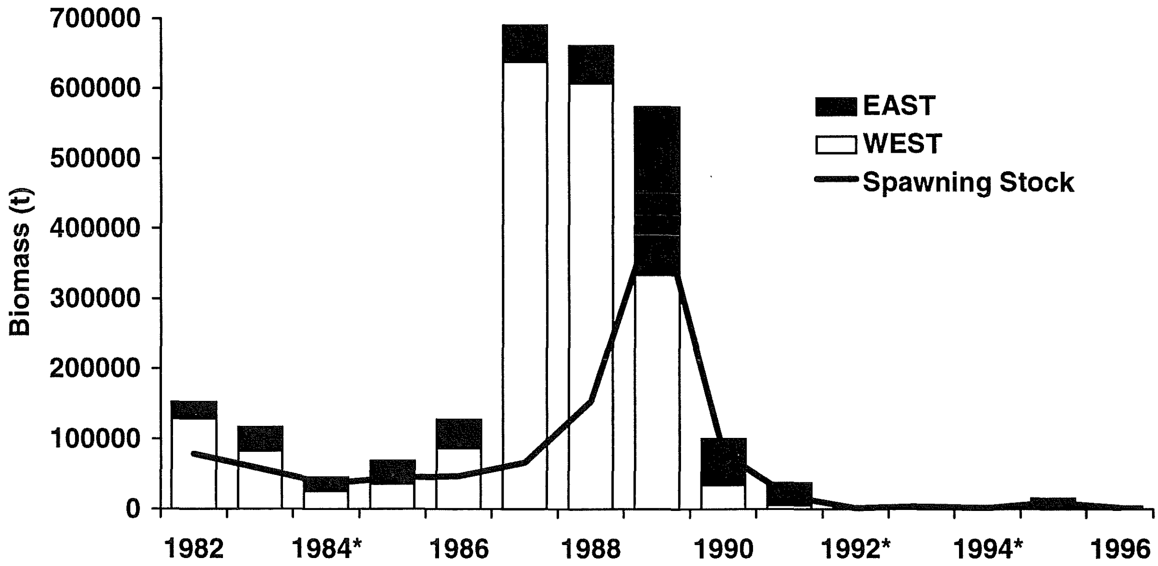

Figure 5.1.3 Cod off Greenland (offshore component). Aggregated survey biomass indices for West and East Greenland and spawning stock biomass, 1982-96. *) incomplete survey coverage.

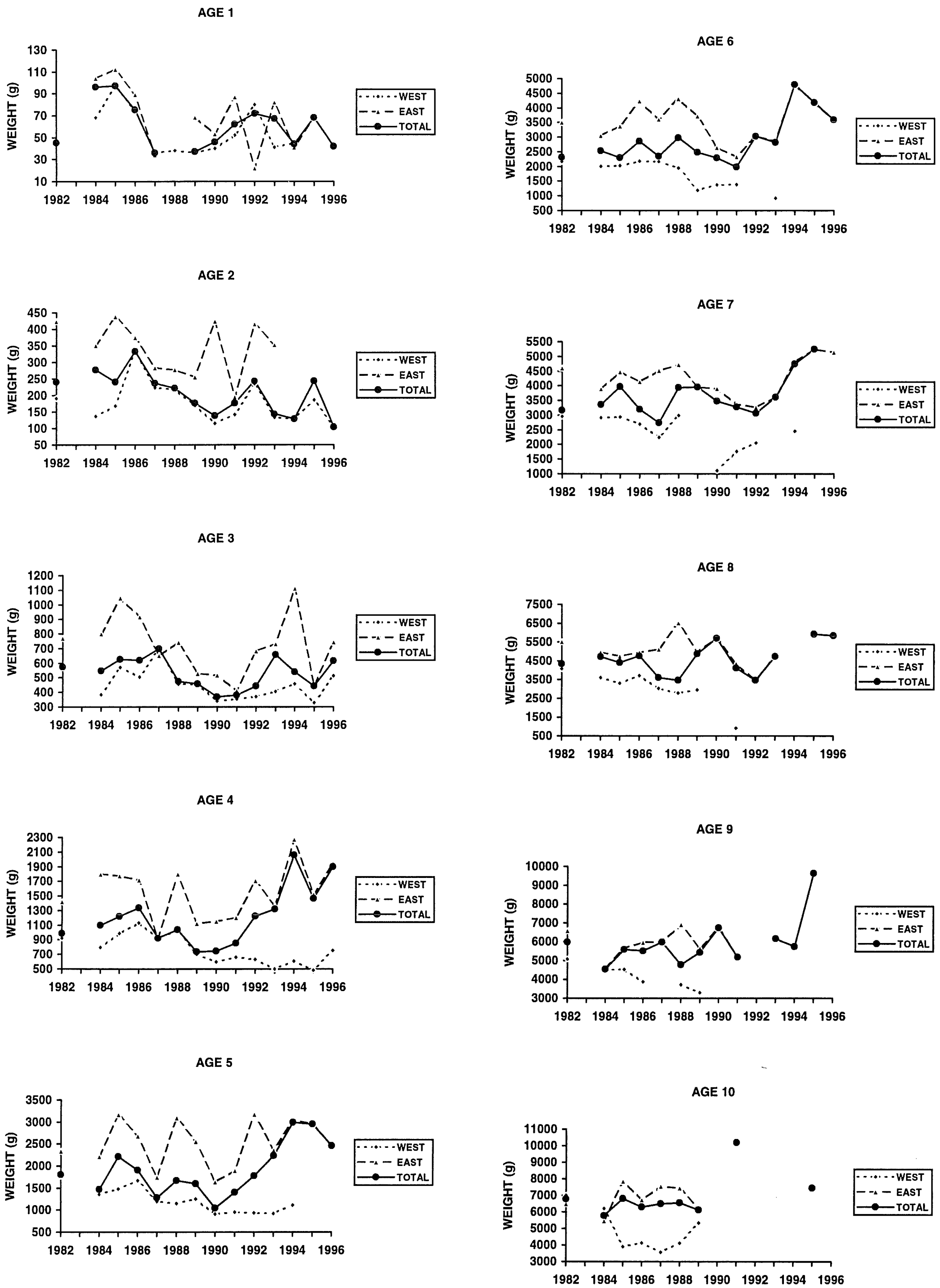

Figure 5.1.4 Cod off Greenland (offshore component). Weighted mean weight at age 1-10 years for West, East Greenland and total, 1982-96.

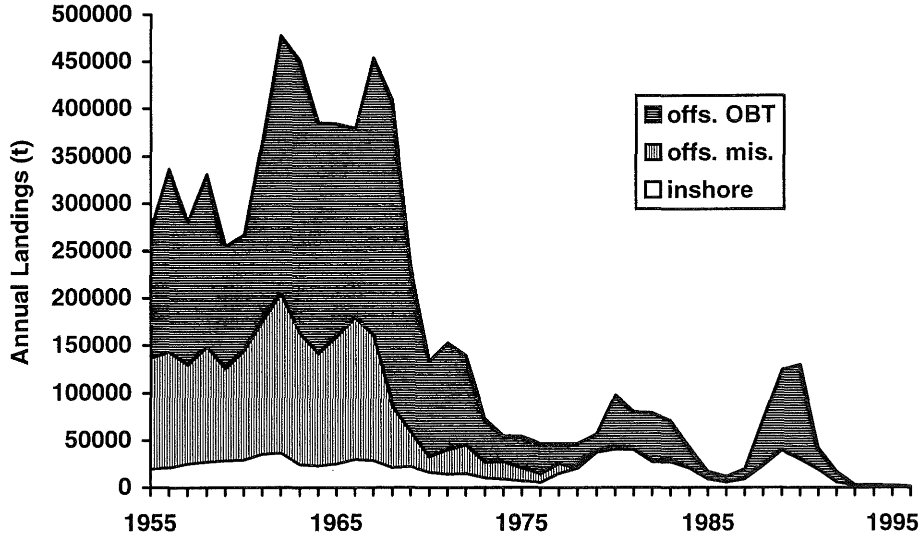

Figure 5.1.5 Cod off Greenland. Catches 1955-95 as used by the Working Group, inshore and offshore by gear (Horsted,1994).

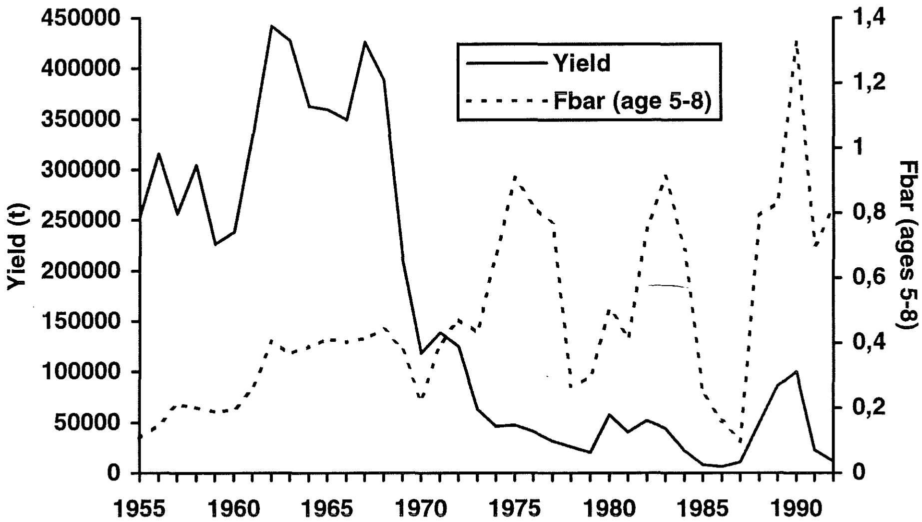

Figure 5.1.6 Greenland cod (offshore component). Trends in yield and fishing mortality.

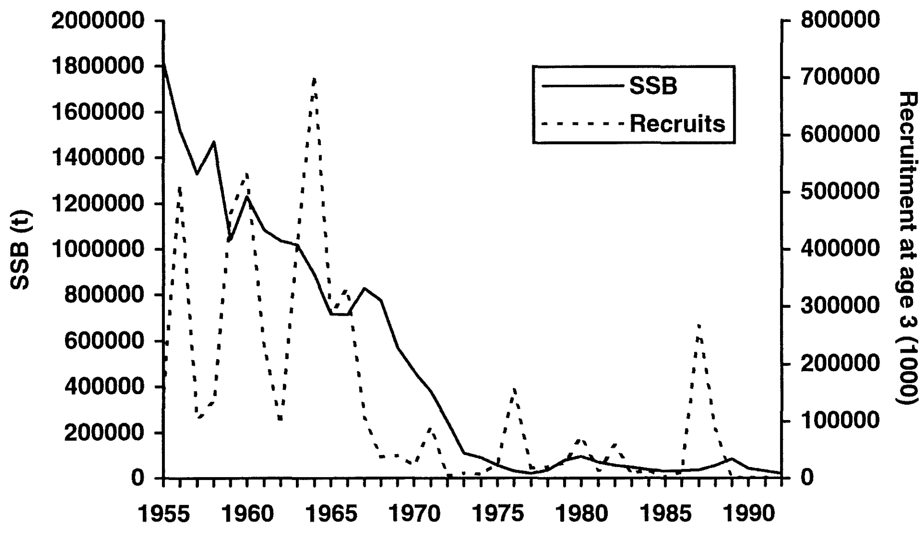

Figure 5.1.7 Greenland cod (offshore component). Trends in spawning stock biomass (SSB) and recruitment.

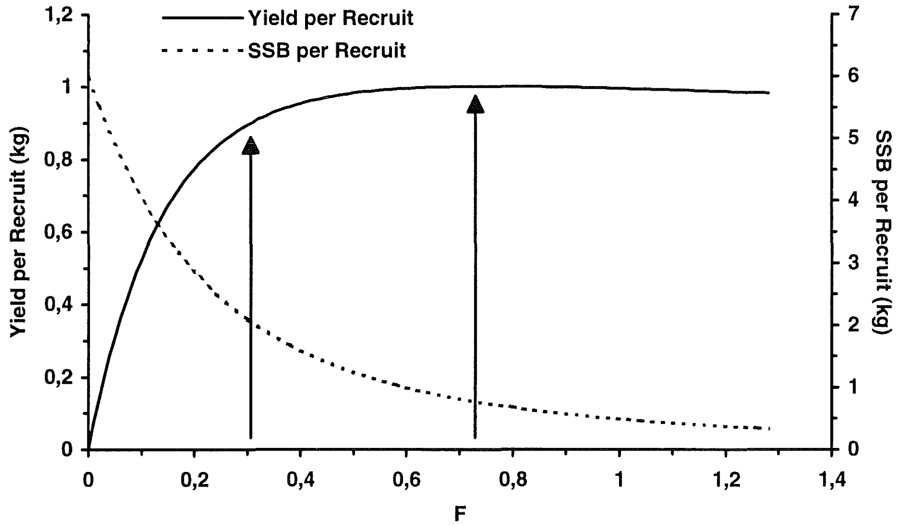

Figure 5.1.8 Greenland cod (offshore component). Long term yield and spawning stock biomass. $F_{0.1}$ reference age 5-8=0.297; F_{max} reference age 5-8=0.722.

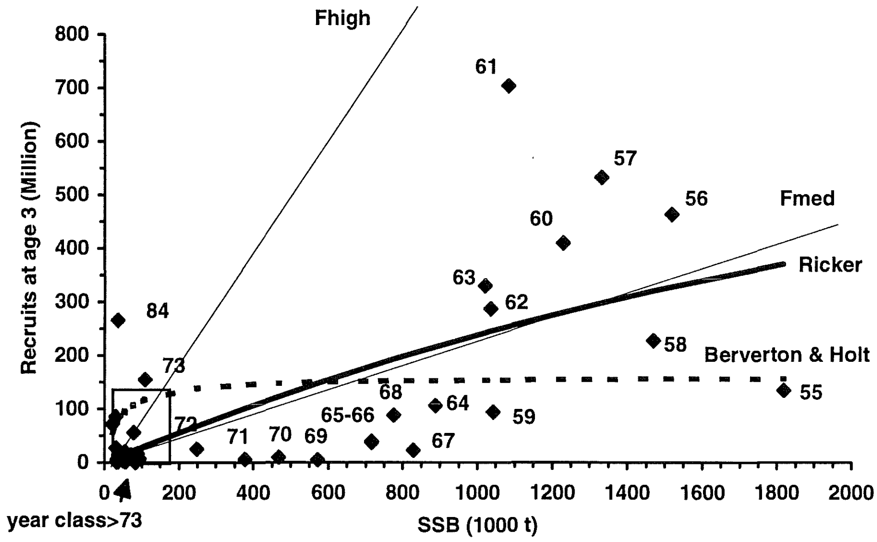

Figure 5.1.9 Greenland cod (offshore component). Spawning stock-recruitment plot for year classes 1955-89 and fitted recruitment curves. F_{med}=0.09 corresponding to a SSB/R=4.502 kg; F_{high}=0.82 corresponding to a SSB/R=0.923 kg.

5.2 Inshore cod stock off Greenland

In the last decade, the inshore cod fishery at West Greenland has contained cod from two different spawning areas. Icelandic 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 the West Greenland (Buch *et al.*, 1994) especially in NAFO Division 1B, 1C and 1D. Tagging experiments and independently fluctuating recruitment in these fjords suggest that these stocks are more or less isolated.

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 catch of 948 tons.

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.

The pronounced decline of catches in 1996 may partly be due to a substantial decrease in the effort, as many small boat fishermen shifted their efforts to snow crab fishing.

5.2.2 West Greenland young cod survey.

A survey using gangs of gill-nets with different mesh-sizes 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), but in 1996 the survey was restricted to Sisimiut and Nuuk because of financial considerations.

Three mesh-sizes (16.5, 24 and 33mm bar length) were used in the first two years, but in 1987 two additional mesh sizes were added (18.5 mm and 28 mm). An index of recruitment for each area is calculated as the mean catch of 2-year old cod per 100 hours net setting taken by all five mesh sizes. Values for 1985-86 have been corrected to five mesh units based on the relationship between catches in the 3 and 5 mesh-series as found since 1987. The recruitment series is shown in Table 5.2.1.

The 1984 and 1985 year-classes, which are considered to have drifted from Iceland to Greenland, show high abundance at age 2 in all areas. For the other year-classes, less resemblance is seen between the areas. For Div. 1F all year classes after 1985 are missing. This pattern of year class occurrence resembles that which has been a found offshore indicating the Icelandic origin of cod in this area. In Div. 1B, where the highest CPUE's are generally seen, the year-classes 1986 to 1988 are prominent whereas the year-class 1989 and all year classes after 1990 are very weak.

Nearly the same development are seen in Division 1D where the year classes of 1986-1987, and 1989-1990 are prominent whereas the four last year-classes 1991-1994 are weak or absent.

5.2.3 Catch in numbers

In West Greenland, 11 samples from poundnet landings were used to convert the total inshore catch into numbers at age. Sampling has been increasingly difficult to perform in recent years due to the low catch levels. Fifty percent of the catch was broken down by samples to the respective area and month; the remaining catch had to be converted to numbers at age using samples taken from other areas or months (Table 5.2.2).

Weight -at-age for West Greenland cod were based on samples from the commercial inshore fisheries (Table 5.2.3). The overall mean weight was derived by weighting catch from the various areas and months. Increased mean weight at age was observed in 1996 for all age groups.

5.2.4 Management Considerations

The inshore fishery possible exploiting self-sustained local fjord populations off West Greenland has historically been small. The inshore stock component has never been assessed separately. Due to insufficient sampling and a variable recruitment situation, the Working Group considered that the use of catch at age data for a VPA- or catch curve analysis would not be likely to give reliable results.

All year-classes since 1991 are estimated to be very poor. One should therefore consider restrictive catch regulations for the fisheries to enhance the recruitment prospects of the inshore stock.

Table 5.2.1 CPUE of age 2 cod by area as observed in the Greenland gill net survey in inshore areas off West Greenland, 1986-1995.

Year	Year class	Sisimiut (Div. 1B)	Nuuk (Div. 1D)	Qaqortoq (Div. 1F)	Average
1986	1984	739.2	222.6	257.7	406.5
1987	1985	119.1	21.8	147.8	144.4
1988	1986	32.6	20.1	0.8	17.8
1989	1987	109.7	76.0	5.1	63.6
1990	1988	101.0	14.4	0.6	38.7
1991	1989	3.6	2.0	1.9	2.5
1992	1990	47.6	53.5	2.1	34.4
1993	1991	21.0	5.7	4.5	10.4
1994	1992	8.1	0.8	0.0	3.0
1995	1993	14.4	1.3	0.0	5.2
1996	1994	7.1	0.8	*	4.0

*(no survey)

Table 5.2.2: Greenland cod (inshore component NAFO 1) Catch in numbers (1000) , 1987 - 1996.

Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Age										
3	3729	639	23	377	174	40	29	12	1	3
4	1128	18018	4680	4221	6712	3323	566	1735	1179	201
5	188	384	22670	10714	5717	2151	750	261	389	318
6	59	114	237	8536	2970	233	235	91	26	71
7	266	58	5	54	276	78	12	5	5	15
8	641	173	8	18	0	11	3	4	0	3
9	2	231	106	0	0	0	0	1	0	1
+10	30	0	267	5	0	0	0	0	0	0

Table 5.2.3: Greenland cod (inshore component NAFO 1) Mean weight at age, 1987-1996.

Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Age										
3	0.9	0,4	0,63	0,67	0,82	0,51	0,45	0,45	0,77	0,95
4	1 05	1,1	0,84	0,87	1 04	0,86	0,91	0,91	0,88	1 08
5	1,96	1,17	1,31	1,16	1,24	1,17	1,56	1,56	1,36	1,61
6	2 06	1,72	1,81	1,48	1,63	1,48	2 03	2,35	2 06	2,64
7	3 05	2,66	2,95	2,97	2 02	2,39	2,23	2,23	2,23	3,93
8	3,25	3 05	3,21	3,21		2,57	2,7	3 07		5,29
9	3,77	3,75	4,65					3,77		6,38
10	5,53		6,42	5,76						

6 GREENLAND HALIBUT IN SUB-AREAS V AND XIV

6.1 Landings, Fisheries and Fleet

Total annual catches in Divisions Va, Vb and Sub-area XIV are presented for the years 1981-1996 in Tables 6.1.1-6.1.4. 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 decreased again gradually to 36 000 t in 1996. 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. Similar conditions exist for Division XIVb, where landings and fishery only relate to the Greenland EEZ part of XIVb.

Catches in Icelandic waters have, due to quota regulations, decreased from 37 000 t in 1990 to 22 000 t in 1996. Faroese catches in Vb have increased from a level of about 1 000 t in 1981-1991 to about 6,500 t in 1996. Catches in Greenland waters (division XIVb) have increased from below 1 000 t in 1987-1991 to about 7 000 t in 1996.

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 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 (1000-1200 meters) west 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 is mainly conducted in a narrow belt of the continental slope at depths of 500-1000 meters in the north-easternmost area of XIVb, while most of the longliners are now fishing between 61°40-62°30N, 40°00-40°30W at depths of 1000-1400 meters. 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.

In 1996, a longline and gill net fishery took place 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 tonnes in 1996.

Annual catches in 1996 are separated by gears in Table 6.1.5.

6.2 Trends in Effort and CPUE

Commercial catch rates of Icelandic bottom trawlers have decreased for all fishing grounds since 1990. For the years 1990-1996 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 1985-1996 (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 1996. The CPUE was relatively stable in 1985-1989, but has declined sharply since then to a historic low last year. The CPUE declined by 72% from 1985 to 1996. In the last two years the effort has increased by 14% and the CPUE decreased by 12%.

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. 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 7000 tons in 1996. The fishermen are therefore assumed to be in the process of learning and hence the CPUE series is not considered reliable for trends in the stock.

6.3 Catch in Numbers at Age and Sampling level

The data set comprising the age-length key for 1996 were from 3 different sources: 65 samples (655 otoliths) from the Icelandic trawl fleet operating in Icelandic water (TRVa-key), 71 samples (1527 otoliths) from the Icelandic long line fleet (LLVa-key) and 16 samples (348 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	13,551	625	19,867	TRVa
Va north & east	Trawl	4,390	78	3,807	TRVa
Va southeast	Trawl	1,684	88	2,862	TRVa
Va	Long line	2,857	76	2,681	LLVa
Vb	Trawl	3,523	9	1,934	TRVa
Vb	Gill net	2,918	3	967	TRVa
XIV	Trawl	5,586	19	728	TRVa
XIV	Long line	1,423	16	7,203	LLXIV
	TOTAL	35,932	914	40,049	

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 $W=2.361*10^{-3}*L^{3.360}$ was used. The total catch in numbers (Table 6.3.1) were obtained from the sum of the above weighted with the catch within each group.

6.4 Weight at Age

The mean weight at age in 1996 (Table 6.4.1) was derived from the weighted average of the above groups. Apart from 1994 and 1996 only Icelandic data has been available. Weights at age in the catch are also used as weights at age in the stock.

6.5 Maturity at Age

Data on maturity at age were available for the years 1982-1984 and 1991-1995, based on samples from the Icelandic trawl fishery. Data on maturity at age for the years 1985-1990 were not available. The maturity at age for these years was therefore estimated by averaging the data from the years 1982-1984 and 1991 (Table 6.5.1). Due to unreliable data for 1994, 1993 data were applied to 1994. The data on maturity for 1996 were based on information from the Icelandic trawl fishery in division Va and from the Norwegian longline fishery in Division XIVb.

6.6 Stock Assessment

6.6.1 Tuning and estimates of fishing mortalities

Age-disaggregated CPUE values for age groups 7-12 over the period 1985-1996, obtained from the Icelandic trawling fleet operating in Division Va, were used in the tuning process. The tuning was performed with reduced shrinkage (by increasing the SEmshr to 1.0), which is the same process as last year. The diagnostics are presented in Table 6.6.1.

Although the increasing trend in effort is reflected in an increasing trend in F, the F values in the two most recent years are somewhat lower than expected if the relationship between these two parameters are simply linear through the origin (Figure 6.6.1.).

The terminal fishing mortalities from the XSA run with a SEmshr = 1.0 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 6.6.2.-4. and Figures 6.6.2.A and B.

6.6.2 Spawning stock and recruitment

Spawning stock biomass is shown in Table 6.6.4. and Figure 6.6.2.B. The spawning stock was between 70 and 80 000 t between 1978-1983, and increased to a maximum of 126 000 t in 1988. Since then it has declined to a low of 70 000 t in 1996.

Estimates of recruitment at age 5 is shown in Table 6.6.5 and Figure 6.6.2 B. The long term average for the period 1976-1994 is 32 million fish. The 1980 and 1981 year classes are the highest on record at about 45 million. Since then there has been a decline in recruitment, the numbers reaching a record low of 20 million fish in the 1987 year class. The size of the 1988 year class is also below average. Estimates of the more recent year classes of 1989 and 1990 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

The input data for the short term prediction are given in Table 6.7.1.1. Mean weight at age is average from 1994-96 and the exploitation pattern is average fishing mortalities from 1994-1996 rescaled to the level of 1996. Maturity at age is the average of 1993-1996, exclusive of the year 1994 (since those are assumed values of 1993). Natural mortality was set to 0.15 and the proportions of F and M before spawning were set to 0. Year classes 1990-1992 were assumed to be equal to the lower 25th percentile recruitment value over the period 1976-1994. This is a reflection of the recruitment being below average since 1983 year class.

The prediction is based on a *status quo* F, using the same reference F in 1997 as in 1996.

The Y/R calculation uses the mean weight at age averaged for the period 1976-1996. The exploitation pattern is based on an average exploitation pattern over the period 1976-1996 rescaled to the level of 1996 (Table 6.7.1.2).

6.7.2 Biological reference points

$F_{0.1}$ was estimated to be 0.22 and F_{max} = 0.56 (Table 6.7.2.1, Figure 6.7.2.1).

F_{med} and F_{high} are estimated to be 0.36 and 0.59, respectively (Figure 6.7.2.2). MBAL could not be assessed from the available data.

6.7.3 Projections of catch and biomass

At the beginning of 1997, the total stock is estimated to have declined to about 140 000 t, and the spawning stock just below 51 000 t (Table 6.7.3.1). The 1997 catch prediction of 32 000 t, based on a *status quo* F, is close to the expected catches. To maintain the catch in 1998 at the recent level of 35 000 t, an increase in F of 25% will be required. At a *status quo* F in 1997 and 1998, the stock biomass will decrease to 134 000 t in the beginning of

1998 and further to 130 000 t in 1999, and SSB will decrease to a record low of 43 000 t in 1999. Even a closure of the fishery is insufficient to increase the SSB in 1999 above the 1996 level. A minimum of a 70% reduction in F is needed to increase SSB to any extent above 1997 level. This will result in catches less than 11 000 t in 1998.

6.8 Management Considerations

The Greenland halibut stock biomass has been falling rapidly from a peak in 1987. Catches in the last 7 years have remained between 36 000-42 000 t, despite drastic 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_{high} . The increase in effort in recent years is not reflected in proportional increases in terminal fishing mortality estimates (Fig 6.6.1). Recruitment for year classes 1986-1989 have been below average and recruitment of year classes 1990 and onward is unknown. 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. Age reading on the long line samples from 1996, both in area Va and XIV were performed by newly trained readers. Although a slight bias is suggested, in relation to the result from the trawl fleet, the overall effect of such a bias on the total catch in number from the long line fleet is minor, even in the oldest age groups.

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 and are currently planning, 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 regions XIV and 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 and XIV 1981-1996, 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]
Denmark	-	-	-	-	-	-	-	
Faroe Islands	2,319	1,803	1,566	2,128	4,405	6,241	3,763	-
France	-	-	-	3	2	-	-	
Germany	493	336	303	382	415	648	811	3,368
Greenland	11	40	66	437	288	867	533	
Iceland	58,330	36,557	34,883	31,955	33,987	27,778	27,383	22,057
Norway	3	50	34	285 [1]	908 [1]	1,171	1,810	2,160
Russia	-	-	-	5	-	-	10	424
UK (Engl. and Wales)	-	27	38	109	811	513	1,436	
UK (Scotland)	-	-	-	19	26	84	232	
United Kingdom	-	-	-	-	-	-		512
Total	61,156	38,813	36,890	35,323	40,842	37,302	35,978	28,521
Working Group estimate	61,396	39,326	37,950	35,487	41,247	37,190	36,288	35,932 [2]

1) Provisional data

2) Working group estimates as in Table 6.1.5.

Table 6.1.2. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Division Va 1981-1996, 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]
Faroe Islands	719	739	273	23	166	910	13	-
Germany	-	-	-	-	-	1	2	4
Greenland	-	-	-	-	-	1	-	
Iceland	58,330	36,557	34,883	31,955	33,968	27,696	27,376	22,057
Norway	-	-	-	-	-	-	-	-
Total	59,049	37,296	35,156	31,978	34,134	28,608	27,391	22,061
Working Group estimate	59,272 [2]	37,308 [3]	35,413 [4]	-	-	-	-	22,072 [5]

1) Provisional data

2) Includes 223 t catch by Norway.

3) Includes 12 t catch by Norway.

4) Includes additional catch of 257 t by Iceland.

5) Working group estimates as in Table 6.1.5.

Table 6.1.3. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Division Vb 1981-1996, 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 [1]
Denmark	-	-	-	-	-	-	-	
Faroe Islands	1,513	1,064	1,293	2,105	4,058	5,163	3,603	
France [6]	...	...	...	3	2	...	...	
Germany	73	43	24	71	24	8	1	21
Greenland	-	-	-	-	-	-	-	
Norway	3	42	16	25 [1]	371 [1]	53	142	281
UK (Engl. and Wales)	-	-	-	1	15	-	31	
UK (Scotland)	-	-	-	1	-	-	27	
United Kingdom	-	-	-	-	-	-		135
Total	1,589	1,149	1,333	2,206	4,470	5,224	3,804	437
Working Group estimate	1,606 [2]	1,282 [3]	1,662 [4]	2,269 [5]	-	-	3,820 [7]	6,441 [8]

1) Provisional data
2) Includes 17 t taken by France
3) Includes 133 t taken in Division IIa (Faroese waters).
4) Includes 317 t taken in Division IIa (Faroese waters) + France 12 t.
5) Includes 63 t taken in Division IIa (Faroese waters).
6) Quantity unknown 1989-1991 and 1993-1994.
7) Includes 16t by France
8) Working group estimates as in Table 6.1.5.

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Table 6.1.4. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Sub-area XIV 1981-1996, 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]
Faroe Islands	87	-	-	-	181	168	147	
Germany	420	293	279	311	391	639	808	3,343
Greenland	11	40	66	437	288	921	533	
Iceland	+	-	-	-	19	82	7	-
Norway	-	8	18	260	537 [1]	773 [1]	1,668 [1]	1,879
Russia	+	-	-	5	-	-	10	424
UK (Engl. and Wales)	-	27	38	108	796	513	1405	
UK (Scotland)	-	-	-	18	26	84	205	
United Kingdom	-	-	-	-	-	-		377
Total	518	368	401	1,139	2,238	3,180	4,783	6,023
Working Group estimate	-	736 [2]	875 [3]	1,240 [4]	2,275 [5]	- [6]	5,077 [7]	7,417 [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).

7) Includes 273 t offshore gillnets (Greenland charter)

8) Working group estimates as in Table 6.1.5.

Table 6.1.5. 1996 Catch statistics for Greenland halibut in V and XIV. Working Group best estimates.

Va	Long line	Trawl	Gill Net	Unknown	SUM
Faroe Islands				14	14
Germany, Fed. Rep.		4			4
Greenland					0
Iceland	2,447	19,607			22,054
Norway					
Total	2,447	19,611	0	14	22,072

Vb	Long line	Trawl	Gill Net	Unknown	SUM
Faroe Islands		3,323	2,603	78	6,004
France					0
Germany Fed. Rep.		21			21
Norway			281		281
UK (England & Wales)					0
UK (Scotland)					0
United Kingdom		135			135
Total	0	3,479	2,884	78	6,441

XII	Long line	Trawl	Gill Net	Unknown	SUM
Norway	2				2
Total	2	0	0	0	2

XIV	Long line	Trawl	Gill Net	Unknown	SUM
Faroe Islands		127		3	130 1)
Germany, Fed. Rep.		3,444			3,444 1)
Greenland	270	889		2	1,161 1)
Iceland					0
Norway (inside 200 EEZ)	1,149	345		4	1,498 1)
Norway (outside 200 EEZ)	250		158		408 2)
Russia		395			395 1)
UK (England & Wales)					0
UK (Scotland)					0
United Kingdom		381			381 1)
Total	1,669	5,581	158	9	7,417

Summary of catch by gear	Long line	Trawl	Gill Net	Unknown	SUM
	4,118	28,671	3,042	101	35,932

1) According to Greenland authorities

2) According to K. Nedreaas: Norwegian catch outside 200 EEZ, on Reykjanes ridge

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Table 6.2.1 GREENLAND HALIBUT. CPUE and total effort based on data from Icelandic trawlers.

Year	Landings	CPUE	Effort
1985	32,075	1,000	32.1
1986	32,984	983	33.6
1987	46,622	955	48.8
1988	51,118	1,118	45.7
1989	61,396	1,069	57.4
1990	39,326	787	50.0
1991	37,950	832	45.6
1992	35,487	667	53.2
1993	41,247	559	73.8
1994	37,190	429	86.7
1995	36,288	319	113.8
1996	35,932	281	127.9

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Table 6.3.1

Run title : G. halibut V & XIV (run: XSAJB008/X08)

At 5-May-97 16:22:34

Table	Catch numbers at age Numbers*10**-3
YEAR,	1976,
AGE	
5,	43,
6,	296,
7,	584,
8,	621,
9,	431,
10,	240,
11,	121,
12,	86,
13,	37,
14,	32,
15,	14,
+gp,	9,
TOTALNUM,	2514,
TONSLAND,	6045,
SOPCOF %,	100,

Table 1	Catch numbers at age Numbers*10**-3									
YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
5,	0,	23,	29,	47,	26,	8,	10,	83,	125,	245,
6,	34,	91,	197,	502,	158,	300,	240,	277,	441,	612,
7,	671,	347,	1605,	1536,	580,	1140,	1611,	891,	1018,	1033,
8,	1727,	1037,	2253,	2630,	1160,	2451,	2651,	2139,	2295,	1942,
9,	2289,	1214,	3090,	3126,	1430,	2646,	3060,	3568,	3454,	2983,
10,	834,	848,	1693,	2324,	1764,	2456,	2443,	2800,	2749,	3097,
11,	420,	567,	880,	1739,	1299,	1803,	1693,	1825,	1452,	1683,
12,	423,	312,	394,	849,	664,	963,	978,	1134,	627,	820,
13,	174,	232,	246,	578,	435,	609,	424,	588,	423,	550,
14,	120,	218,	189,	306,	252,	331,	174,	363,	137,	202,
15,	28,	114,	147,	143,	176,	195,	37,	92,	36,	59,
+gp,	141,	204,	125,	116,	159,	132,	47,	20,	46,	34,
TOTALNUM,	6861,	5207,	10848,	13896,	8103,	13034,	13368,	13780,	12803,	13260,
TONSLAND,	16578,	14349,	23616,	31252,	19239,	32441,	30888,	34024,	32075,	32984,
SOPCOF %,	100,	100,	101,	99,	100,	100,	101,	99,	103,	101,

Run title : G. halibut V & XIV (run: XSAJB008/X08)

At 5-May-97 16:22:34

Table	Catch numbers at age Numbers*10**-3									
YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
5,	182,	129,	499,	188,	289,	17,	45,	78,	503,	179,
6,	3123,	742,	1657,	463,	1225,	421,	402,	673,	1587,	1493,
7,	4863,	2068,	4485,	1513,	1797,	2023,	1918,	2200,	3030,	2917,
8,	2586,	2985,	5961,	3515,	2866,	3262,	5082,	3820,	3286,	3190,
9,	2156,	3166,	5763,	4186,	2935,	2646,	4374,	3653,	2607,	2126,
10,	3476,	2966,	3246,	3143,	2074,	3019,	2892,	2334,	1962,	1760,
11,	1847,	1848,	1601,	1224,	1130,	1962,	1557,	1718,	1548,	1614,
12,	1829,	1761,	1458,	959,	1072,	1278,	1428,	991,	1132,	1220,
13,	886,	1851,	1237,	568,	924,	509,	582,	422,	657,	667,
14,	243,	701,	506,	358,	554,	144,	138,	371,	444,	550,
15,	31,	216,	362,	137,	342,	36,	137,	169,	240,	239,
+gp,	5,	246,	145,	61,	82,	56,	14,	178,	228,	504,
TOTALNUM,	21227,	18679,	26920,	16315,	15290,	15373,	18569,	16607,	17224,	16459,
TONSLAND,	46622,	51118,	61396,	39326,	37950,	35487,	41247,	37190,	36288,	35932,
SOPCOF %,	98,	101,	100,	100,	101,	101,	100,	100,	100,	100,

Table 6.4.1

Run title : G. halibut V & XIV (run: XSAJBO08/X08)

At 5-May-97 16:22:34

Table	Catch weights at age (kg)
YEAR,	1976,
AGE	
5,	1.1570,
6,	1.5850,
7,	1.7680,
8,	2.1800,
9,	2.5700,
10,	3.0180,
11,	3.7300,
12,	4.0520,
13,	4.8150,
14,	5.3480,
15,	5.7520,
+gp,	7.0940,
SOPCOFAC,	1.0024,

Table 2	Catch weights at age (kg)									
YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
5,	1.1570,	.9680,	.9110,	1.1250,	1.0710,	1.0100,	.9840,	.9420,	.9950,	1.0300,
6,	1.0460,	1.1990,	.9420,	1.2830,	1.2570,	1.3680,	1.3380,	1.2750,	1.2300,	1.2380,
7,	1.4290,	1.4230,	1.2780,	1.4870,	1.4400,	1.6180,	1.5770,	1.5920,	1.6300,	1.4990,
8,	1.7940,	1.8540,	1.6760,	1.7560,	1.6600,	1.9050,	1.8480,	1.8170,	1.9510,	1.9370,
9,	2.2280,	2.2560,	2.0720,	2.1530,	1.9670,	2.1870,	2.1590,	2.2400,	2.3670,	2.3630,
10,	2.6870,	2.6070,	2.3330,	2.2790,	2.2580,	2.5160,	2.4340,	2.4610,	2.6370,	2.6310,
11,	3.0170,	3.0810,	2.7230,	2.4980,	2.5150,	2.7610,	2.6030,	2.8350,	2.8290,	2.8480,
12,	3.9140,	3.5910,	3.2970,	3.0590,	2.9500,	3.1290,	3.0340,	3.2620,	3.3530,	3.3350,
13,	4.0400,	4.6040,	3.9850,	3.7830,	3.4500,	3.7850,	3.7840,	3.9620,	4.0060,	4.0390,
14,	4.7140,	4.6950,	4.6680,	4.5070,	4.0330,	4.4750,	4.4460,	4.9360,	4.7920,	4.9250,
15,	5.4010,	5.1510,	4.7920,	5.1390,	4.6520,	4.9850,	4.7510,	5.2300,	5.2310,	5.4660,
+gp,	5.5970,	6.4500,	5.3870,	5.9830,	5.3300,	6.0880,	6.3850,	7.1920,	6.3230,	5.9850,
SOPCOFAC,	1.0008,	.9993,	1.0124,	.9902,	1.0024,	.9997,	1.0110,	.9937,	1.0258,	1.0060,

Run title : G. halibut V & XIV (run: XSAJBO08/X08)

At 5-May-97 16:22:34

Table	Catch weights at age (kg)									
YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
5,	1.0300,	1.1290,	.8420,	1.0290,	1.0010,	1.0160,	.9910,	1.1630,	.9500,	1.1010,
6,	1.2180,	1.3040,	1.0470,	1.2100,	1.2470,	1.2560,	1.2490,	1.2540,	1.2130,	1.1240,
7,	1.5330,	1.5410,	1.4250,	1.5720,	1.4720,	1.4010,	1.4010,	1.4880,	1.4130,	1.3460,
8,	1.8240,	1.7700,	1.7270,	1.7900,	1.8100,	1.7180,	1.6850,	1.7360,	1.7030,	1.6490,
9,	2.1870,	2.2360,	2.1250,	2.1260,	2.0880,	2.0490,	1.9820,	2.1500,	2.0280,	1.9250,
10,	2.6660,	2.6830,	2.6370,	2.5360,	2.4400,	2.4360,	2.4250,	2.3520,	2.2790,	2.3420,
11,	2.9960,	3.0820,	3.2200,	3.2140,	2.9350,	2.8680,	2.9520,	2.7360,	2.6430,	2.5950,
12,	3.5950,	3.6240,	3.7330,	3.6930,	3.7370,	3.4780,	3.4290,	3.0820,	2.9920,	3.0130,
13,	4.4310,	4.3120,	4.1350,	4.4480,	4.4010,	4.5100,	4.4790,	3.6070,	3.5680,	3.5150,
14,	5.1400,	5.0980,	5.3800,	5.1970,	5.0220,	4.6810,	6.0430,	4.2420,	4.0680,	4.1230,
15,	5.7640,	5.2130,	6.5690,	5.8910,	5.9910,	6.0100,	5.8320,	5.2930,	5.3020,	4.9960,
+gp,	7.2670,	5.7640,	6.4970,	6.0490,	6.4120,	5.1280,	2.7560,	6.0870,	5.6260,	5.8450,
SOPCOFAC,	.9785,	1.0063,	.9999,	.9998,	1.0097,	1.0051,	.9999,	1.0048,	1.0018,	1.0011,

Table 6.5.1

Run title : G. halibut V & XIV (run: XSAJBO08/X08)

At 5-May-97 16:22:34

Table	Proportion mature at age
YEAR,	1976,
AGE	
5,	.0000,
6,	.0300,
7,	.1000,
8,	.3500,
9,	.7700,
10,	.9600,
11,	1.0000,
12,	1.0000,
13,	1.0000,
14,	1.0000,
15,	1.0000,
+gp,	1.0000,

Table 5	Proportion mature at age									
YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
5,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0400,	.0000,	.0100,	.0100,
6,	.0300,	.0300,	.0300,	.0300,	.0300,	.0500,	.0700,	.0800,	.0600,	.0600,
7,	.1000,	.1000,	.1000,	.1000,	.1000,	.2000,	.1500,	.1900,	.2100,	.2100,
8,	.3500,	.3500,	.3500,	.3500,	.3500,	.3300,	.2800,	.3200,	.3500,	.3500,
9,	.7700,	.7700,	.7700,	.7700,	.7700,	.5000,	.3800,	.4200,	.4600,	.4600,
10,	.9600,	.9600,	.9600,	.9600,	.9600,	.7000,	.6000,	.6400,	.6400,	.6400,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.8500,	.8500,	.7500,	.8200,	.8200,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9400,	.9800,	.9300,	.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,

Run title : G. halibut V & XIV (run: XSAJBO08/X08)

At 5-May-97 16:22:34

Table	Proportion mature at age									
YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
5,	.0100,	.0100,	.0100,	.0100,	.0100,	.0200,	.0300,	.0300,	.1780,	.1710,
6,	.0600,	.0600,	.0600,	.0600,	.0600,	.0400,	.1200,	.1200,	.1810,	.2140,
7,	.2100,	.2100,	.2100,	.2100,	.2900,	.1100,	.2700,	.2700,	.4770,	.4470,
8,	.3500,	.3500,	.3500,	.3500,	.4800,	.2500,	.4000,	.4000,	.5970,	.5840,
9,	.4600,	.4600,	.4600,	.4600,	.5600,	.4700,	.4500,	.4500,	.5860,	.5320,
10,	.6400,	.6400,	.6400,	.6400,	.6200,	.6800,	.5400,	.5400,	.7050,	.7220,
11,	.8200,	.8200,	.8200,	.8200,	.8500,	.8500,	.6500,	.6500,	.7860,	.7620,
12,	.9600,	.9600,	.9600,	.9600,	1.0000,	.9600,	.7800,	.7800,	.7640,	.7450,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.8300,	.8300,	.9610,	.9250,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9700,	.9700,	1.0000,	.9750,
15,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9910,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9960,

Table 6.6.1 Output from XSA tuning

```
Lowestoft VPA Version 3.1

   5-May-97  16:21:59

Extended Survivors Analysis

G. halibut V & XIV (run: XSAJB008/X08)

CPUE data from file /users/fish/ifad/ifapwork/nwwg/ghl_grn/FLEET.X08

Catch data for  21 years. 1976 to 1996. Ages  5 to  16.

     Fleet,           First, Last, First, Last, Alpha,  Beta
                   ,   year, year,  age ,  age
FLT06: Va TRW 85-96 ,   1985, 1996,    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 =   1.000

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

     Prior weighting not applied


Tuning converged after   52 iterations
```

Regression weights

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

Fishing mortalities

Age,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996
5,	.005,	.004,	.016,	.006,	.013,	.001,	.002,	.004,	.017,	.006
6,	.091,	.024,	.066,	.018,	.048,	.023,	.026,	.039,	.093,	.060
7,	.175,	.076,	.188,	.075,	.085,	.098,	.131,	.180,	.234,	.235
8,	.152,	.147,	.309,	.208,	.187,	.206,	.359,	.393,	.418,	.390
9,	.193,	.267,	.437,	.350,	.255,	.249,	.441,	.447,	.481,	.493
10,	.437,	.416,	.453,	.426,	.276,	.425,	.445,	.421,	.434,	.662
11,	.269,	.413,	.391,	.289,	.251,	.430,	.382,	.489,	.516,	.733
12,	.408,	.419,	.633,	.405,	.417,	.470,	.605,	.422,	.659,	.964
13,	.324,	.897,	.552,	.510,	.817,	.336,	.382,	.336,	.518,	1.016
14,	.308,	.433,	.619,	.285,	1.403,	.260,	.134,	.423,	.670,	1.081
15,	.351,	.465,	.394,	.314,	.456,	.264,	.397,	.229,	.504,	.909

Table 6.6.1 (Cont'd)

XSA population numbers (Thousands)

YEAR	AGE 5	6	7	8	9	10	11	12		
1987	3.92E+04	3.86E+04	3.27E+04	1.97E+04	1.32E+04	1.06E+04	8.44E+03	5.89E+03	3.45E+03	9.89E+02
1988	3.28E+04	3.36E+04	3.03E+04	2.36E+04	1.46E+04	9.40E+03	5.89E+03	5.55E+03	3.37E+03	2.15E+03
1989	3.33E+04	2.81E+04	2.82E+04	2.42E+04	1.75E+04	9.61E+03	5.34E+03	3.35E+03	3.14E+03	1.18E+03
1990	3.32E+04	2.82E+04	2.27E+04	2.01E+04	1.53E+04	9.76E+03	5.26E+03	3.11E+03	1.53E+03	1.56E+03
1991	2.35E+04	2.84E+04	2.39E+04	1.81E+04	1.41E+04	9.27E+03	5.48E+03	3.39E+03	1.78E+03	7.92E+02
1992	2.00E+04	2.00E+04	2.33E+04	1.89E+04	1.29E+04	9.39E+03	6.05E+03	3.67E+03	1.92E+03	6.78E+02
1993	2.20E+04	1.72E+04	1.68E+04	1.82E+04	1.32E+04	8.68E+03	5.28E+03	3.39E+03	1.97E+03	1.18E+03
1994	2.24E+04	1.89E+04	1.44E+04	1.27E+04	1.09E+04	7.32E+03	4.79E+03	3.10E+03	1.59E+03	1.16E+03
1995	3.24E+04	1.92E+04	1.56E+04	1.04E+04	7.36E+03	6.01E+03	4.14E+03	2.53E+03	1.75E+03	9.80E+02
1996	3.01E+04	2.74E+04	1.50E+04	1.07E+04	5.88E+03	3.92E+03	3.35E+03	2.13E+03	1.13E+03	8.97E+02

Estimated population abundance at 1st Jan 1997

, .00E+00, 2.57E+04, 2.22E+04, 1.02E+04, 6.21E+03, 3.09E+03, 1.74E+03, 1.39E+03, 6.98E+02, 3.51E+02,

Taper weighted geometric mean of the VPA populations:

, 3.00E+04, 2.60E+04, 2.17E+04, 1.74E+04, 1.26E+04, 8.50E+03, 5.32E+03, 3.23E+03, 1.75E+03, 8.82E+02,

Standard error of the weighted Log(VPA populations) :

, .2570, .2666, .2789, .2944, .3425, .3196, .2599, .3202, .4120, .5048,

YEAR	AGE 15
1987	1.13E+02
1988	6.26E+02
1989	1.20E+03
1990	5.48E+02
1991	1.01E+03
1992	1.67E+02
1993	4.50E+02
1994	8.91E+02
1995	6.54E+02
1996	4.31E+02

Estimated population abundance at 1st Jan 1997

, 2.62E+02,

Taper weighted geometric mean of the VPA populations:

, 4.02E+02,

Standard error of the weighted Log(VPA populations) :

, .8179,

Table 6.6.1 (Cont'd)

Log catchability residuals.

Fleet : FLT06: Va TRW 85-96

Age	1985	1986
7	-.04	-.65
8	.04	-.52
9	.14	.06
10	.23	.12
11	.19	.25
12	.10	.07

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
7	.39	.00	.20	-.09	-.40	.09	-.05	.34	.12	-.06
8	-.29	-.09	.18	.19	-.14	.04	.24	.28	-.01	-.13
9	-.17	.17	.30	.28	-.17	-.13	.10	.00	-.21	-.23
10	.15	.25	.30	.21	-.28	.06	-.05	-.20	-.44	-.08
11	.15	.28	.23	-.11	-.21	-.02	-.16	-.16	-.23	.06
12	-.02	.06	.53	-.08	.33	.00	.00	-.60	-.31	.05

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	-6.2813	-5.5619	-5.2274	-5.0986	-5.1783	-4.9358
S.E(Log q)	.2781	.2271	.1947	.2408	.1922	.2935

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	1.08	-.215	6.00	.47	12	.32	-6.28
8	.98	.063	5.63	.63	12	.24	-5.56
9	.72	2.950	6.41	.93	12	.10	-5.23
10	.71	1.951	6.23	.85	12	.15	-5.10
11	.75	1.569	6.05	.82	12	.13	-5.18
12	.86	.501	5.39	.60	12	.26	-4.94

Terminal year survivor and F summaries :

Age 5 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	25997.	.27				.934	.006
F shrinkage mean	22274.	1.00				.066	.007

Weighted prediction :

Survivors, at end of year	Int s.e	Ext s.e	N	Var Ratio	F
25732.	.26	10.16	2	39.425	.006

Table 6.6.1 (Cont'd)

Age 6 Catchability dependent on age and year class strength

Year class = 1990

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 ,	21733.,	.28,,,,				.928,	.062
F shrinkage mean ,	29548.,	1.00,,,,				.072,	.046

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
22220.,	.27,	10.01,	2,	37.260,	.060

Age 7 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
FLT06: Va TRW 85-96 ,	9650.,	.300,	.000,	.00,	1,	.898,	.247
F shrinkage mean ,	17217.,	1.00,,,,				.102,	.146

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
10238.,	.29,	.19,	2,	.642,	.235

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

Year class = 1988

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT06: Va TRW 85-96 ,	6094.,	.214,	.125,	.59,	2,	.931,	.396
F shrinkage mean ,	8029.,	1.00,,,,				.069,	.314

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
6211.,	.21,	.10,	3,	.473,	.390

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

Year class = 1987

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT06: Va TRW 85-96 ,	3023.,	.179,	.163,	.91,	3,	.937,	.502
F shrinkage mean ,	4318.,	1.00,,,,				.063,	.376

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
3091.,	.18,	.14,	4,	.776,	.493

Table 6.6.1 (Cont'd)

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

Year class = 1986

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT06: Va TRW 85-96 ,	1661.,	.163,	.094,	.58,	4,	.932,	.685
F shrinkage mean ,	3298.,	1.00,,,,				.068,	.402

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1740.,	.17,	.12,	5,	.715,	.662

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

Year class = 1985

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT06: Va TRW 85-96 ,	1314.,	.152,	.117,	.77,	5,	.933,	.761
F shrinkage mean ,	2905.,	1.00,,,,				.067,	.416

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1385.,	.16,	.14,	6,	.870,	.733

Age 12 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 ,	644.,	.148,	.072,	.49,	6,	.916,	1.014
F shrinkage mean ,	1670.,	1.00,,,,				.084,	.518

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
698.,	.16,	.13,	7,	.810,	.964

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

Year class = 1983

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT06: Va TRW 85-96 ,	291.,	.144,	.043,	.30,	6,	.850,	1.139
F shrinkage mean ,	1003.,	1.00,,,,				.150,	.481

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
351.,	.19,	.20,	7,	1.028,	1.016

Table 6.6.1 (Cont'd)

Age 14   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 ,	211.,	.143,	.133,	.93,	6,	.808,	1.228
F shrinkage mean ,	647.,	1.00,,,,				.192,	.582

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
262.,	.22,	.23,	7,	1.018,	1.081

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

Year class = 1981

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT06: Va TRW 85-96 ,	149.,	.144,	.070,	.49,	6,	.714,	.913
F shrinkage mean ,	152.,	1.00,,,,				.286,	.898

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
150.,	.30,	.05,	7,	.179,	.909

Table 6.6.2

Run title : G. halibut V & XIV (run: XSAJBO08/X08)

At 5-May-97 16:22:34

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1976,
AGE	
5,	.0018,
6,	.0153,
7,	.0426,
8,	.0688,
9,	.0856,
10,	.0803,
11,	.0671,
12,	.0596,
13,	.0421,
14,	.1746,
15,	.0849,
+gp,	.0849,
FBAR 8-12,	.0723,

Table 8 Fishing mortality (F) at age

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
5,	.0000,	.0009,	.0009,	.0012,	.0007,	.0003,	.0004,	.0027,	.0030,	.0059,
6,	.0017,	.0044,	.0089,	.0177,	.0048,	.0092,	.0089,	.0119,	.0169,	.0172,
7,	.0414,	.0198,	.0940,	.0847,	.0243,	.0416,	.0595,	.0395,	.0526,	.0474,
8,	.1618,	.0790,	.1634,	.2078,	.0807,	.1284,	.1219,	.0994,	.1286,	.1276,
9,	.3640,	.1548,	.3350,	.3371,	.1577,	.2521,	.2216,	.2266,	.2182,	.2323,
10,	.2244,	.2094,	.3165,	.4273,	.3050,	.4167,	.3675,	.3062,	.2583,	.2931,
11,	.1863,	.2216,	.3298,	.5875,	.4249,	.5508,	.5345,	.4868,	.2431,	.2353,
12,	.3310,	.1945,	.2235,	.5760,	.4380,	.6089,	.6216,	.7981,	.2881,	.1992,
13,	.1560,	.2877,	.2189,	.5565,	.6230,	.8811,	.5602,	.9216,	.7535,	.4160,
14,	.1767,	.2820,	.3792,	.4365,	.4735,	1.4452,	.6334,	1.3748,	.5270,	.9779,
15,	.2156,	.2399,	.2947,	.5197,	.4553,	.7863,	.5467,	.7832,	.4161,	.4265,
+gp,	.2156,	.2399,	.2947,	.5197,	.4553,	.7863,	.5467,	.7832,	.4161,	.4265,
FBAR 8-12,	.2535,	.1719,	.2736,	.4271,	.2813,	.3914,	.3734,	.3834,	.2273,	.2175,

Run title : G. halibut V & XIV (run: XSAJBO08/X08)

At 5-May-97 16:22:34

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	FBAR 94-96
AGE											
5,	.0050,	.0042,	.0163,	.0061,	.0133,	.0009,	.0022,	.0038,	.0169,	.0064,	.0090,
6,	.0913,	.0241,	.0656,	.0178,	.0477,	.0230,	.0255,	.0391,	.0934,	.0605,	.0643,
7,	.1749,	.0764,	.1878,	.0746,	.0846,	.0984,	.1314,	.1796,	.2341,	.2346,	.2161,
8,	.1524,	.1465,	.3089,	.2084,	.1869,	.2061,	.3590,	.3929,	.4175,	.3897,	.4000,
9,	.1930,	.2667,	.4369,	.3499,	.2546,	.2490,	.4409,	.4474,	.4807,	.4935,	.4739,
10,	.4369,	.4159,	.4528,	.4264,	.2760,	.4254,	.4448,	.4209,	.4340,	.6618,	.5055,
11,	.2692,	.4131,	.3908,	.2889,	.2512,	.4298,	.3823,	.4887,	.5162,	.7328,	.5792,
12,	.4080,	.4188,	.6328,	.4046,	.4167,	.4703,	.6051,	.4221,	.6586,	.9642,	.6816,
13,	.3239,	.8972,	.5524,	.5102,	.8169,	.3357,	.3824,	.3361,	.5184,	1.0164,	.6237,
14,	.3076,	.4332,	.6188,	.2850,	1.4035,	.2598,	.1343,	.4230,	.6702,	1.0810,	.7247,
15,	.3507,	.4652,	.3935,	.3140,	.4557,	.2636,	.3974,	.2288,	.5038,	.9090,	.5472,
+gp,	.3507,	.4652,	.3935,	.3140,	.4557,	.2636,	.3974,	.2288,	.5038,	.9090,	
FBAR 8-12,	.2919,	.3322,	.4444,	.3356,	.2771,	.3561,	.4464,	.4344,	.5014,	.6484,	

Table 6.6.3

Run title : G. halibut V & XIV (run: XSAJB008/X08)

At 5-May-97 16:22:34

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1976,
AGE	
5,	25855,
6,	21018,
7,	15108,
8,	10066,
9,	5660,
10,	3354,
11,	2010,
12,	1601,
13,	968,
14,	215,
15,	185,
+gp,	119,
TOTAL,	86159,

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

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
5,	26149,	27792,	35882,	40949,	40965,	33753,	29246,	33075,	45001,	45105,
6,	22213,	22507,	23899,	30857,	35201,	35235,	29044,	25163,	28391,	38616,
7,	17816,	19088,	19287,	20388,	26093,	30151,	30048,	24776,	21401,	24028,
8,	12462,	14712,	16107,	15112,	16123,	21921,	24894,	24368,	20498,	17476,
9,	8087,	9124,	11700,	11773,	10567,	12801,	16593,	18967,	18990,	15514,
10,	4472,	4837,	6727,	7204,	7233,	7768,	8563,	11443,	13015,	13140,
11,	2664,	3075,	3377,	4219,	4044,	4589,	4408,	5104,	7252,	8652,
12,	1618,	1903,	2121,	2090,	2018,	2276,	2277,	2223,	2700,	4894,
13,	1298,	1000,	1349,	1460,	1011,	1121,	1065,	1053,	861,	1742,
14,	799,	956,	646,	932,	720,	467,	400,	524,	360,	349,
15,	156,	576,	621,	380,	519,	386,	95,	183,	114,	183,
+gp,	781,	1027,	525,	306,	466,	259,	119,	39,	145,	105,
TOTAL,	98515,	106597,	122241,	135670,	144960,	150726,	146753,	146918,	158727,	169803,

Run title : G. halibut V & XIV (run: XSAJB008/X08)

At 5-May-97 16:22:34

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	GMST
AGE												
5,	39239,	32839,	33341,	33161,	23504,	19998,	22010,	22371,	32406,	30089,	0,	312
6,	38595,	33605,	28145,	28234,	28367,	19962,	17196,	18903,	19183,	27426,	25732,	268
7,	32670,	30322,	28235,	22687,	23872,	23280,	16791,	14428,	15645,	15039,	22220,	225
8,	19722,	23607,	24180,	20141,	18123,	18879,	18160,	12673,	10377,	10655,	10238,	178
9,	13240,	14576,	17550,	15281,	14075,	12940,	13223,	10916,	7363,	5883,	6211,	127
10,	10585,	9395,	9608,	9759,	9269,	9391,	8683,	7323,	6006,	3919,	3091,	80
11,	8437,	5886,	5335,	5259,	5483,	6054,	5282,	4790,	4138,	3349,	1740,	47
12,	5885,	5548,	3352,	3107,	3391,	3671,	3390,	3102,	2529,	2125,	1385,	27
13,	3452,	3368,	3141,	1532,	1784,	1924,	1974,	1593,	1751,	1127,	698,	15
14,	989,	2149,	1182,	1556,	792,	678,	1184,	1159,	980,	897,	351,	7
15,	113,	626,	1199,	548,	1007,	167,	450,	891,	654,	431,	262,	3
+gp,	18,	708,	478,	243,	240,	259,	46,	935,	617,	899,	461,	
TOTAL,	172945,	162629,	155746,	141507,	129907,	117204,	108390,	99084,	101649,	101840,	72390,	

Table 6.6.4

Run title : G. halibut V & XIV (run: XSAJB008/X08)

At 5-May-97 16:22:35

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS, Age 5	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 8-12,
1976,	25855,	158256,	53975,	6045,	.1120,	.0723,
1977,	26149,	159930,	65067,	16578,	.2548,	.2535,
1978,	27792,	176513,	76020,	14349,	.1888,	.1719,
1979,	35882,	177162,	76700,	23616,	.3079,	.2736,
1980,	40949,	214719,	79229,	31252,	.3945,	.4271,
1981,	40965,	216989,	73548,	19239,	.2616,	.2813,
1982,	33753,	249998,	80921,	32441,	.4009,	.3914,
1983,	29246,	243100,	73524,	30888,	.4201,	.3734,
1984,	33075,	247322,	85686,	34024,	.3971,	.3834,
1985,	45001,	270098,	98709,	32075,	.3249,	.2273,
1986,	45105,	286709,	107991,	32984,	.3054,	.2175,
1987,	39239,	298252,	119912,	46622,	.3888,	.2919,
1988,	32839,	298276,	125564,	51118,	.4071,	.3322,
1989,	33341,	262186,	114913,	61396,	.5343,	.4444,
1990,	33161,	245211,	97754,	39326,	.4023,	.3356,
1991,	23504,	227014,	104525,	37950,	.3631,	.2771,
1992,	19998,	204150,	82328,	35487,	.4310,	.3561,
1993,	22010,	190645,	81221,	41247,	.5078,	.4464,
1994,	22371,	177619,	74004,	37190,	.5025,	.4344,
1995,	32406,	158126,	80488,	36288,	.4508,	.5014,
1996,	30089,	152435,	70256,	35932,	.5114,	.6484,
Arith. Mean	32035,	219748,	86778,	33145,	.3746,	.3400,
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: 1997								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
5	26000.000	0.1500	0.1000	0.0000	0.0000	1.071	0.0110	1.071
6	22236.000	0.1500	0.1390	0.0000	0.0000	1.197	0.0790	1.197
7	22220.000	0.1500	0.3260	0.0000	0.0000	1.416	0.2650	1.416
8	10238.000	0.1500	0.4580	0.0000	0.0000	1.696	0.4910	1.696
9	6211.000	0.1500	0.5100	0.0000	0.0000	2.034	0.5820	2.034
10	3091.000	0.1500	0.6620	0.0000	0.0000	2.324	0.6210	2.324
11	1740.000	0.1500	0.7620	0.0000	0.0000	2.658	0.7110	2.658
12	1385.000	0.1500	0.8120	0.0000	0.0000	3.029	0.8370	3.029
13	698.000	0.1500	0.9290	0.0000	0.0000	3.563	0.7660	3.563
14	351.000	0.1500	0.9860	0.0000	0.0000	4.144	0.8900	4.144
15	262.000	0.1500	0.9980	0.0000	0.0000	5.197	0.6720	5.197
16+	461.000	0.1500	0.9990	0.0000	0.0000	5.853	0.6720	5.853
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 1998								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
5	26000.000	0.1500	0.1000	0.0000	0.0000	1.071	0.0110	1.071
6	.	0.1500	0.1390	0.0000	0.0000	1.197	0.0790	1.197
7	.	0.1500	0.3260	0.0000	0.0000	1.416	0.2650	1.416
8	.	0.1500	0.4580	0.0000	0.0000	1.696	0.4910	1.696
9	.	0.1500	0.5100	0.0000	0.0000	2.034	0.5820	2.034
10	.	0.1500	0.6620	0.0000	0.0000	2.324	0.6210	2.324
11	.	0.1500	0.7620	0.0000	0.0000	2.658	0.7110	2.658
12	.	0.1500	0.8120	0.0000	0.0000	3.029	0.8370	3.029
13	.	0.1500	0.9290	0.0000	0.0000	3.563	0.7660	3.563
14	.	0.1500	0.9860	0.0000	0.0000	4.144	0.8900	4.144
15	.	0.1500	0.9980	0.0000	0.0000	5.197	0.6720	5.197
16+	.	0.1500	0.9990	0.0000	0.0000	5.853	0.6720	5.853
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	26000.000	0.1500	0.1000	0.0000	0.0000	1.071	0.0110	1.071
6	.	0.1500	0.1390	0.0000	0.0000	1.197	0.0790	1.197
7	.	0.1500	0.3260	0.0000	0.0000	1.416	0.2650	1.416
8	.	0.1500	0.4580	0.0000	0.0000	1.696	0.4910	1.696
9	.	0.1500	0.5100	0.0000	0.0000	2.034	0.5820	2.034
10	.	0.1500	0.6620	0.0000	0.0000	2.324	0.6210	2.324
11	.	0.1500	0.7620	0.0000	0.0000	2.658	0.7110	2.658
12	.	0.1500	0.8120	0.0000	0.0000	3.029	0.8370	3.029
13	.	0.1500	0.9290	0.0000	0.0000	3.563	0.7660	3.563
14	.	0.1500	0.9860	0.0000	0.0000	4.144	0.8900	4.144
15	.	0.1500	0.9980	0.0000	0.0000	5.197	0.6720	5.197
16+	.	0.1500	0.9990	0.0000	0.0000	5.853	0.6720	5.853
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANJB001
Date and time: 05MAY97:16:48

Table 6.7.1.2

Greenland halibut (Fishing Areas V and XIV)

Yield per recruit: Input data

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
5	1.000	0.1500	0.0260	0.0000	0.0000	1.023	0.0090	1.029
6	.	0.1500	0.0700	0.0000	0.0000	1.233	0.0560	1.233
7	.	0.1500	0.2030	0.0000	0.0000	1.492	0.1820	1.492
8	.	0.1500	0.3730	0.0000	0.0000	1.800	0.3750	1.800
9	.	0.1500	0.5580	0.0000	0.0000	2.165	0.5800	2.165
10	.	0.1500	0.7310	0.0000	0.0000	2.507	0.7060	2.507
11	.	0.1500	0.8530	0.0000	0.0000	2.890	0.7240	2.890
12	.	0.1500	0.9350	0.0000	0.0000	3.398	0.8560	3.398
13	.	0.1500	0.9780	0.0000	0.0000	4.079	1.0270	4.079
14	.	0.1500	0.9960	0.0000	0.0000	4.787	1.2140	4.787
15	.	0.1500	1.0000	0.0000	0.0000	5.401	0.8420	5.401
Unit	Numbers	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : YLDJB002
Date and time: 05MAY97:17:10

Table 6.7.2.1

16:10 Monday, May 5, 199

Greenland halibut (Fishing Areas V and XIV)

Yield per recruit: Summary table

						1 January		Spawning time	
F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0.000	0.000	5.800	12748.440	2.576	8038.784	2.576	8038.784
0.0500	0.0324	0.102	311.241	5.509	11623.724	2.316	6991.442	2.316	6991.442
0.1000	0.0648	0.181	534.441	5.261	10689.055	2.098	6128.952	2.098	6128.952
0.1500	0.0972	0.243	694.315	5.048	9907.146	1.913	5414.534	1.913	5414.534
0.2000	0.1296	0.293	808.657	4.864	9248.597	1.755	4819.235	1.755	4819.235
0.2500	0.1620	0.333	890.275	4.703	8690.146	1.620	4320.187	1.620	4320.187
0.3000	0.1945	0.365	948.389	4.563	8213.325	1.504	3899.272	1.504	3899.272
0.3500	0.2269	0.392	989.632	4.439	7803.415	1.402	3542.082	1.402	3542.082
0.4000	0.2593	0.415	1018.774	4.328	7448.644	1.314	3237.121	1.314	3237.121
0.4500	0.2917	0.434	1039.246	4.230	7139.555	1.237	2975.178	1.237	2975.178
0.5000	0.3241	0.450	1053.513	4.142	6868.521	1.168	2748.846	1.168	2748.846
0.5500	0.3565	0.465	1063.345	4.062	6629.364	1.107	2552.147	1.107	2552.147
0.6000	0.3889	0.477	1070.013	3.989	6417.059	1.053	2380.231	1.053	2380.231
0.6500	0.4213	0.488	1074.429	3.923	6227.496	1.004	2229.148	1.004	2229.148
0.7000	0.4537	0.499	1077.247	3.862	6057.303	0.960	2095.671	0.960	2095.671
0.7500	0.4862	0.508	1078.933	3.806	5903.698	0.921	1977.146	0.921	1977.146
0.8000	0.5186	0.516	1079.824	3.754	5764.372	0.885	1871.383	0.885	1871.383
0.8500	0.5510	0.524	1080.156	3.706	5637.406	0.852	1776.569	0.852	1776.569
0.9000	0.5834	0.531	1080.100	3.661	5521.190	0.821	1691.193	0.821	1691.193
0.9500	0.6158	0.537	1079.777	3.619	5414.373	0.794	1613.990	0.794	1613.990
1.0000	0.6482	0.543	1079.272	3.580	5315.812	0.768	1543.898	0.768	1543.898
1.0500	0.6806	0.549	1078.647	3.543	5224.538	0.745	1480.021	0.745	1480.021
1.1000	0.7130	0.555	1077.943	3.509	5139.722	0.723	1421.599	0.723	1421.599
1.1500	0.7454	0.560	1077.191	3.476	5060.656	0.702	1367.985	0.702	1367.985
1.2000	0.7778	0.565	1076.411	3.445	4986.729	0.683	1318.625	0.683	1318.625
1.2500	0.8103	0.569	1075.617	3.415	4917.415	0.665	1273.045	0.665	1273.045
1.3000	0.8427	0.573	1074.820	3.387	4852.256	0.649	1230.833	0.649	1230.833
1.3500	0.8751	0.578	1074.026	3.360	4790.852	0.633	1191.637	0.633	1191.637
1.4000	0.9075	0.581	1073.239	3.335	4732.855	0.618	1155.147	0.618	1155.147
1.4500	0.9399	0.585	1072.462	3.310	4677.957	0.605	1121.094	0.605	1121.094
1.5000	0.9723	0.589	1071.697	3.287	4625.889	0.591	1089.243	0.591	1089.243
1.5500	1.0047	0.592	1070.944	3.265	4576.410	0.579	1059.388	0.579	1059.388
1.6000	1.0371	0.596	1070.205	3.243	4529.308	0.567	1031.346	0.567	1031.346
1.6500	1.0695	0.599	1069.478	3.222	4484.395	0.556	1004.956	0.556	1004.956
1.7000	1.1019	0.602	1068.765	3.203	4441.500	0.546	980.075	0.546	980.075
1.7500	1.1344	0.605	1068.065	3.183	4400.472	0.535	956.575	0.535	956.575
1.8000	1.1668	0.608	1067.378	3.165	4361.175	0.526	934.344	0.526	934.344
1.8500	1.1992	0.611	1066.703	3.147	4323.485	0.517	913.280	0.517	913.280
1.9000	1.2316	0.613	1066.041	3.130	4287.292	0.508	893.291	0.508	893.291
1.9500	1.2640	0.616	1065.390	3.113	4252.495	0.499	874.296	0.499	874.296
2.0000	1.2964	0.618	1064.750	3.097	4219.003	0.491	856.221	0.491	856.221
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YLDJB002
Date and time : 05MAY97:17:10
Computation of ref. F: Simple mean, age 8 - 12
F-0.1 factor : 0.3417
F-max factor : 0.8658
F-0.1 reference F : 0.2215
F-max reference F : 0.5612
Recruitment : Single recruit

Table 6.7.3.1

The SAS System 16:10 Monday, May 5, 1997

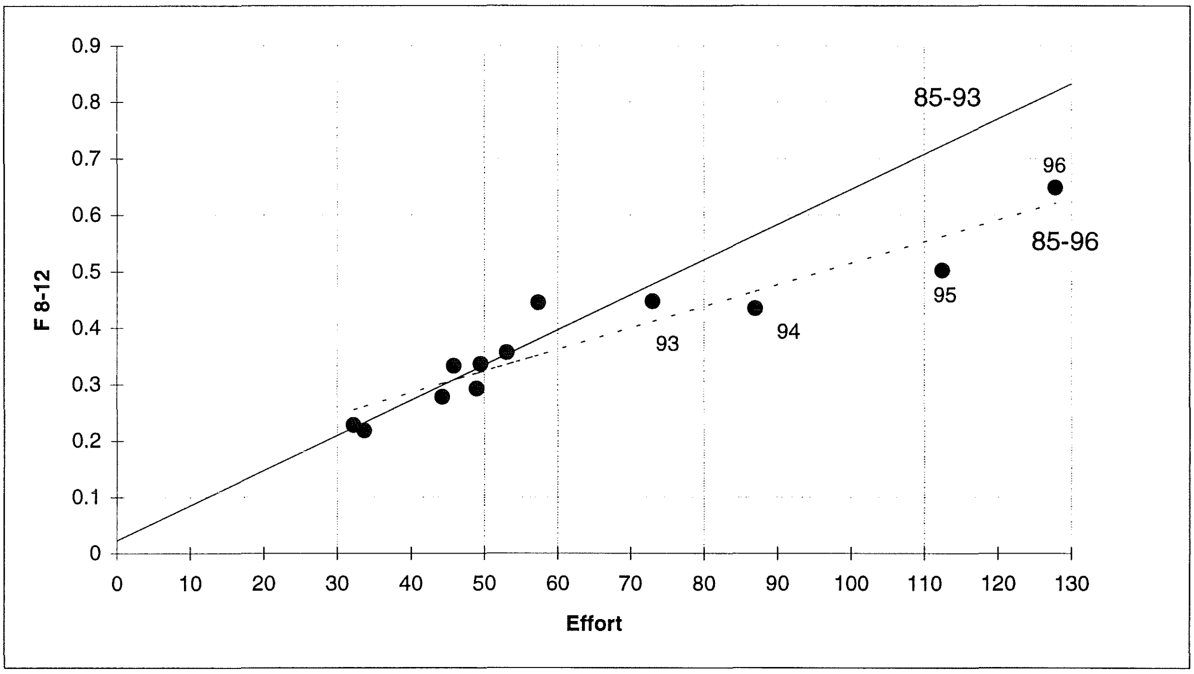
Greenland halibut (Fishing Areas V and XIV)

Prediction with management option table

Year: 1997					Year: 1998					Year: 1999	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.6484	139928	50622	31953	0.0000	0.0000	133708	46275	0	162033	62983
.	.	.	.	.	0.0500	0.0324	.	46275	1863	160011	61721
.	.	.	.	.	0.1000	0.0648	.	46275	3681	158040	60495
.	.	.	.	.	0.1500	0.0973	.	46275	5453	156118	59303
.	.	.	.	.	0.2000	0.1297	.	46275	7183	154245	58143
.	.	.	.	.	0.2500	0.1621	.	46275	8870	152419	57016
.	.	.	.	.	0.3000	0.1945	.	46275	10516	150638	55920
.	.	.	.	.	0.3500	0.2269	.	46275	12122	148900	54854
.	.	.	.	.	0.4000	0.2594	.	46275	13689	147206	53817
.	.	.	.	.	0.4500	0.2918	.	46275	15219	145554	52809
.	.	.	.	.	0.5000	0.3242	.	46275	16713	143941	51828
.	.	.	.	.	0.5500	0.3566	.	46275	18170	142368	50873
.	.	.	.	.	0.6000	0.3890	.	46275	19594	140834	49945
.	.	.	.	.	0.6500	0.4215	.	46275	20983	139336	49041
.	.	.	.	.	0.7000	0.4539	.	46275	22340	137874	48162
.	.	.	.	.	0.7500	0.4863	.	46275	23665	136448	47306
.	.	.	.	.	0.8000	0.5187	.	46275	24960	135055	46473
.	.	.	.	.	0.8500	0.5511	.	46275	26224	133696	45662
.	.	.	.	.	0.9000	0.5836	.	46275	27459	132369	44873
.	.	.	.	.	0.9500	0.6160	.	46275	28666	131073	44105
.	.	.	.	.	1.0000	0.6484	.	46275	29845	129807	43357
.	.	.	.	.	1.0500	0.6808	.	46275	30997	128571	42628
.	.	.	.	.	1.1000	0.7132	.	46275	32124	127364	41919
.	.	.	.	.	1.1500	0.7457	.	46275	33224	126185	41228
.	.	.	.	.	1.2000	0.7781	.	46275	34300	125033	40555
.	.	.	.	.	1.2500	0.8105	.	46275	35352	123907	39899
.	.	.	.	.	1.3000	0.8429	.	46275	36381	122807	39260
.	.	.	.	.	1.3500	0.8753	.	46275	37387	121732	38638
.	.	.	.	.	1.4000	0.9078	.	46275	38371	120682	38031
.	.	.	.	.	1.4500	0.9402	.	46275	39333	119655	37441
.	.	.	.	.	1.5000	0.9726	.	46275	40274	118651	36865
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANJB001
Date and time : 05MAY97:16:48
Computation of ref. F: Simple mean, age 8 - 12
Basis for 1997 : F factors

Figure 6.6.1. Plot of Fbar (8-12) versus total effort. F values based on XSA with SEmshr = 1.0 (Table 6.6.1.1) and effort based on Icelandic trawlfleet (Table 6.2.1). Linear relationships are shown for the two periods, 1985-93 and 1985-96.



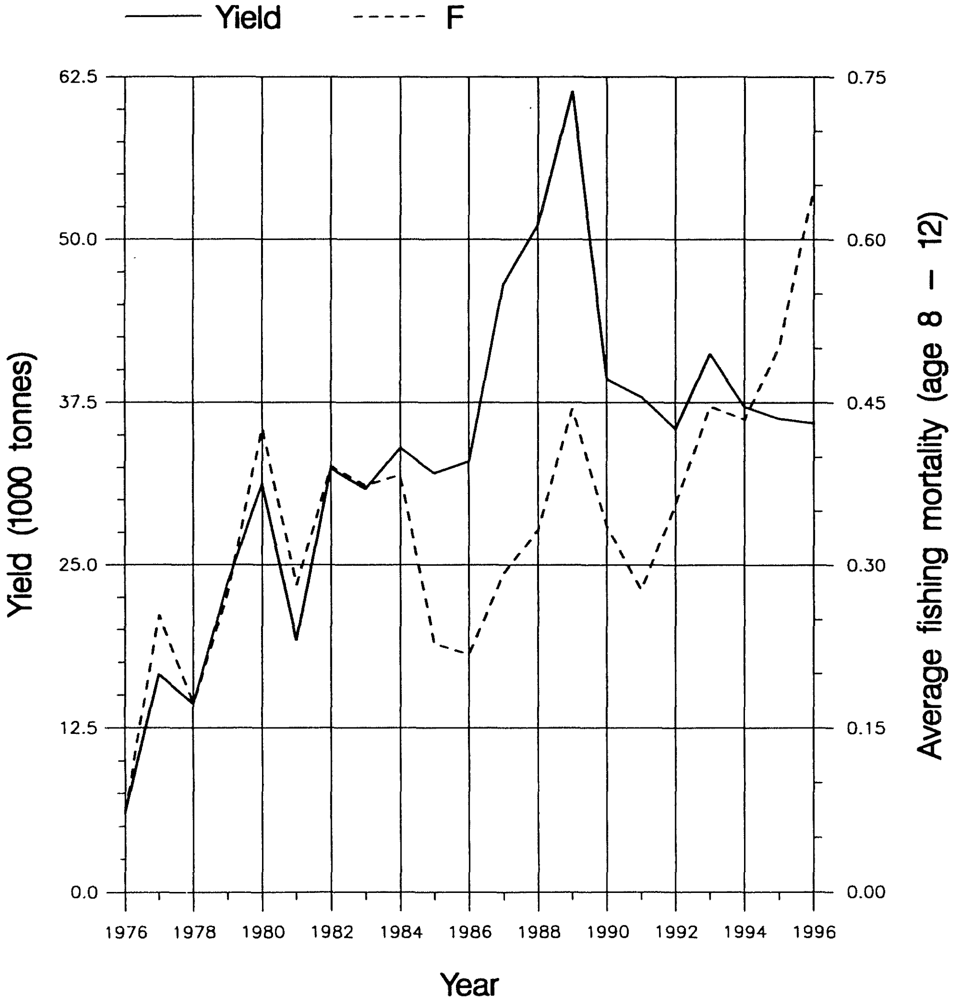
Fish Stock Summary

Figure 6.7.2 . 1

Greenland halibut (Fishing Areas V and XIV)

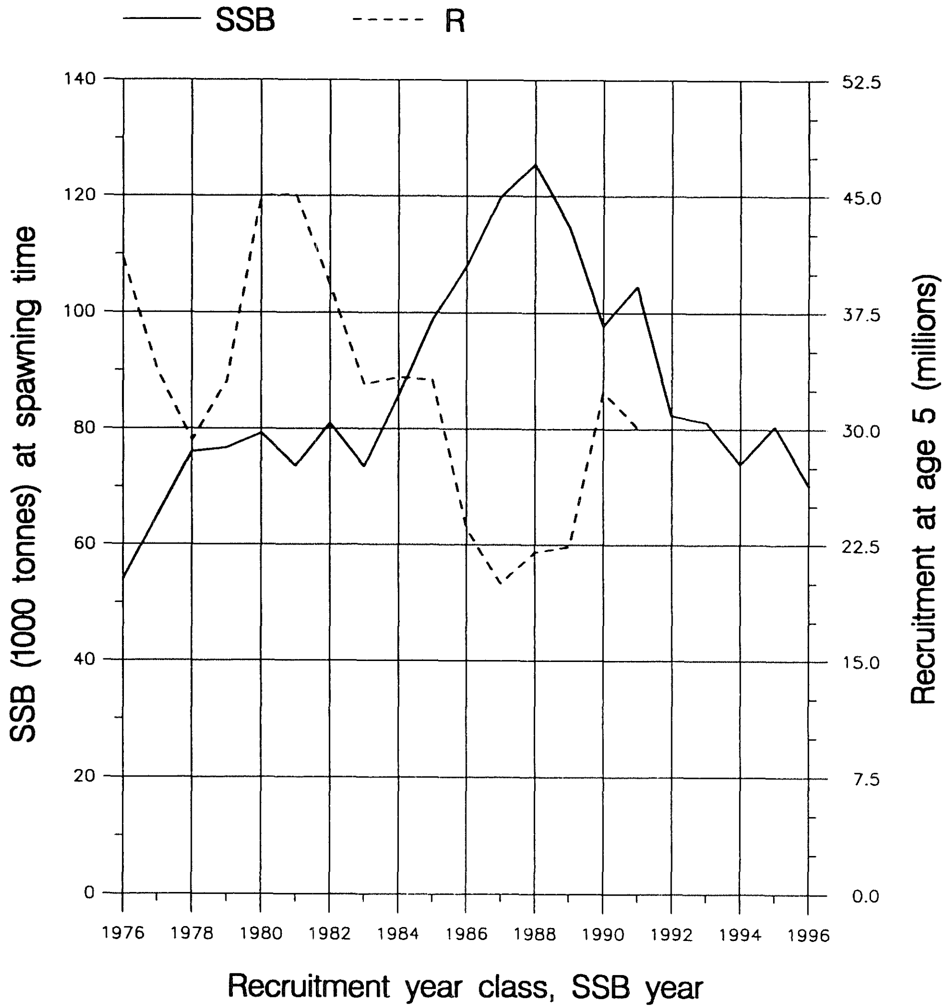
5 – 5 – 1997

Yield and fishing mortality



(run: XSAJBO08) A

Spawning stock and recruitment

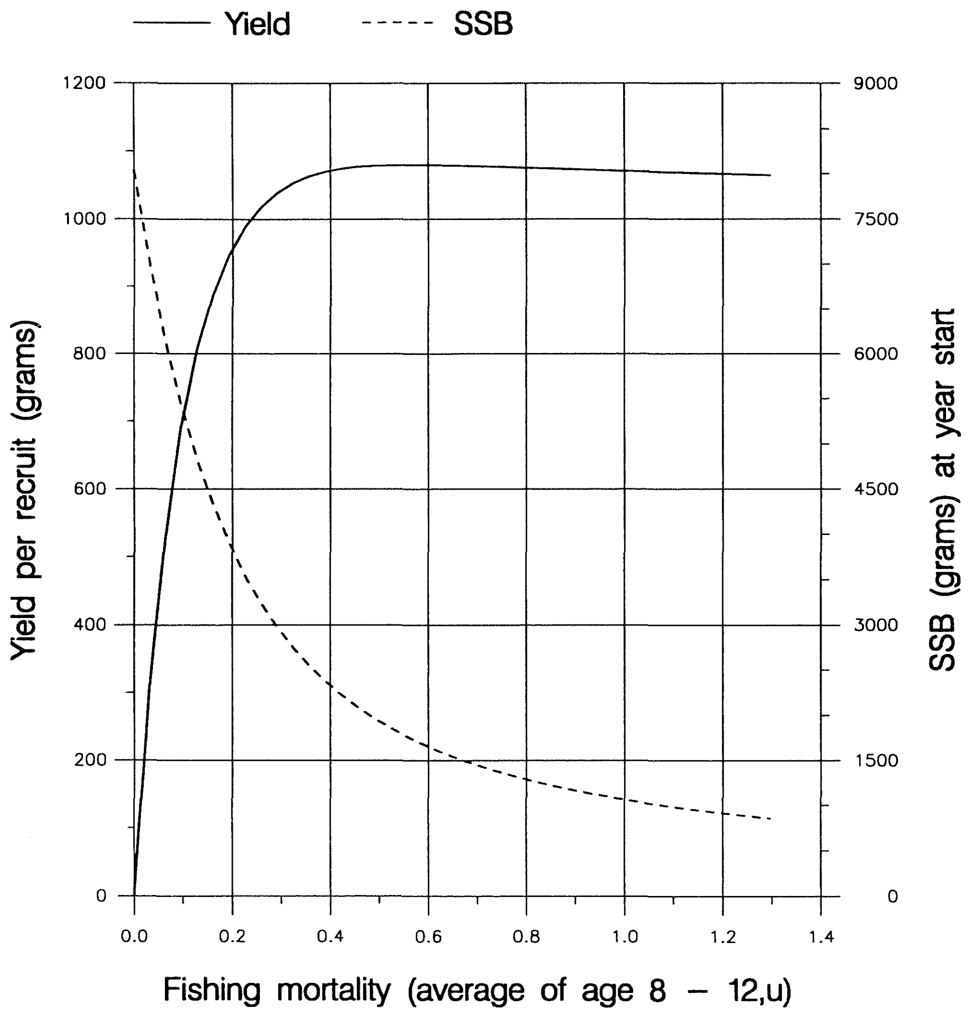


(run: XSAJBO08) B

Figure 6.7.2.1

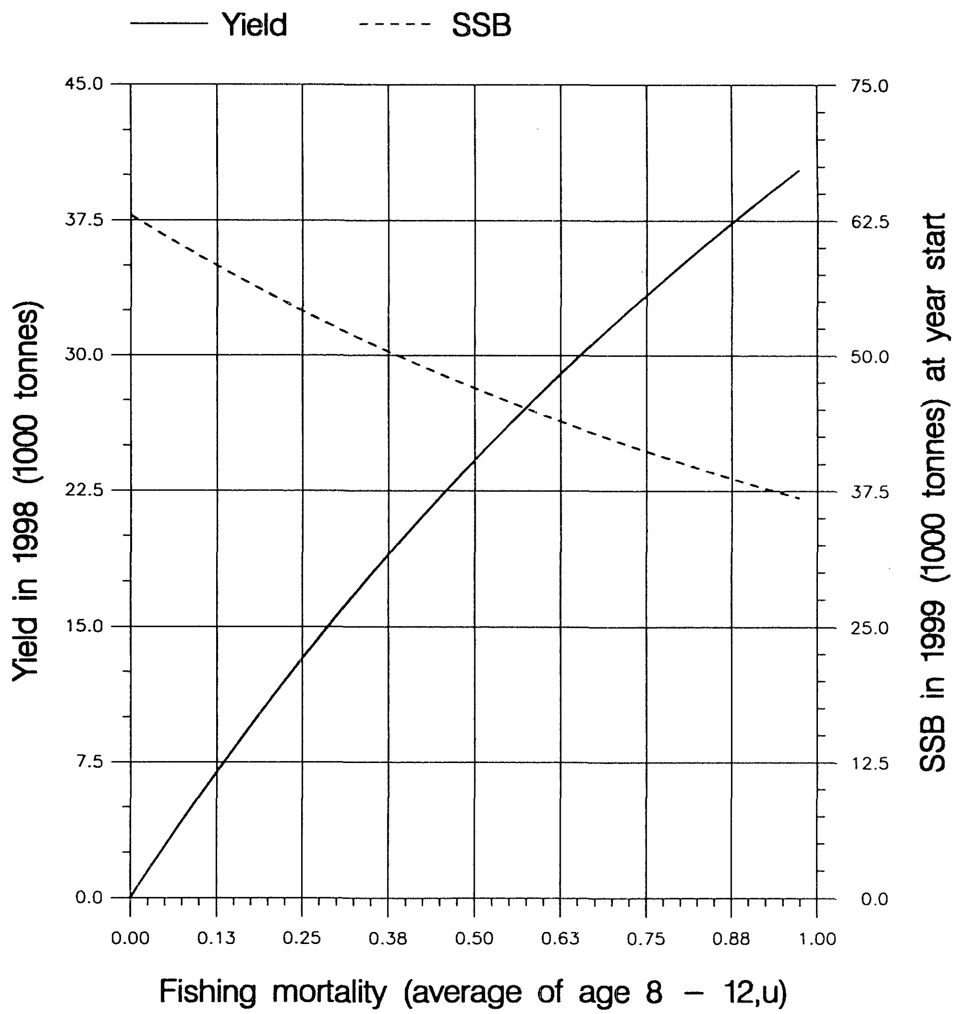
Fish Stock Summary
Greenland halibut (Fishing Areas V and XIV)
5 – 5 – 1997

Long term yield and spawning stock biomass



(run: YLDJBO02) C

Short term yield and spawning stock biomass



(run: MANJBO01) D

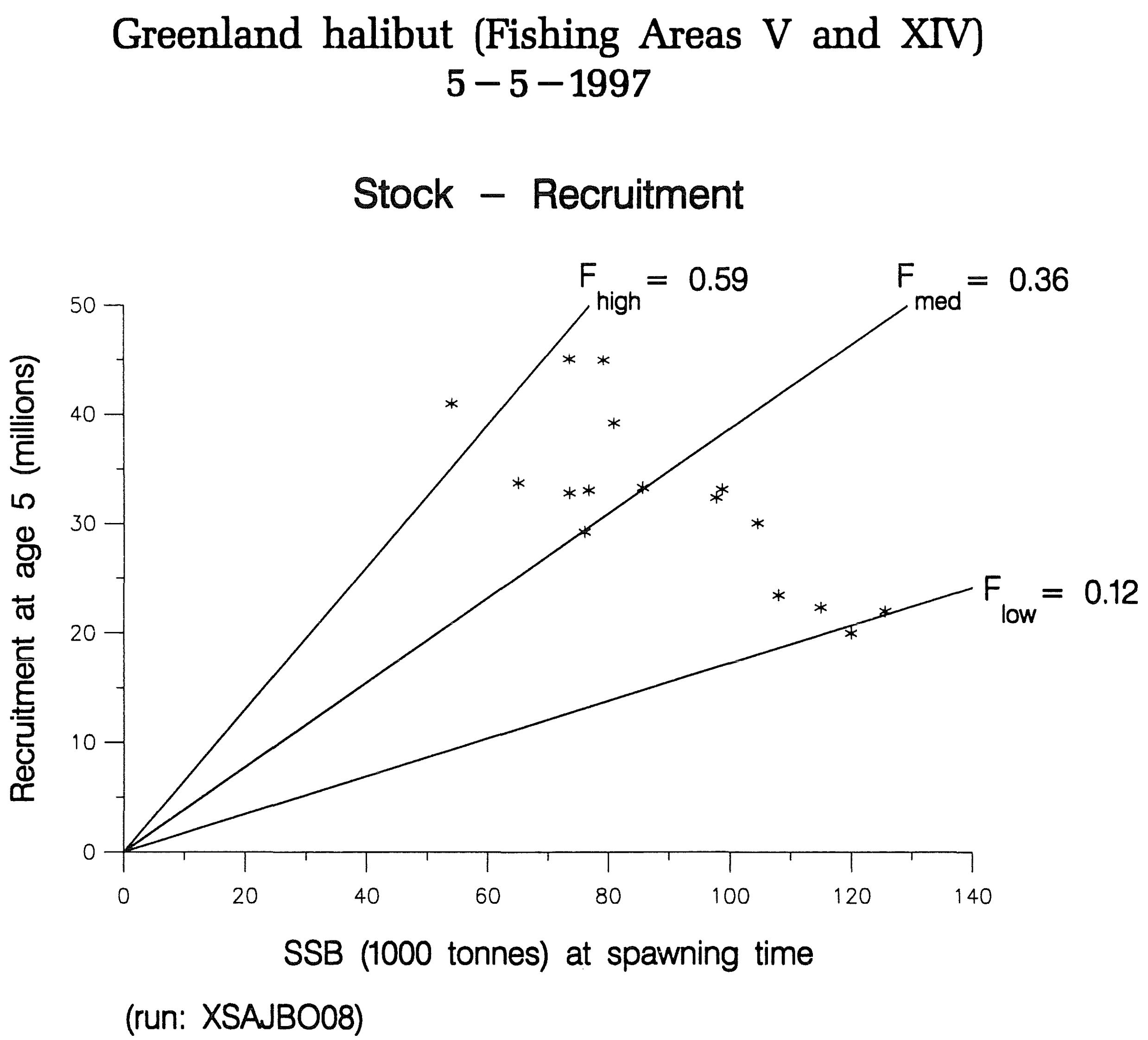

Greenland halibut (Fishing Areas V and XIV)
5 – 5 – 1997
Stock – Recruitment
F_{high} = 0.59
F_{med} = 0.36
F_{low} = 0.12
Recruitment at age 5 (millions)
0
10
20
30
40
50
0
20
40
60
80
100
120
140
SSB (1000 tonnes) at spawning time
(run: XSAJBO08)

Figure 6.7.2.2

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

7.1 Stock Identification and Species Biology

In the Northeast Atlantic three common species of redfish are found: *Sebastes viviparus*, *S. marinus* and *S. mentella*. These three *Sebastes* species are distributed along the Norwegian coast, in the Barents Sea, at the Faroes and around Iceland, Greenland and in the Irminger Sea.

7.1.1 Stock identification

S. marinus. The Working Group considers the *S. marinus* in East Greenland, Iceland and the Faroes as one stock.

In 1996 a new fishery with longlines and gillnets started on the Reykjanes ridge deeper than 500 meters. 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.* Nearly all these redfishes were above 65 cm and 5 kg (Figure 7.1.1). During the fishery in May 1996 most of these large redfish were spent, although a running female was also observed. Independent Icelandic and Norwegian otolith readings using the same method showed an age of these fishes in the range of 25-50 years old (Figure 7.1.2). Genetic analyses conducted by Icelandic and Norwegian scientists revealed that all these large redfish displayed hemoglobin patterns diagnostically different from both *S. mentella* and common *S. marinus* (Johansen *et al.* 1996). Due to the size, the genetic difference and the morhological 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 by earlier scientists (e.g., Altukhov and Nefyodov 1968, Kotthaus 1960a,b, Kosswig 1974). Kotthaus (1960b) found that the "giants" possessed a different number of gillrakers. Altukhov and Nefyodov (1968) described the "giant" redfish as follows: "in spite of its external likeness to the *marinus*-type, shows no biochemical identity with it, differing significantly from the latter in frequency of albumin B and α_1-globulins (i.e., blood serum proteins). The "giant"-type also differs significantly from the *mentella*-type". The youngfish and nursery areas for these large redfish have not yet been defined. Variation previously observed in haemoglobin patterns by e.g., Nedreaas and Naevdal 1991 in what were considered common *S. marinus* from East-Greenland should be further investigated to see if this variation can be explained by the recently discovered haemoglobin pattern found in the "giants". "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 catches in Division V.

Work is at present going on which hopefully will lead us to a better understanding of the biological status of these "giants". Nevertheless, the Working Group felt that sufficient biological evidence already exists 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.

S. mentella. *S. mentella* is considered to exist as two types. One type is found on the continental slopes and is called deep-sea *S. mentella* (deep-sea redfish). The adult and mature part of another type of *S. mentella*, called oceanic *S. mentella* (oceanic redfish), is pelagic and is found from about 100 m to 1 000 m in the Irminger Sea. In 1991, another *S. mentella* type resembling the deep-sea *S. mentella* was discovered by Icelandic scientists in the Irminger Sea in pelagic waters deeper than 500 meters, far from the continental shelves. Until then, deep-sea *S. mentella* was considered to be restricted along the continental slopes in the region, similar to that of *S. marinus*. 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

Genetic analyses (both traditional electrophoresis of haemoglobin and tissue enzymes and DNA analyses) are currently being conducted at Iceland and Norway. Preliminary results so far show some variation WITHIN the two *S. mentella* types, although these results do not permit, at this time, a clarification. More biological material and more research is required before anything can be concluded regarding the stock identity of the two types.

Separating the two pelagic *S. mentella* types in the Irminger Sea by morphological and biological criteria requires considerable experience. At present, only Icelandic scientists have thoroughly investigated this matter and possess the necessary ability. A protocol that details the methodology to separate the two types is urgently required so that other researchers can investigate the separation criteria, the behaviour and interrelationship of the two types. This will also allow researchers to compare the pelagic deep-sea *S. mentella* in the Irminger Sea with the deep-sea *S. mentella* on the continental shelf and slope.

ICES has been requested by the Northeast Atlantic Fisheries Commission (NEAFC) to provide information on the relationship between pelagic deep-sea *S. mentella* 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). More detailed results from this research are therefore needed before anything definite can be said about the relationship.

The Working Group therefore will deal with the following stocks:

S. marinus	Greenland-Iceland-Faroes stock.
	Giants
S. mentella	Greenland-Iceland-Faroes deep-sea stock.
	Irminger Sea oceanic stock.

7.1.2 **Biology of the species** (updated information)

ICES has been requested by the Northeast Atlantic Fisheries Commission (NEAFC) to described the depth distribution of the *S. mentella* by season, area and year. The only information is available come from the trawl-acoustic survey on oceanic *S. mentella* in the Irminger Sea and adjacent waters was carried out by Germany, Iceland and Russia in June-July 1996 which is described in Section 10.2.1.

During the summer and autumn, the oceanic redfish in the Irminger Sea has been most common at depths from 100 to 350 meters while the deep-sea redfish was common below 500 meters. In late winter and spring (March to May), i.e., during the "pre"-spawning" and "spawning" period, oceanic redfish inhabit deeper layers in the eastern part of the Irminger Sea. During that time there is considerable overlap in the depth distribution of the two types of *S. mentella* (Magnússon, 1983; Magnússon *et al.*, 1995). Depth distribution of the oceanic redfish in 1996 is discussed in chapter 10.

The mean size of redfish taken in shallower waters is smaller that from redfish in deeper waters. This characteristic, together with the lower infestation rate of deeper redfish probably explains the increase of catches in deeper waters, particularly since 1992. Though the catches have been reported as oceanic redfish, it has been presumed that the deeper in the water column the grater proportion of deep-sea *S. mentella* type. Iceland has taken steps (sampling on board, at landing sites and by collecting log-book reportings on depth) which hopefully will enable separation of these types in the catches of the Icelandic fleet in the future. It is imperative that countries participating in this fishery report monthly to NEAFC giving the catch at depth-intervals and by gear type.

Females of both types extrude larvae mainly during the April-May period. Magnusson *et al* (1995b) reported differences in average depth spawning between both types, although an overlapping exists. Shibanov and Melnikov (1994) reported redfish larvae only in upper layers (0-50 meters). Data collected on surveys (Magnusson *et al*, 1996) and in commercial vessels show that the spawning time probably occurred earlier in 1996 than in 1994.

The length distribution of the catches taken above 500 m shows little change in recent years, the modal length being about 35 cm. However, new information on age determination shows than Oceanic *S. mentella* between 30 and 40 cm (the bulk of the catches) probably belong to more than twenty different year classes.

In 1996 No new information about redfish migration patterns was available.

In 1995, the distribution of redfish extruded larvae (April-May) and fry that started their active feeding (June-July) were observed (Figure 7.1.3.A). Extrusion of larvae in the Irminger Sea started in mid-April in the south-eastern area and was completed by 20 May on the western slopes of the Reykjanes Ridge. The larvae were widely distributed over an area of 126,700 sq. nm. The larval density reached 45 specimens/sq. m in some locations, situated generally along the Reykjanes Ridge.

In June-July 1995 a northward drift of fry concentrations was registered. It is obvious that the general direction of redfish larvae/fry drift was in the same direction as the surface currents. In the northern part of the area surveyed a westward drift was registered, which is consistent with the direction of the Irminger current. It is quite likely that the fry later drifted in a southern direction within the Greenland EEZ following the water masses of the Irminger Current. In this case the most probable location of young oceanic redfish settling will be on the shelf and slopes of West and East Greenland and, perhaps, off Baffin Island.

It is obvious that redfish larvae which are extruded in the same places and at the same time will mix but it has not been possible to distinguish between larvae extruded by the two hypothetic pelagic redfish types. Density of redfish fry at 60°30'N, 32°00'W is presented in Figure 7.1.3.B.

7.2 Nominal Catches and Splitting of the Landings in Stocks

7.2.1 Nominal catches of Redfish by countries and areas

The total catch of redfish in 1996 approximated 80 000 t excluding the catch figures from the oceanic *S. mentella* fishery and was 20% less than in 1995 (100 000 t) and has decreased from a level of 120-130 000 t in 1991-1994. The decrease in the last two years is caused by a decrease in the German deep-sea *S.mentella* fishery in Sub-area XIV in 1994 and because of a decreased catch of both *S. marinus* and deep-sea *S.mentella* in Division Va, due to effort reduction..

The preliminary reported landings of oceanic *S. mentella* in 1996 are about 160 000 t. Thus the total catch of redfish in the area amounts to about 240 000 t in 1996 compared to about 275 000 t in 1995.

In Division Va (Iceland), the total redfish landings reached 73,300 t including 5 000 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 (Tables 7.2.1–7.2.2), manly due to quota regulations.

In Division Vb (Faroes) (Tables 7.2.3–7.2.4) 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 8-9 000 t in 1994-1996.

Landings from Sub-area VI have been of minor importance in recent years, but a steady increase in the UK redfish landings is reported (Tables 7.2.5–7.2.6) and in 1996 the Faroes also report 550 t taken in that area. 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 of *S. mentella.*

All landings from Sub-area XII are oceanic *S. mentella* taken by large pelagic trawl (Tables 7.2.7-7.2.8) except about 400 t of "Giant" *S. marinus* taken by longliners and gillnett .

The highest landings from Sub-area XIV were reported in 1996, having reached 137 000 t. After high catches in 1987-88 (90-95 000 t), landings dropped to about 25 000 t in 1989 before increasing to nearly 60 000 t in 1994. Data for 1995 show a decrease to about 43 000 t. The decline in 1995 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 changing in the oceanic *S. mentella* fishery in 1996. (Tables 7.2.9-7.2.10). Some of the "giant" *S. marinus* catches (approximately 600 t) 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 1996, about 99% were oceanic *S.mentella*.

7.2.2 Splitting of the catches

Since 1993, an attempt has been made to divide the redfish catches in Division Va into *S. marinus* and *S. mentella*, using both data from log-books and data collected by the staff of the Icelandic Marine Research

Institute. A new attempt was made this year for 1996 catches, 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 1996, 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	22.3	77.7
B. Landings in Germany	32.0	68.0
C. Landings in Iceland (excluding from freezer vessels).	68.9	31.1
Results	**48.9**	**51.1**

The splitting values (%) between *S. marinus* and deep sea *S. mentella* for the years 1992-1996 are given in the following text table:

	Results from 1992-1996 (%)	
Year	*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

For other areas and divisions, catches were split according to information from different laboratories (Tables 7.2.11-7.2.12).

7.2.3 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 - 1996. 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 1996.

The results are given in Figure 7.2.1. 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 7.2.1). 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*.

7.3 Juvenile Redfish

7.3.1 Recruitment indices

7.3.1.1 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 7.3.1). 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.

7.3.1.2 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 7.3.1. 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 generalized 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 two year-classes (1985 and 1987) to the fishable stock.

7.3.1.3 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 7.3.2 and 7.3.3. Respective values were shown in Figures 7.3.2 and 7.3.3. 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 1985, both abundance and biomass indices vary without a clear trend. In 1985 and 1993-96 small redfish were more abundant, in the entire survey area off East Greenland.

Length distributions are illustrated in Figures 7.3.4 and 7.3.5 aggregated for West and East Greenland. They revealed that juveniles off East Greenland were bigger than those off West 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.

7.3.1.4 Greenland Trawl Survey

Juvenile redfish are caught both off West and East Greenland during the Greenland trawl survey, which commenced in 1992 and 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 7.3.4 and 7.3.5 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 7.3.6. 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.

7.3.2 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. The shrimp fishery at both West and East Greenland takes small redfish as a by-catch and it can be concluded that the area of the shrimp fishery also includes a part of the nursery area for redfish.

During 1996, the Greenland Institute of Natural Resources started a project, in collaboration with the Greenland Fisheries License Control (GFLC), seeking to quantify bycatches and length structure of redfish in the East Greenland shrimp fishery.

A total of 455 catch samples and 41 length measurements from each major shrimp area was collected by GFLC-observers onboard Greenlandic, Faeroes and Danish shrimp trawlers during November-December 1996.

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 estimated bycatch rates are representative for the whole shrimp fishing season, the total bycatch of redfish at East Greenland is estimated to 350 tons by using the figure of the total shrimp catch for 1996. Redfish length distribution of the estimated bycatch are illustrated on Figure 7.3.7.

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).

7.3.3 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.
This regulation has not been effective in recent years, since a temporary dispensation is given for shrimp fishing in the Redfish Box.

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 7.2.1 REDFISH. Nominal catches (in tonnes) by countries, in Division Va 1983-1996, as officially reported to ICES.

Country	1983	1984	1985	1986	1987	1988	1989
Belgium	389	291	400	423	398	372	190
Faroe Islands	1,357	686	291	144	332	372	394
Germany, Fed. Rep.	-	-	-	-	-	-	-
Iceland	122,749	108,270	91,381	85,992	87,768	93,995	91,536
Norway	32	12	8	2	7	7	1
Total	124,527	109,259	92,080	86,561	88,505	94,746	92,121

Country	1990	1991	1992	1993	1994	1995	1996 [1]
Belgium	70	146	107	96	50		
Faroe Islands	624	412	389	438	202	521	
Germany, Fed. Rep.	-	-	-	-	46	229	233
Iceland[2]	90,891	96,770	94,382	96,577	95,091	89,474	64,967
Norway	-	-	-	-	-	-	135
Total	91,585	97,328	94,878	97,111	95,389	90,224	65,335

1 Provisional
2 Oceanic *S. mentella* not included

Table 7.2.2 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 [1]		309	233	72,759 [6]	0	73,301

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 4862 tonnes oceanic *S. mentella.*

Table 7.2.3 REDFISH. Nominal catches (tonnes) by countries,in Division Vb 1981-1996, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988
Denmark	-	-	-	-	-	36	176	8
Faroe Islands	3,232	3,999	4,642	8,770	12,634	15,224	13,477	12,966
France	59	204	439	559	1,157	752	819	582
Germany, Fed. Rep. [2]	3,841	4,660	4,300	4,460	5,091	5,142	3,060	1,595
Iceland	-	1	-	-	-	-	-	
Norway	13	7	3	1	4	2	5	5
UK (Engl. and Wales)	-	-	-	-	-	-	-	
USSR	-	-	-	142	-	-	-	
Total	7,145	8,871	9,384	13,932	18,886	21,156	17,537	15,156

Country	1989	1990	1991	1992	1993	1994	1995	1996 [1]
Denmark	-	+	-	-	-	-	-	-
Faroe Islands	12,636	10,017	14,090	15,279	9,687	8,872	7,978	
France [1]	996	909	473	114	32	90		
Germany, Fed. Rep. [2]	1,191	441	447	450	239	155	91	190
Norway	21	21	20	34	26 [1]	31 [1]	34	35
UK (Engl. and Wales)	-	-	2	21	28	1	2	
UK (Scotland)	-	+	1	8	1	18	24	
United Kingdom								78
USSR/Russia [3]	-	-	-	15	44	3		
Total	14,844	11,388	15,033	15,921	10,057	9,170	8,129	303

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

Table 7.2.4 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	26	22	29	44	10,432
1994	0	8,872	90 [3]	155	0	0	31	0	19	3	9,170
1995	0	7,978	18 [3]	91	0	0	34	0	26	9 [3]	8,156
1996 [1]	0	7,286	31 [3]	190	0		35		78		7,620

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

Table 7.2.5 REDFISH. Nominal catches (tonnes) by countries, in Sub-area VI 1981-1996, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988
Faroe Islands	-	-	-	19	18	-	-	1
France	24	44	93	102	397	480	1,032	1,024
Germany, Fed. Rep.	983	604	359	563	76	24	-	16
Ireland	-	-	-	-	-	-	-	-
Norway	3	4	2	9	-	14	2	1
Spain	1	-	2	-	-	-	-	-
UK (Engl. and Wales)	-	2	-	1	1	2	3	75
UK (Scotland)	-	-	-	1	-	10	17	6
Total	1,011	654	456	695	492	530	1,054	1,123

Country	1989	1990	1991	1992	1993	1994	1995	1996 [1]
Faroe Islands	61	-	22	6	-	-	2	
France [1]	726	684	483	127	268	555		
Germany, Fed. Rep.	1	6	8	-	77	87	5	9
Ireland	-	-	-	1	1	-	4	
Norway	2	5	+	4 [1]	3 [1]	2 [1]	8 [1]	6
Spain								
UK (Engl. and Wales)	1	29	11	4	4	9	105	...
UK (Scotland)	6	6	39	32	94	118	500	...
United Kingdom								621
Total	797	730	563	174	447	771	624	636

1) Provisional

Table 7.2.6 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	50	563
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		5	4	8	0	605	624
1996 [1]	550		9		6		621	1,186

1 Provisional data.

Table 7.2.7 REDFISH. Nominal catches (tonnes) by countries, in Sub-area XII 1983-1996, 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 [1]
Bulgaria	1,617	-	628	3,163	3,600	3,800	
Estonia	-	-	1,810	6,365	17,875	421	7,092
Faroe Islands	-	-	-	4,026	2,896	3,467	
Germany' Fed. Rep. [3]	7	62	1,084	6,459	6,354	9,673	4,391
Greenland	-	-	9	710	-	1,856	
Iceland	185	95	361	8,098	17,892	19,577	1,675
Latvia	-	-	780	6,803	13,205	5,003	1,084
Lithuania	-	-	6,656	7,899	7,404	22893	
Netherlands	-	-	-	-	-	13	
Norway	249	726	380	6,207 [1]	4,275 [1]	4,593 [1]	1,190
Poland	-	-	-	-	-		
UK	-	-	-	+	-		260
Ukraine	-	-	-	2,782	5561	3,185	
USSR/Russia [2]	4,274	6,624	2,485	4,106	10,489	34,730	606
Total	6,332	7,507	14,193	56,618	89,551	109,211	

1) Provisional

2) As from 1991.

3) Includes former GDR

Table 7.2.8 Landings of REDFISH (in tonnes) by countries in Sub-area XII as used by the Working Group.

Year	Bulgaria	Canada	Estonia	Faroes	France	FRG [4]	Greenland	Iceland	Japan	Latvia	Lithuania	Nederland	Norway	Poland	Ukraine	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		0		0	370	0	110 [5]					764 [2]	0		6,624			7,868
1992	628		1,810		2	1,280	9	419 [5]		780	6,656		369 [2]	0		11,266			23,219
1993	3,163		6,365	4,026	0	6,144	8	9,394 [5]		6,803	7,899		5,735 [2]	0	2,782	18,669			70,988
1994	3,600		17,875	2,896	606 [6]	7,058	0	20,755 [5]		13,205	7,404		4,774 [2]	0	5,561	10,489			94,223
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	3,201 [2]	0	3,185	32,730	20		127,452
1996 [1]		650 [7]	7,092	4,198		4,419		1,943 [5]	415	1,084			1,108 [2]			606	500	260	22,275

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.
6 As reported to Greenland
7 Taken in NAFO area 1F
8 As reported to FAO for the North East Atlantic.

Table 7.2.9 REDFISH. Nominal catches (tonnes) by countries, in Sub-area XIV 1983-1996, 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]
Bulgaria	1,073	-	-	-			
Denmark	-	-	-	-	-		
Faroe Islands	-	115	3,765	3,095	164	8	
Germany, Fed. Rep [4]	11,218	9,122	7,959	26,969	22,406	9,702	16,995
Greenland	24	42	962	264	422	2,936	
Iceland	3,726	7,477	12,982	11,650	29,114	8,947	49,797
Norway	6,070	4,954	14000	7,162 [1]	2,609 [1]	2,003 [1]	6,042
Portugal	-	-	-	-	1,887	5,125	2,379
UK (Engl. and Wales)	39	219	178	241	138	48	
UK (Scotland)	3	+	28	8	4	10	
United Kingdom	-	-	-	-			6
USSR/Russia [3]	3,040	2,665	1,844	6,560	13,917	9,439	45,142
Total	25,193	24,594	41,718	55,949	70,661	38,218	

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

Table 7.2.10 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		241	5,496		56,197
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 [1]	0	0	2,153	17,039	350 [6]	57,765 [4]		6,212 [2]		2,379	6	45,142	6,729	137,775

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 1978-1991; Russia since 1992.
4 Raised by 16% to account for discarding.
5 Includes former GDR
6 Estimated bycatch in the shrimfishery

Table 7.2.11. Proportions used for splitting the 1995 REDFISH landings between *S.marinus* and *S.mentella* stocks.

Area	Va			Vb		VI		XII	XIV		
Species/stock	*S.mar.*	*S.ment.*	*S.ment.*	*S.mar.*	*S.ment.*	S.mar.	S.ment.	*S.ment.*	*S.mar.*	*S.ment.*	*S.ment.*
		deep-sea	oceanic		deep-sea		deep-sea	oceanic		deep-sea	oceanic
Bulgaria											
Belgium	1.00										
Canada								1.00			
Danmark										1.00	
Estonia								1.00			
Faroes				0.31	0.69			1.00	0.00	1.00	0.00
France					1.00						
Germany	0.00	1.00	0.00		1.00	0.00	1.00	1.00	0.00	0.04	0.96
Greenland								1.00	0.10	0.90	
Iceland	0.46	0.53	0.02					1.00			1.00
Japan								1.00			1.00
Latvia								1.00			
Nederlands								1.00			
Norway				1.00	0.00	1.00	0.00	1.00	0.002		0.998
Portugal											1.00
Russia				1.00	0.00			1.00			1.00
Spain								1.00			1.00
Ukraine								1.00			
UK				1.00	0.00	1.00		1.00	0.03	0.97	

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 7.2.12. 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. *"Giant"*	*S.mar.*	*S.ment.* deep-sea	*S.ment.* oceanic	*S.mar.* *"Giant"*
Bulgaria													
Belgium	1.000												
Canada								1.00					
Danmark													
Estonia								1.00					
Faroes	1.000			0.302	0.698	0.000	1.000	1.000		0.000	0.015	0.985	
France					1.000								
Germany	0.000	1.000	0.000		1.000	0.000	1.000	1.000		0.000	0.010	0.990	
Greenland										0.100	0.900		
Iceland	0.456	0.477	0.067					1.000				1.000	
Ireland													
Japan								1.000					
Latvia								1.000					
Lithuania													
Nederlands													
Norway		1.000		1.000	0.000	1.000	0.000	0.685	0.315	0.009		0.902	0.089
Poland													
Portugal												1.000	
Russia								1.000				1.000	
Spain								1.000				1.000	
Ukraine													
UK				1.000	0.000	1.000		1.000		0.030	0.970		

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.

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Table 7.3.1 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 7.3.2 *Sebastes* spp. (<17 cm). Abundance indices (n*1000) for West, East Greenland and total by stratum as derived from the German groundfish survey, 1982-96. 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	13718						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

Table 7.3.3 *Sebastes* spp. (<17 cm). Biomass indices (tons) for West, East Greenland and total by stratum as derived from the German groundfish survey, 1982-96. 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

Table 7.3.4. 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

Table 7.3.4. cont'd

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

Table 7.3.5. 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

Table 7.3.5. cont'd

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

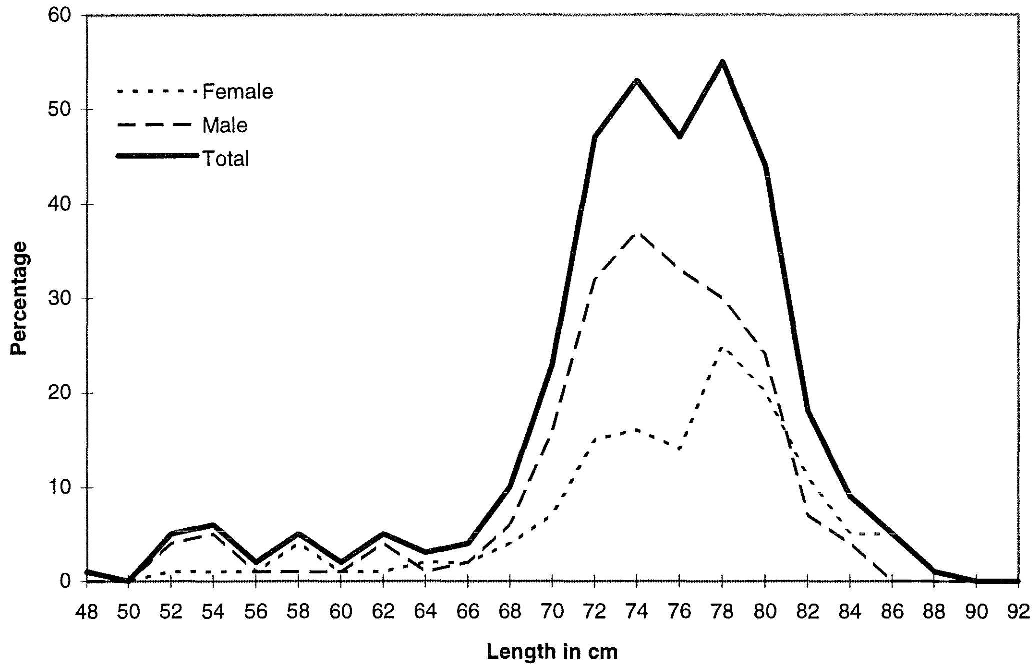


Figure 7.1.1. Length distribution of "Giant" *Sebastes marinus* caught by the Faroes in 1996. (Source: Hareide and Thomsen 1997).

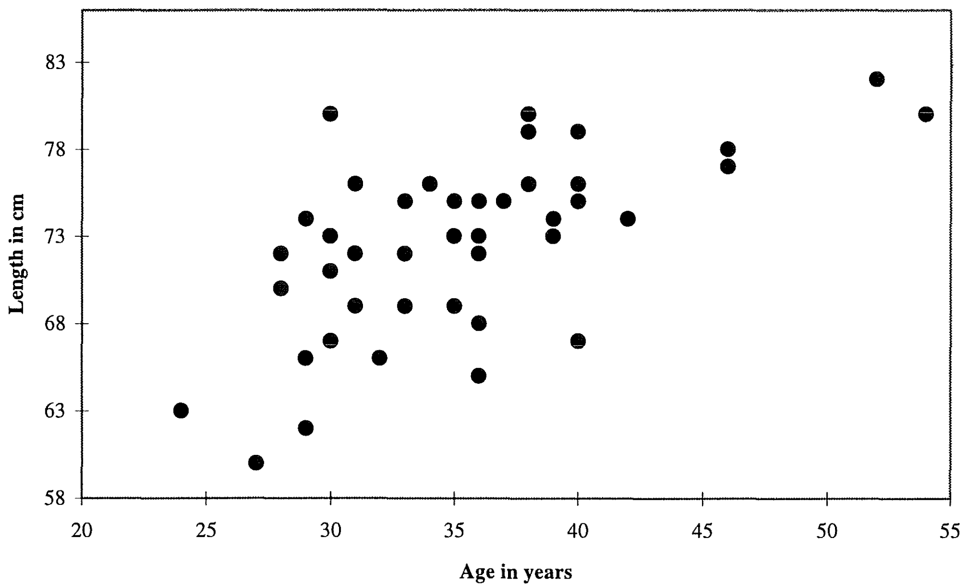


Figure 7.1.2. Age determination of "Giant" *Sebastes marinus* caught on the Mid-Atlantic ridge in May 1996.

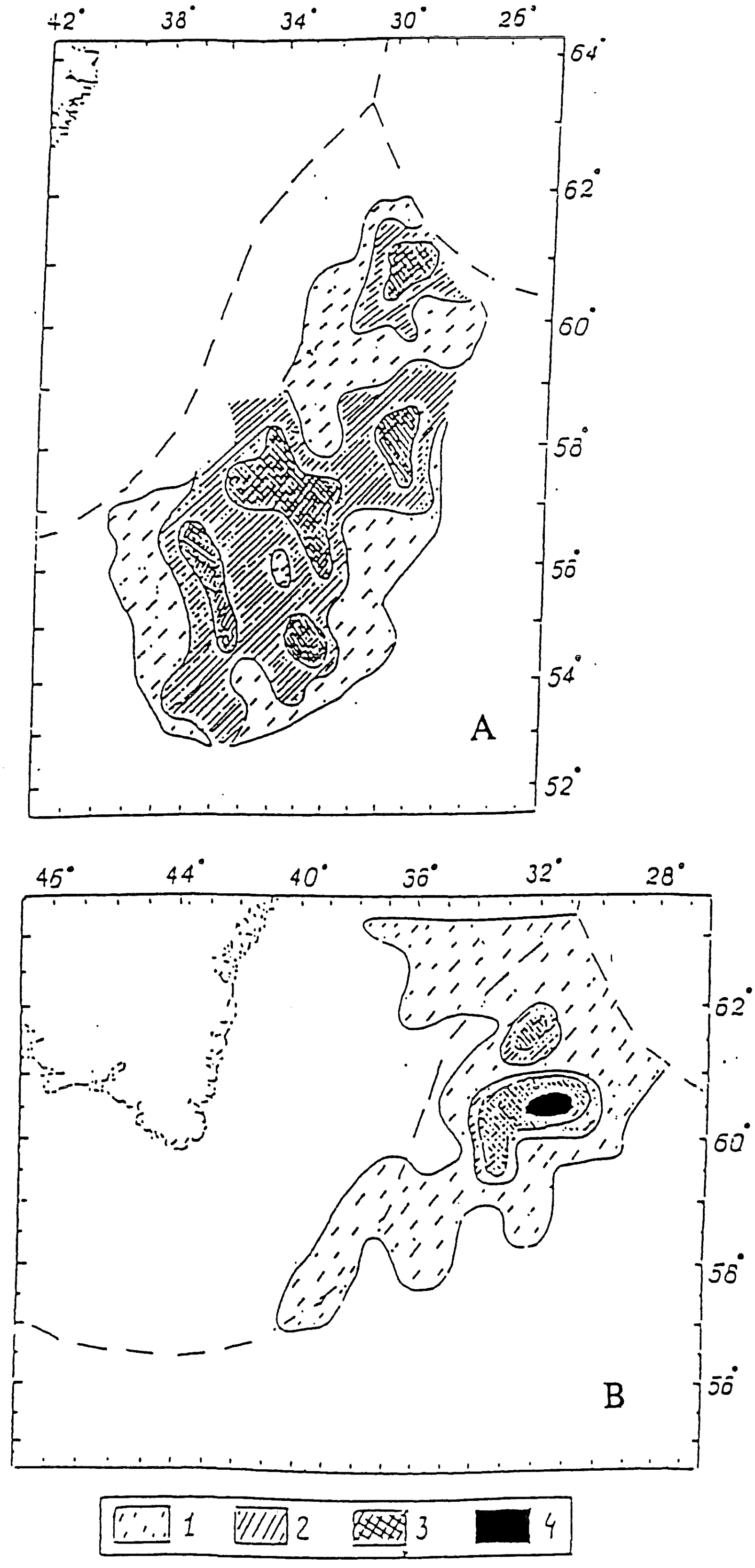


Figure 7.1.3 Density of larvae and fry of *S. mentella* (spec./m^2) during the ichthyoplankton survey (A) and TAS (B) in 1995.

A: 1 - less than 10; 2 - 10.1-25; 3 - 25.1-50.

B: 1 - less than 2.5; 2 - 2.6-5; 3 - 5.1-10; 4 - more than 10.

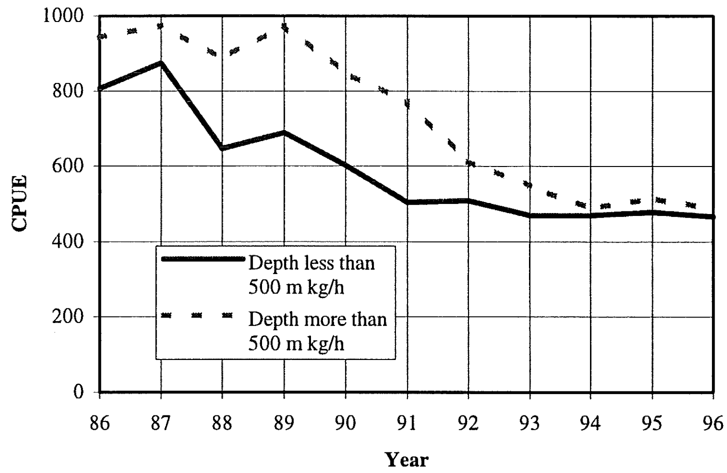


Figure 7.2.1. Results of CPUE from Icelandic trawlers data at different depths, and where redfish is more than 10% of total catch in haul.

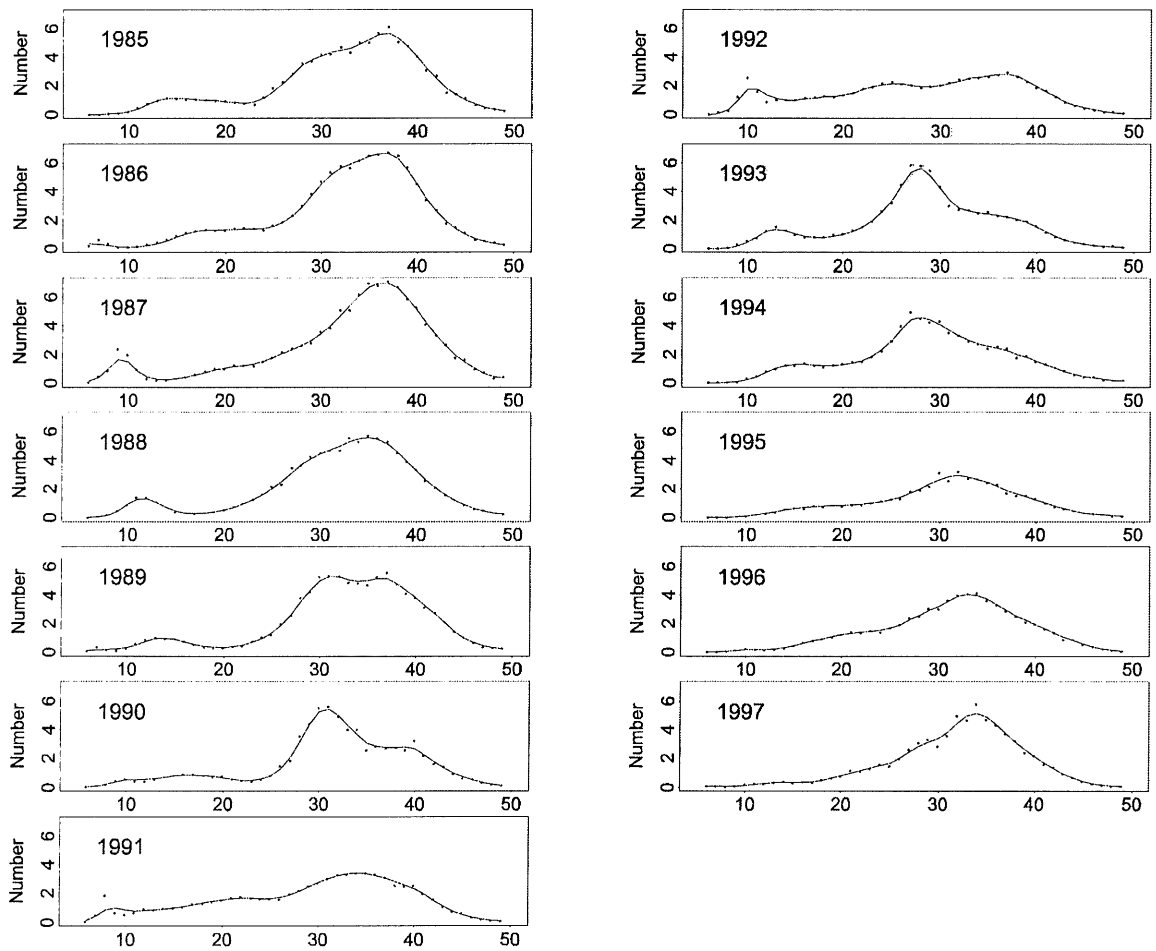


Figure 7.3.1. *S. marinus.* Length distribution from Icelandic groundfish survey of 0-500 m depth range. Number of fish per towing mile by cm groups. All areas.

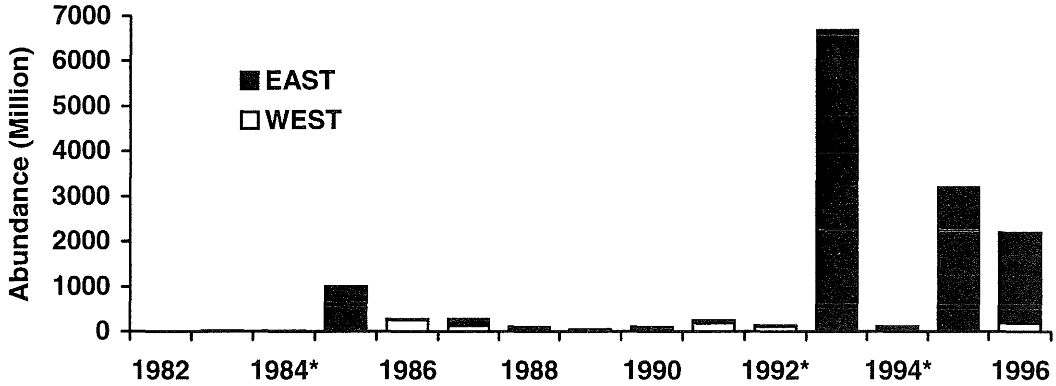


Figure 7.3.2 *Sebastes* spp. (<17 cm). Survey abundance indices for East and West Greenland as derived from the German groundfish survey, 1982-96. *) incomplete survey coverage.

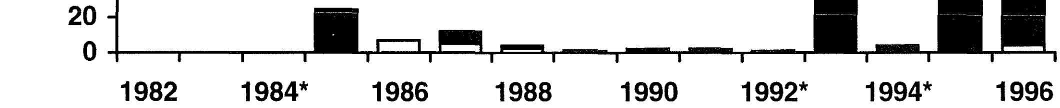


Figure 7.3.3 *Sebastes* spp. (<17 cm). Survey biomass indices for East and West Greenland as derived from the German groundfish survey, 1982-96. *) incomplete survey coverage.

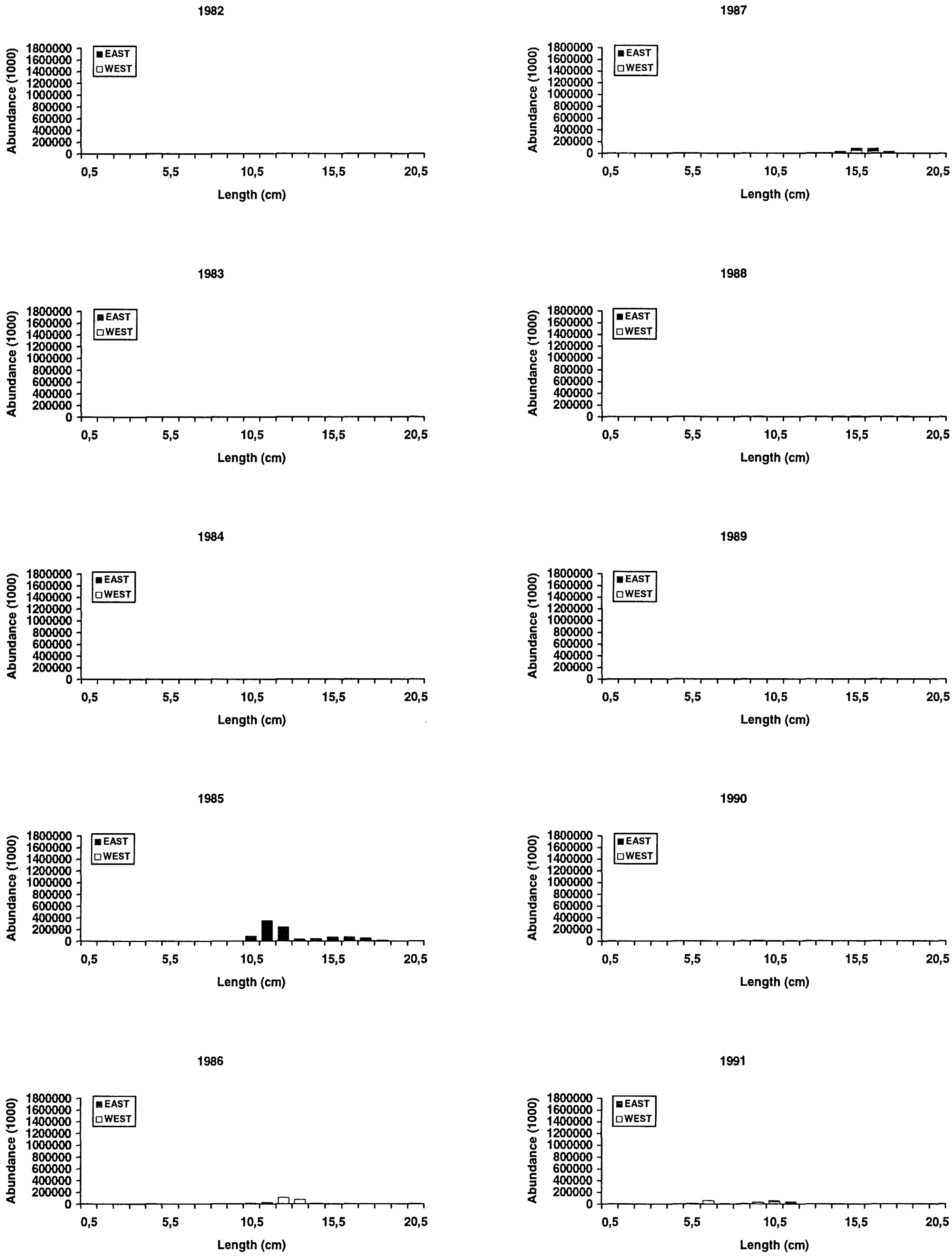


Figure 7.3.4 *Sebastes* spp. (<17 cm). Length frequencies for East and West Greenland as derived from the German groundfish survey, 1982-91.

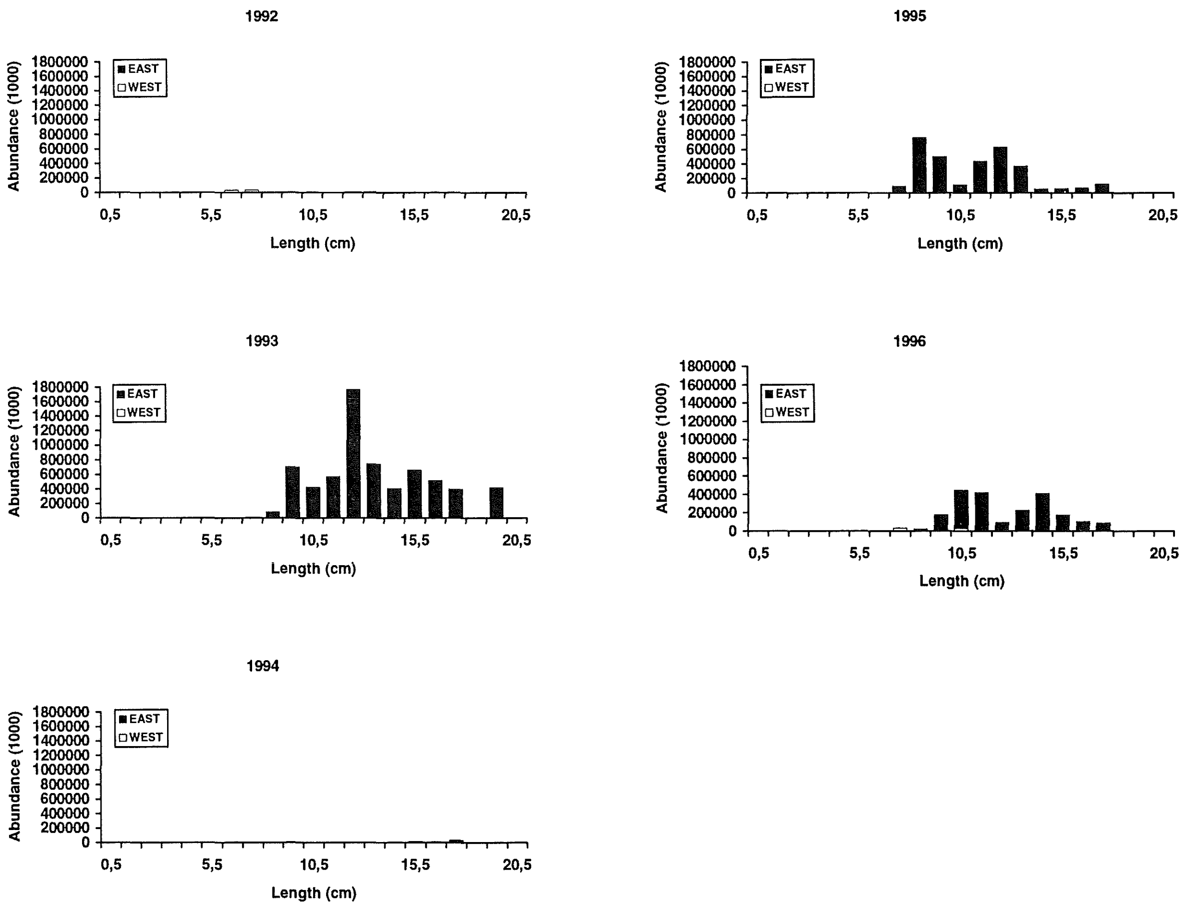


Figure 7.3.5 *Sebastes* spp. (<17 cm). Length frequencies for East and West Greenland as derived from the German groundfish survey, 1992-96.

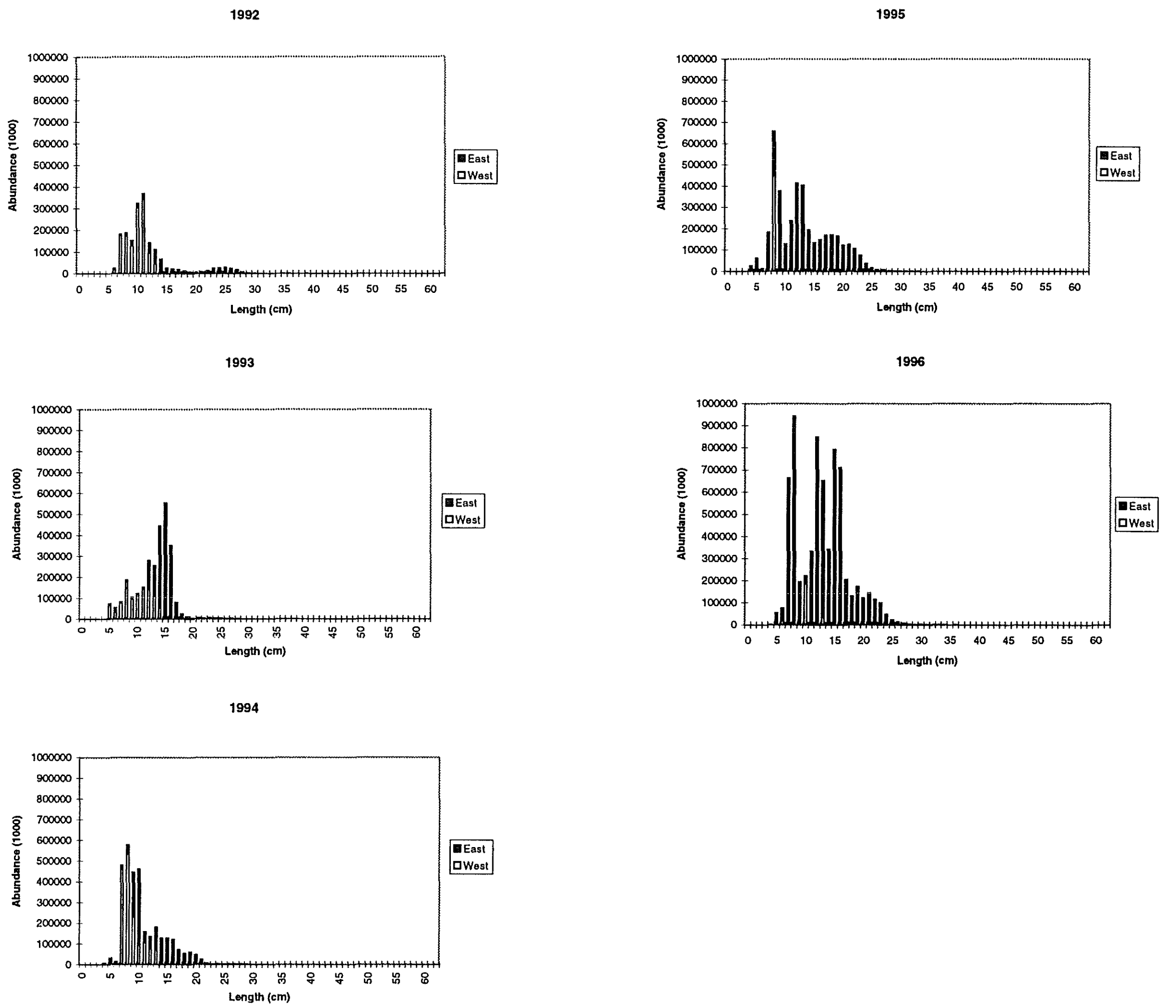


Figure 7.3.6. *Sebastes* spp. Length frequencies for East and West Greenland, 1992-1996 data from the Greenland Shrimp Trawl Survey.

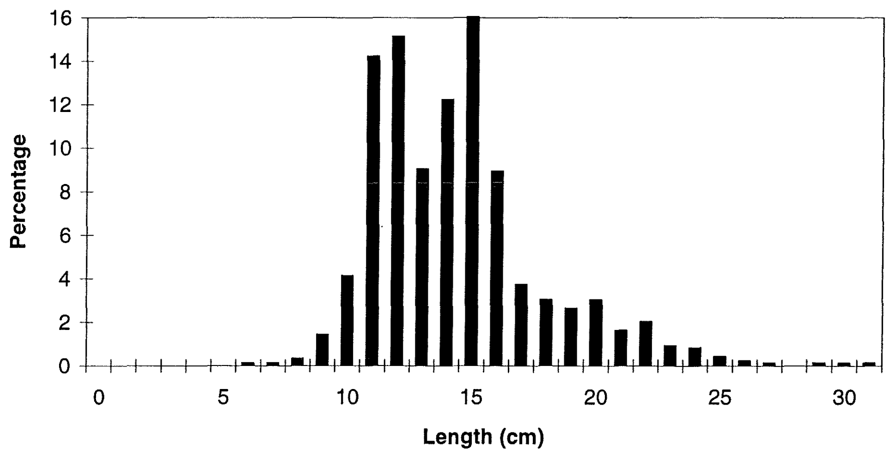


Figure 7.3.7. *Sebastes* spp. Length distributions of redfish bycatch in the shrimp fishery in ICES XIVb, 1996

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 t in 1996 (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 occurred in area Va, where 34 000 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 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 are the lowest catch of *S. marinus* in Va since 1978. The length distributions in the Icelandic landing in 1989-1995 along with measurements at sea from the commercial trawler fleet are shown in Figure 8.1.1.

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 gear and partly as a bycatch in the gill net and long line fishery.

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 redfish (both *S. marinus* and *S. mentella*) catches in the Vb have been taken by large bottom trawlers (> 1000 HP) with more than 80% of their catches during the last 10 years having been redfish. No length distribution were available for this year.

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

8.2 Assessment

8.2.1 Trends in CPUE and survey indices

Figure 8.2.1 shows the *S. marinus* abundance index with 95% confidence intervals using Icelandic groundfish survey data. The index is a biomass index of the fishable stock computed by using a fishable stock ogive as shown in Figure 8.2.2. The index is a Cochran index (see Pálsson *et.al*, 1989) and the stratification is based on depth intervals and is shown in Figure 8.2.3. The reason for not using the same stratification as used earlier 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. The index indicates a strong increase in the fishable biomass in 1996 and in 1997. The length distribution from the survey (Figure 7.3.1) shows a peak in the length distribution at about 33-35 cm., which is in accordance to the peak in earlier years, showing a growth of about 2 cm each year. The high survey index in 1996 and again in 1997 can be explained both by an increase in catchability and also by increasing recruitment to the fishable stock.

The results from the trawler fleet do not reflect the situation shown in the groundfish survey and the CPUE is at a very low level which has been the case for recent years (Figure 8.2.4). However, by looking at the period from January - March, there seems to be an increasing trend in 1997 (Figure 8.2.5)

In summary, the Icelandic groundfish survey as well as the CPUE data seems to indicate a considerable decline in fishable biomass of *S. marinus* during the period from 1986 to 1994. The stock seems to have started to recover in 1995 - 1997 but it is still at a very low level.

For the period 1982-96, abundance and biomass indices from German groundfish survey for *S. marinus* (≥17 cm) are listed in Tables 8.2.1 and 8.2.2 by stratum, West and East Greenland, aggregated to total and accompanying confidence intervals, and illustrated in Figures 8.2.6 and 8.2.7. 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 1996 index amounted to 15 000 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 1987-96, abundance estimates decreased from 610 million to 30 million.

It can be taken from Figures 8.2.8 and 8.2.9 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 8.2.8 and 8.2.9, 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

Based on the Icelandic groundfish survey information and the CPUE data (see text table below), the *S. marinus* stock seems to be at a low level and the fishable biomass appears to have decreased considerably from 1986 to 1995. The Icelandic groundfish survey does indicate increased recruitment to the fishable stock although the CPUE from the Icelandic trawler fleet does not reflect that situation. However, the CPUE shows a similar increase in 1997 as does the groundfish survey if we only look at the period from January - March. The length distributions from the catches also show signs of incoming recruitment to the fishable stock.

Although there are some indications of incoming recruitment, it is the opinion of the Working Group that this recruitment be used to build the fishable stock up from its present low level.

The results from the German groundfish surveys in Sub-area XIV are alarming concerning *S. marinus*. It is therefore urgent to protect the juvenile fish which are presently observed in large quantities at East - Greenland.

The working group also tried a new version of a age-production model. The model is described in working document nr. 23 as 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 a same general trend in the fishable biomass as the Icelandic groundfish survey does and it seem to be able to reflect the peak in the recruitment of the assumed 1985 and 1990 year classes.

Year	SMB_index	Catch Va	Effort
85	1000	67,312	67
86	1082	67,772	63
87	1101	69,212	63
88	877	80,472	92
89	916	51,825	57
90	773	63,156	82
91	550	49,677	90
92	511	51,464	101
93	468	45,890	98
94	444	38,669	87
95	382	41,516	109
96	585	33,202	57
97	676		
Average 85-90			
	958	av.86-89	68.4

The Icelandic groundfish survey indices (*U*) may be assumed to be related to overall biomass (*B*) by a simple multiplicative 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 1998 as it was in 1996 and calculating the catch in 1998 as:

$$\textbf{Catch}_{98} = \textbf{SMB}_{97} * \textbf{Effort}_{96},$$

the catch will be around 39 000 tonnes.

8.2.3 MBAL

The fishable stock of *S. marinus* is at a very low level, and the catches in recent years have been low despite of increased effort, especially in Division Va. However, in 1996 there seems to be a real effort reduction in Division Va in and the fishable biomass has started to increase. There are no indication of recruitment failure in Division Va.

The Working Group agreed that it is difficult to define any MBAL for the stock based on available information.

8.3 "Giant" *Sebastes marinus*.

8.3.1 Fishery

In March 1996 a new fishery with longlines and gillnets started on Reykjanes ridge deeper than 500 meters. Icelandic (2 longliners), Faroes (4 longliners) and Norwegian (10 longliners and 1 gillneters vessel) vessels participated in this fishery. In addition to traditional bottom longlines, vertical longlines were used on the steep sea mountains. One of the main species caught in this fishery were the "giant" *Sebastes marinus* (see chapter 7.1). Catches of deep-sea *S. mentella* composed only 0.8% of the redfish catches. The fishery has taken place from within the Icelandic EEZ (north to approx. 63°N) and southwards in international waters to approx. 56°N, although "giant" redfish have been caught south to 52°30'N. Figure 8.3.1 show the area fished by the Icelandic longliners in 1996.

The only landing statistics presented in 1996 were by Iceland, the Faroes and Norway (Table 8.3.1). The total reported landings of "giant" *S. marinus* taken by the Faroes and Norway in Sub-areas XII and XIV in 1996 were 1 022 tonnes. In addition and according to log-books, the Icelandic catches amount to 300-400 tonnes which provisionally have been included in the *S. marinus* statistics for the area Va. The Working Group realizes that “giant” redfish have been caught by fishermen within the Icelandic and Greenland zones since the 1930s, and that some “giants” have been observed annually in the landings since then. However, not until this new fishery started in 1996 on Reykjanes ridge have such large quantities of “giant” *S. marinus* been reported.

8.3.2 Management considerations

Although not all were necessarily convinced, the consensus of the Working Group was that sufficient biological evidence already exists to keep these “giant” *S.marinus* 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. The Working Group, however, had no basis to suggest any management recommendations upon although a very conservative and cautious harvesting strategy should be used on these long-lived specimens. Countries participating should analyse and present effort and CPUE data together with biological data from this 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	2,631	101	0	1,737	50,360
1994	38,669	2,271	129	0	1,443	42,512
1995	41,516	2,579	613	0	61	44,769
1996 [1]	33,202	2,313	627	0	92	37,253

'1) Provisional data.

Table 8.2.1 *S. marinus* (≥17 cm). Abundance indices (n*1000) for West, East Greenland and total by stratum as derived from the German groundfish survey, 1982-96. 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	5885	1697			140766	453	264813		14365	28714	420397	449111	53
1984	1324	3438	460	1209	10671	2776	4214		6888			47974		9890	24092	(64752)	(88844)	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

Table 8.2.2 *S. marinus* (≥17.5cm). Biomass indices (tons) for West, East Greenland and total by stratum as derived from the German groundfish survey, 1982-96. 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	308	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	1282	1215	752	1229	10122	1705	1762			43119	382	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	8896		1141	101	10914	11015	38
1996	64	102	4	60	128	118	8	132	139	1714	196	10855		1408	616	14312	14928	40

Table 8.3.1. Landings (in tonnes) of "giant" S. marinus in Divisions XII and XIV.

Area XII

Year	Norway	Total
1996	349	349

Area XIV

Year	Faroes[1]	Norway	Total
1996	80	551	551

1) Includes area XII

Iceland has caught 300-400 t which are included in Div Va
Catch figures for other areas or nations are not available for the meeting.

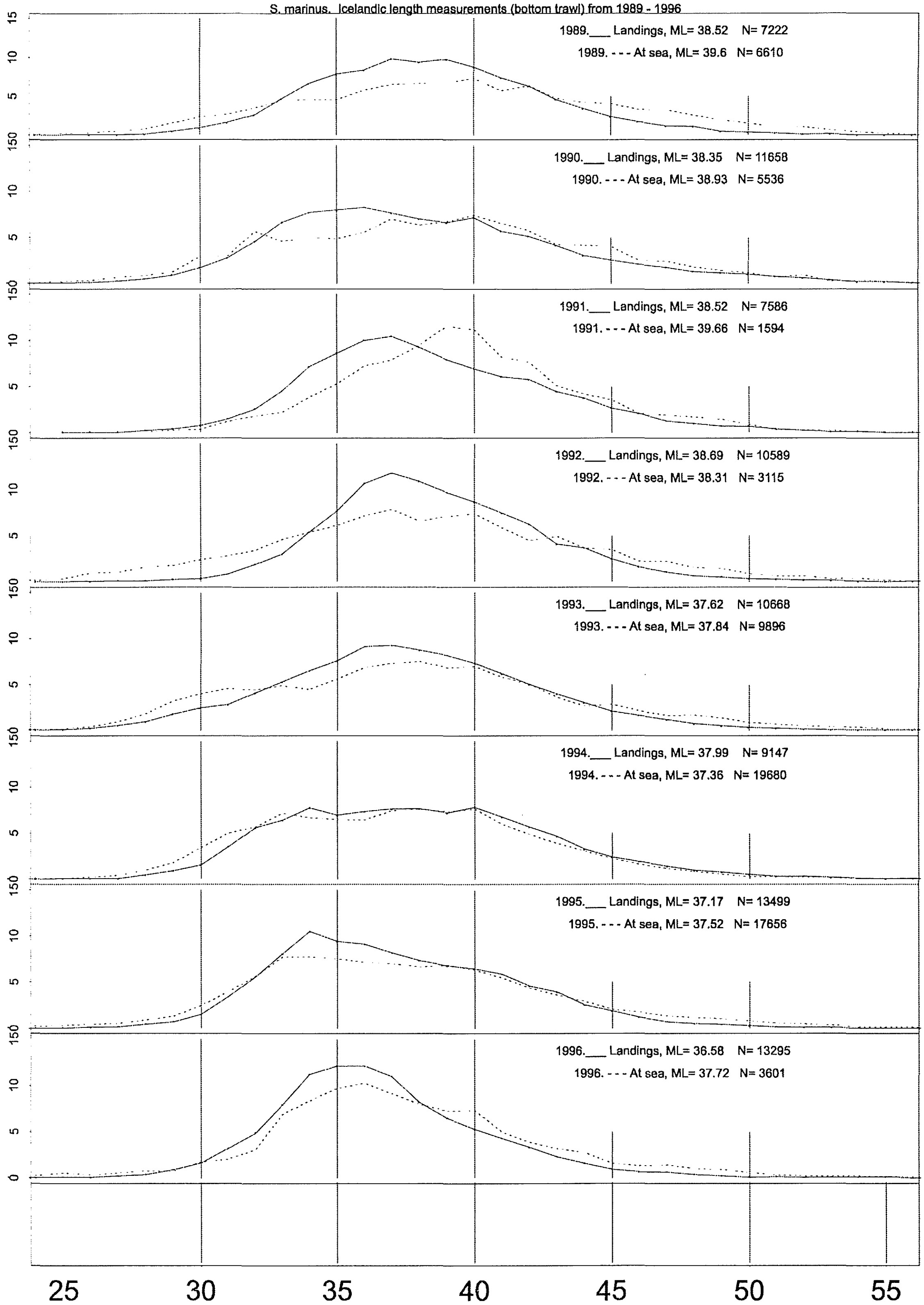


Figure 8.1.1. Length distribution of *S. marinus* in Icelandic landings and from samples taken at sea from the trawler fleet 1989-1996.

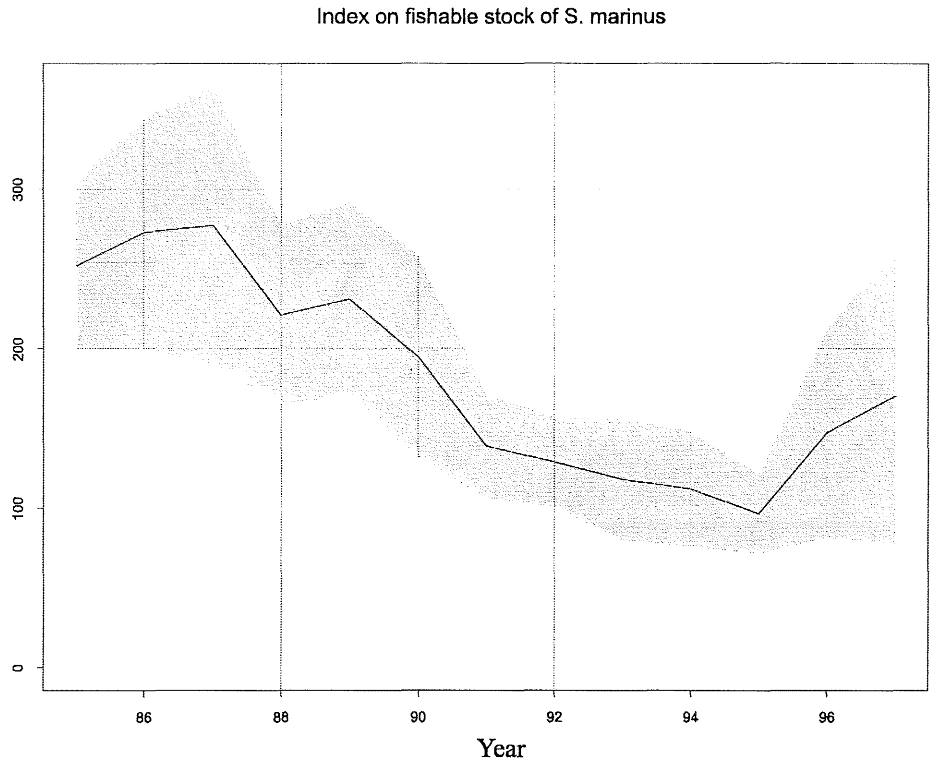


Figure 8.2.1 Index on fishable stock of S. marinus from Icelandic groundfish survey and 95% confidence intervals.

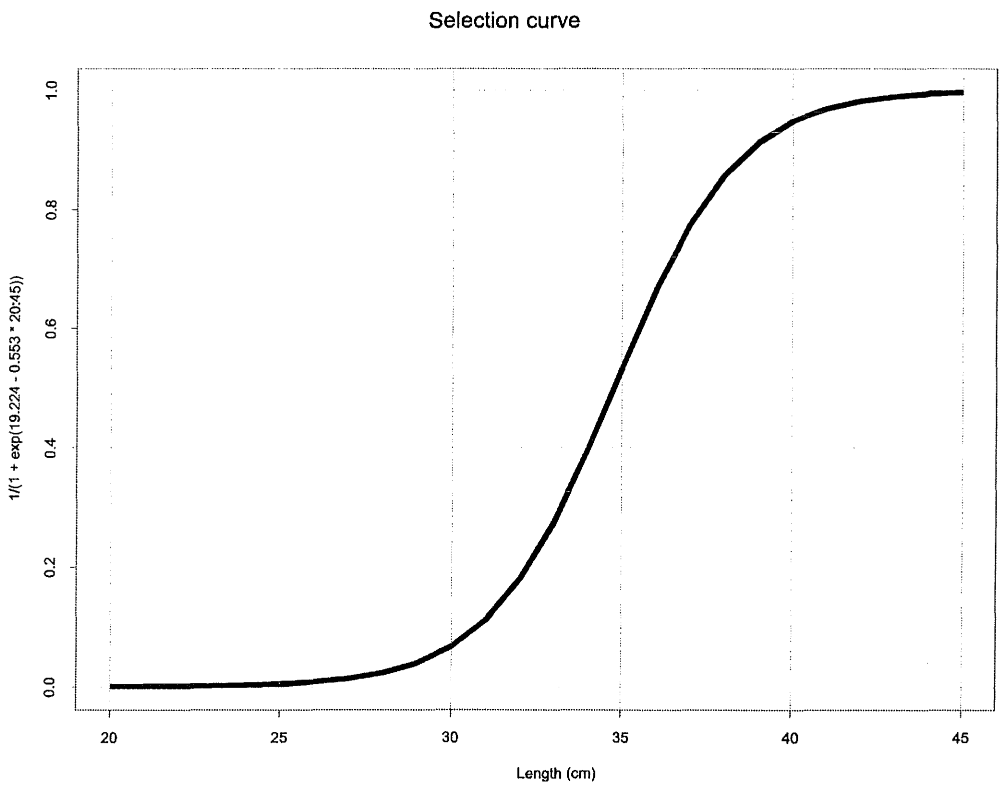


Figure 8.2.2 Selection curve for estimating the fishable stock in the groundfish survey.

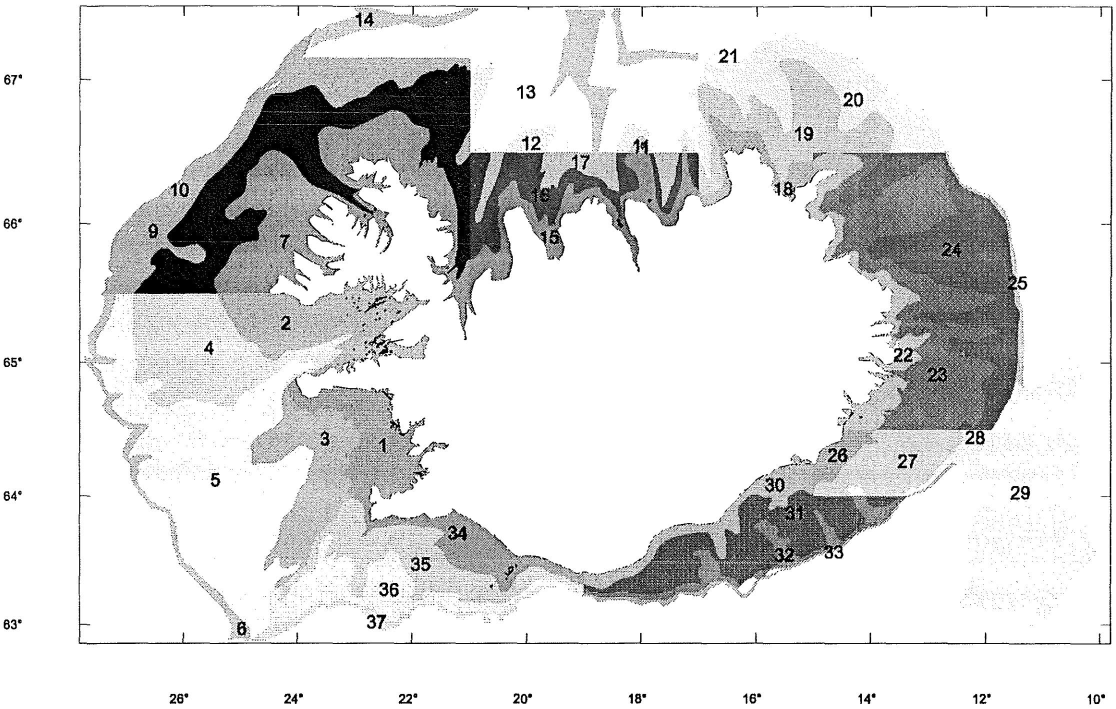


Figure 8.2.3. Stratification in the Icelandic groundfish survey

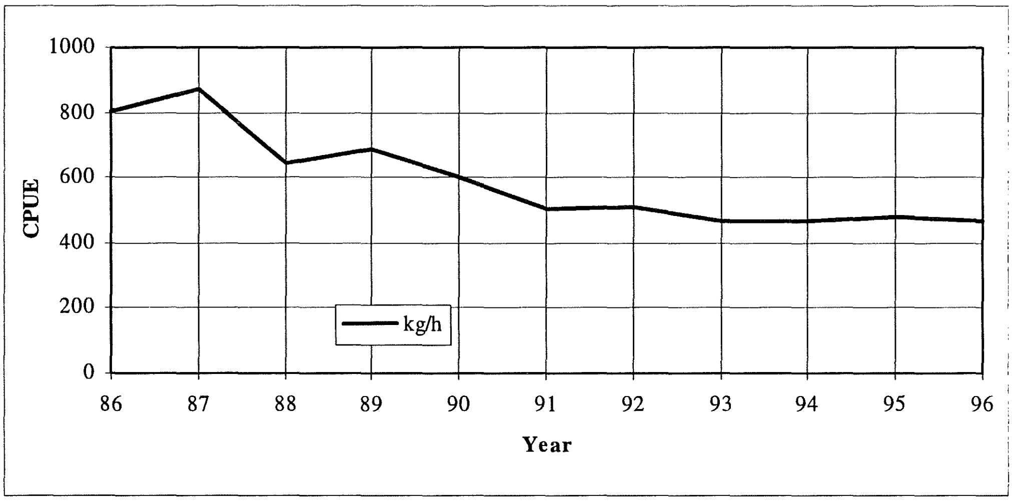


Figure 8.2.4. CPUE in *S. marinus* from Icelandic trawlers (January - December).

Figure 8.2.5. CPUE in *S. marinus* from Icelandic trawlers in January - March.

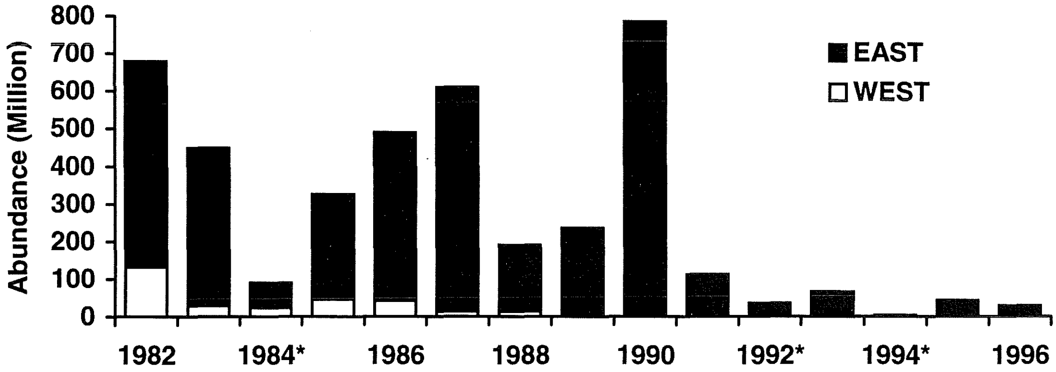


Figure 8.2.6 *S. marinus* (≥17 cm). Survey abundance indices for East and West Greenland as derived from the German groundfish survey, 1982-96. *) incomplete survey coverage.

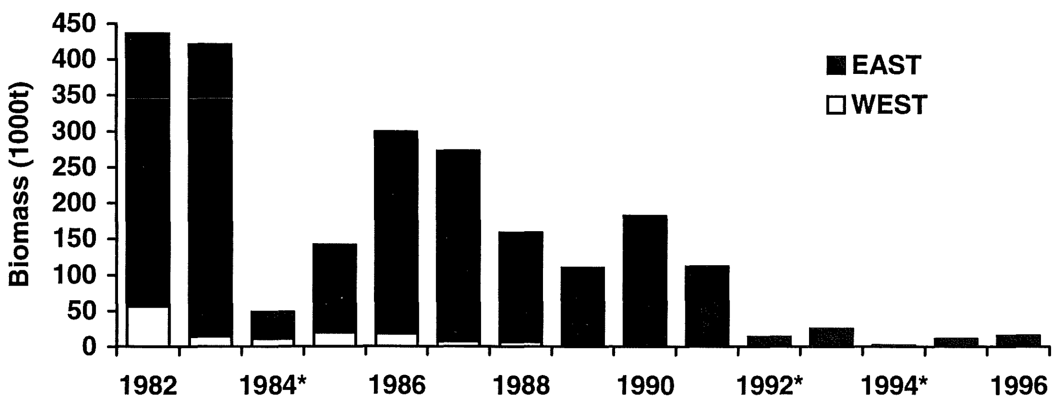


Figure 8.2.7 *S. marinus* (≥17 cm). Survey biomass indices for East and West Greenland as derived from the German groundfish survey, 1982-96. *) incomplete survey coverage.

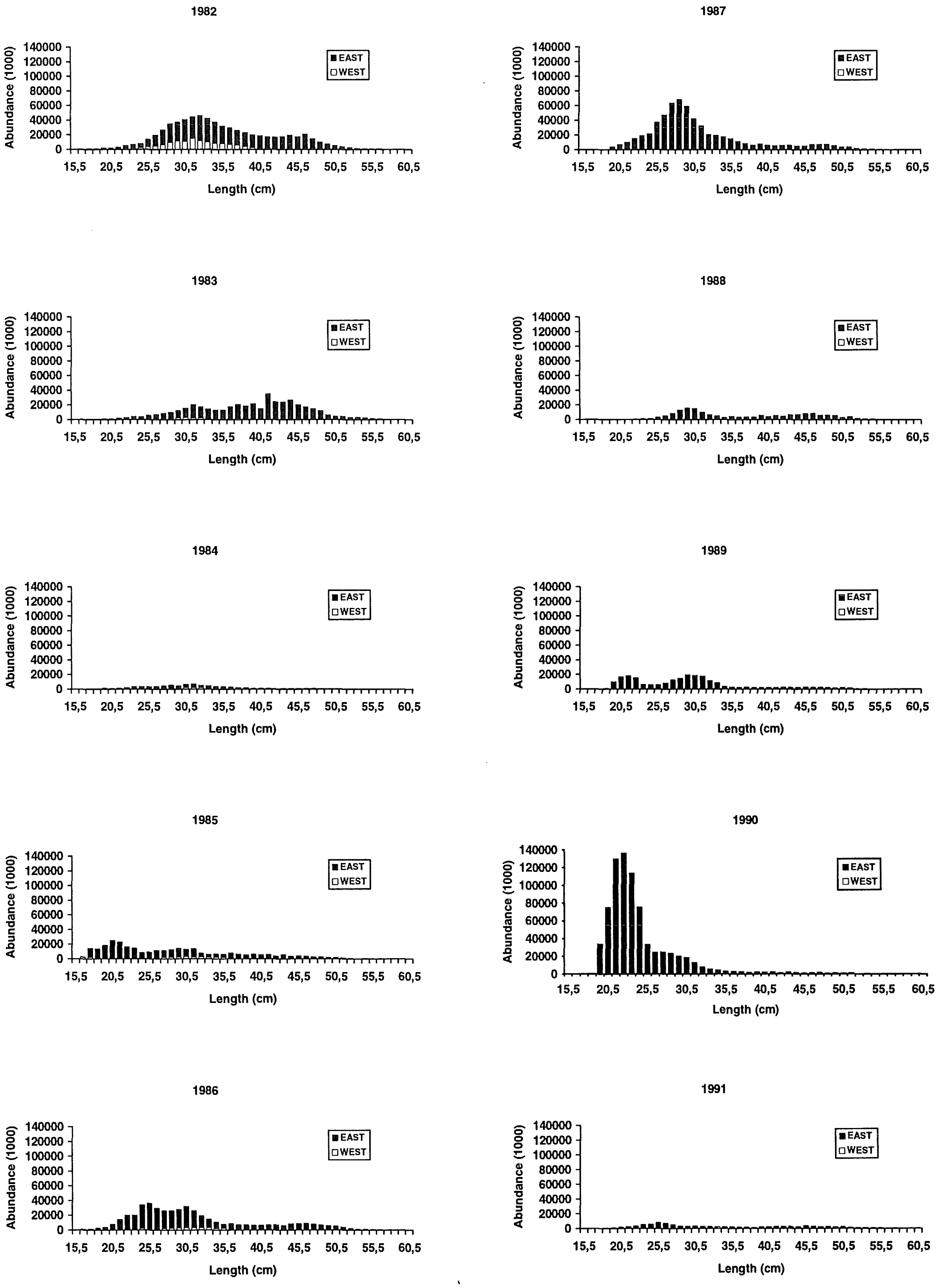
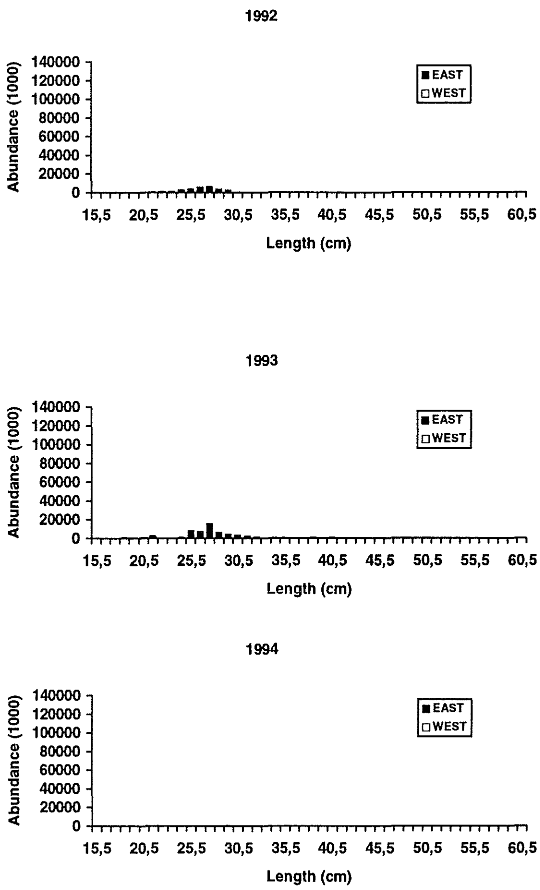


Figure 8.2.8 *S. marinus* (≥17 cm). Length frequencies for East and West Greenland as derived from the German groundfish survey, 1982-91.



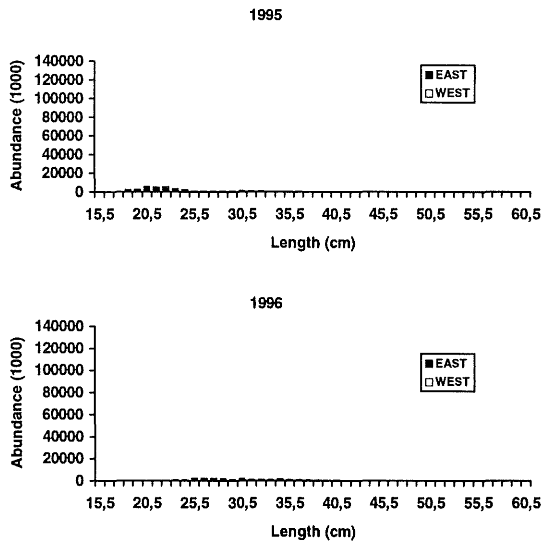


Figure 8.2.9 *S. marinus* (≥17 cm). Length frequencies for East and West Greenland as derived from the German groundfish survey, 1992-96.

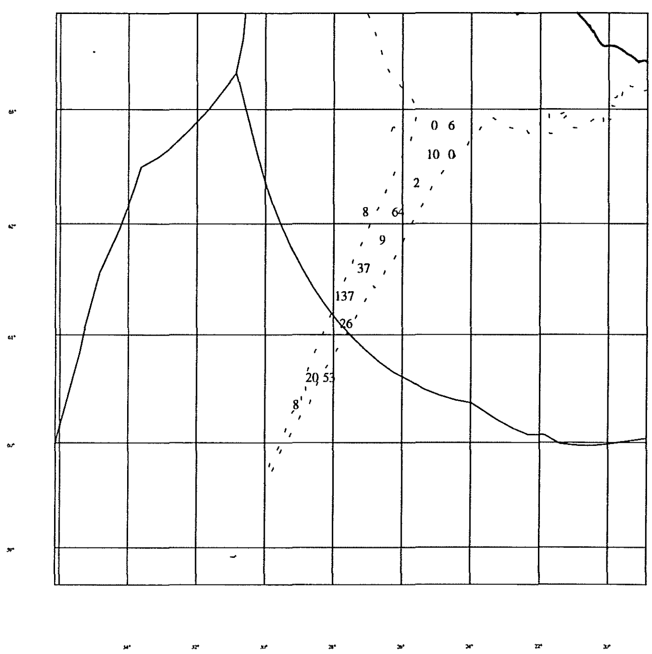


Figure 8.3.1. Longliners catches of redfish south of 63°N in 1996, as reported in Icelandic log- books.

9 DEEP-SEA *SEBASTES MENTELLA*

9.1 Landings and Trends in the Fisheries

The total annual catches of deep-sea *S. mentella* in 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 catch was 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 catches decreased to approximately 55 000 and 41 000 t respectively. In summary, the average annual catch in the period from 1991-1994 increased substantially from the average in the 1980s (42 000 t), but decreased in the last two years. In the last year, the catches were similar to the average of the 1980s (Table 9.1.1).

In Division Va, the total catch in 1996 was about 35 000 t, decreasing from the record high catches in 1994 of 59 000 t. In the 1980s the catches varied from 10 000-40 000 t, but mostly averaged of 21 000 t during that period. The catches doubled from 1990-1994 i.e. 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 only 10% of the 1994 level due to low catch rate. Length distributions from the Icelandic catches in 1989-1996 are shown in Figure 9.1.1.

About 90-95% of the total deep-sea redfish catches in area Va in 1996 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 low at almost half the 1991 catch, a reduction of almost 60% (5,300 t in 1995) (Table 9.1.1). No length distributions from Division Vb were available for 1996.

In Sub-area VI the annual catches were highest in 1980 (1 000 t), but have varied from 11 - 642 t during recent years, with the lowest catches in 1995. In 1996, the catches were assumed to be about 550 tonnes (Table 9.1.1).

In Sub-area XIV, annual catches have varied considerably. In the beginning of the 1980s, the landings were between 10 000-15 000t, but then decreased to 6 000 t in 1987-1992 and increased to 19 000 t in 1994. At that time the fleet were mainly fishing very small redfish. The catches in 1995 and in 1996 were the lowest on record, at only 900 t and 500 t, respectively (Table 9.1.1). This is due to a reduction in effort.

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. Since 1990, there has been a strong declining trend in CPUE (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 effort has been decreased, the CPUE from the Icelandic trawler fishery is still the lowest in the entire time series since 1986.

Abundance and biomass indices from 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 9.2.2 and 9.2.3. An increasing trend was evident for both abundance and biomass indices. In 1991, 1993 and 1995, when the survey area was completely covered, this species was found to be very abundant with 970 million and 1,400 million and 2,500 million individuals and 290 000, 230 000, and 375 000 t respectively. Last year's (1996) estimates revealed a continued increase by 100 % to the maximum values of the time series amounting 4,500 million and 880 000 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 9.2.4 and 9.2.5. Since 1985, juveniles (<25 cm) contributed significant portions and have dominated the stock structure since 1989. In 1991 and 1993, most of the beaked redfish were smaller than 20 cm or varied between 25-27 cm. Compared to 1995 measurements, the annual growth increment to the mean length of 24.1 cm in 1996 amounted to 2.2 cm. Further growth indications for single cohorts between successive years were hardly derivable from the length distributions, the only occurring in 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

It should be noted that in the last few years the CPUE in Division Va has decreased drastically, catches have increased and fishing effort has increased by a factor of 3 since 1989-1990.

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	Effort 10%
86	943	18898	20
87	974	19293	20
88	886	14290	16
89	974	40248	41
90	847	28429	34
91	770	47651	62
92	612	43414	71
93	547	51221	94
94	488	56720	116
95	514	48708	95
96	488	35237	72
Average 86-90	925	24232	26

In recent years, the CPUE has decreased drastically, the catches have increased while the effort increased by a factor of 3 from 1989-1994. In 1995 and 1996, catches have decreased as quotas in area Va have been reduced significantly. However, CPUEs are still at a very low level, showing the lowest value in the whole series from 1986. This may be taken as a indication that the stock in this area cannot sustain the present level of exploitation.

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

9.3 MBAL

The fishable stock seems to be at a very low level, and knowledge about recruitment is scarce. Therefore, it is difficult to define any MBAL limit for the stock.

9.4 Management Considerations

The stock seemed stable during 1989-1990 when the effort was the half of present level. There seems to be a real effort reduction in Division Va in last 2 years.

According to the German survey data, there is a large depletion of the adult stock (over 30 cm) in Sub-area XIV. The survey shows nevertheless that the quantity of deep-sea *S. mentella* between 20 and 30 cm has never been higher in the whole series since 1982. The fishery in earlier years targeting on small fish has not continued in the last two years. The working group points out that exploiting the juvenile redfish will neither lead to stock recovery nor improve catches in the future.

Regarding Division Vb the catches of deep-sea *S. mentella* have decreased in recent years although the effort has remained at approximately the same level.

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.

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	395	0	15,207	58,707
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	425	0	2,284	53,885
1990	28,429	9,330	348	0	6,097	44,204
1991	47,651	12,897	271	0	7,057	67,876
1992	43,414	12,533	134	0	6,992	63,072
1993	51,221	7,801	346	0	14,821	74,188
1994	56,720	6,899	642	0	19,305	83,566
1995	48,708	5,577	11	0	908	55,204
1996 [1]	35,237	5,307	559	0	603	41,706

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, 1982-96. 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

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, 1982-96. 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	2859	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

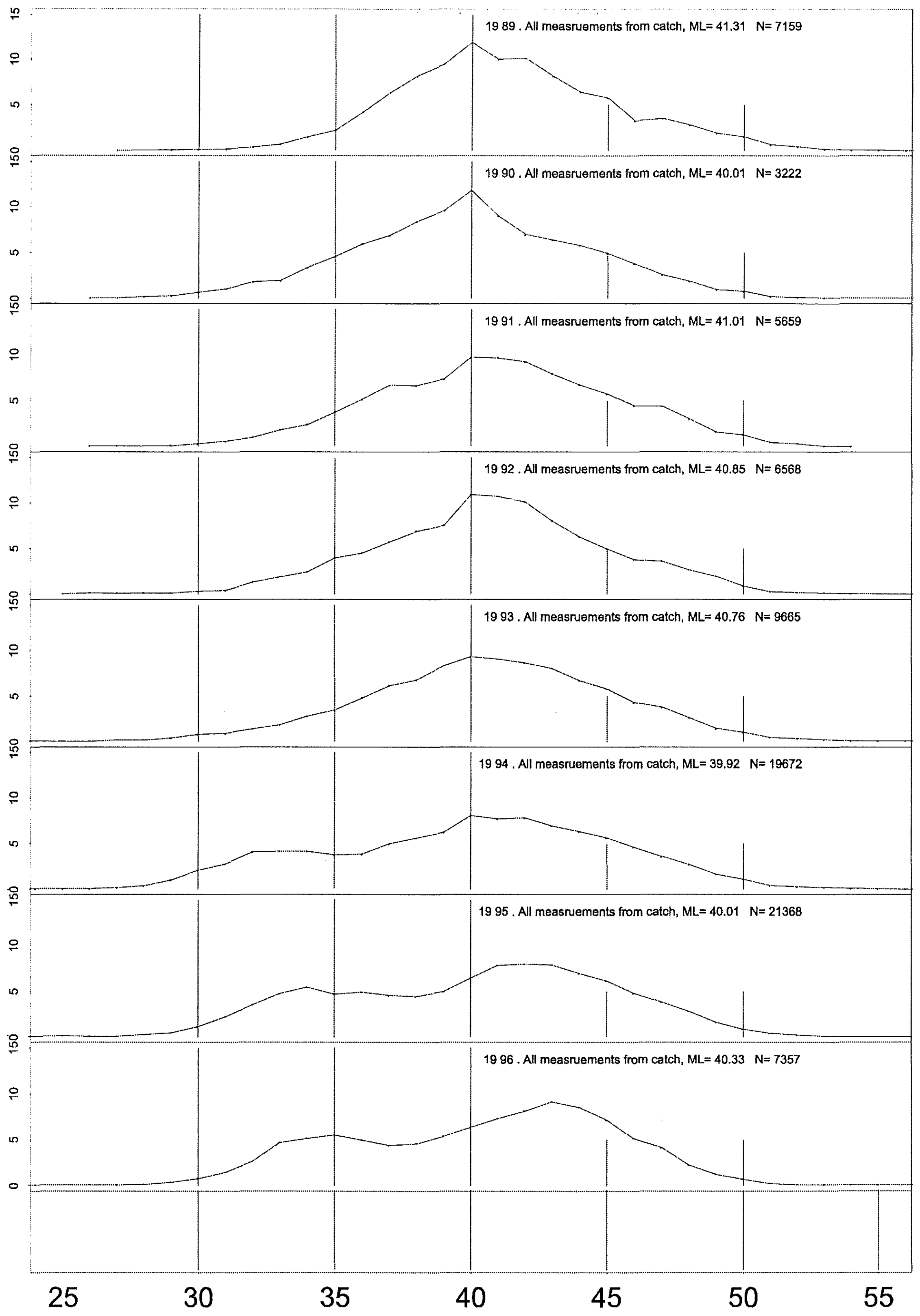


Figure 9.1.1. Length distribution of *S. mentella* from Icelandic catch.

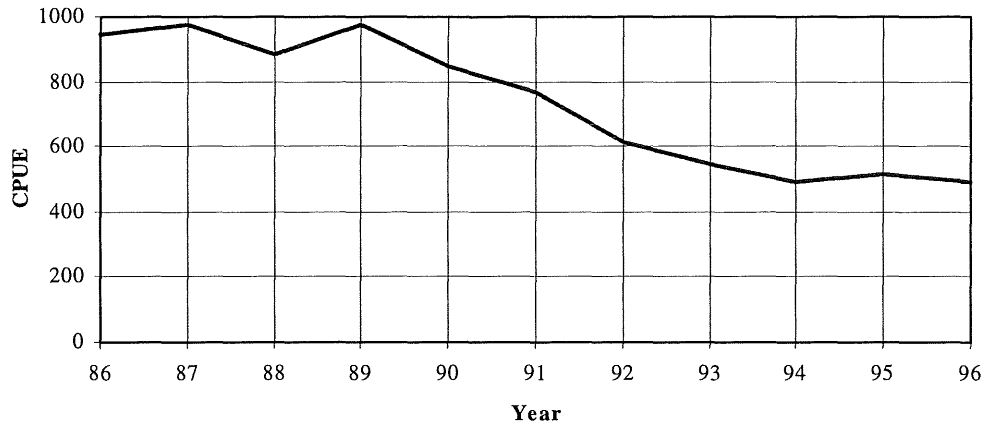


Figure 9.2.1 CPUE in *S. mentella* from Icelandic trawlers since 1986 (January - December).

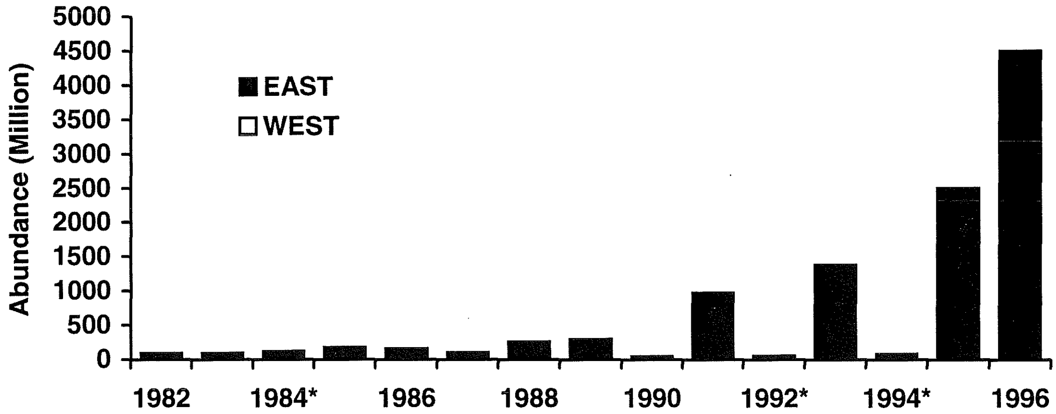


Figure 9.2.2 Deep sea *S. mentella* (≥17 cm). Survey abundance indices for East and West Greenland as derived from the German groundfish survey, 1982-96. *) incomplete survey coverage.

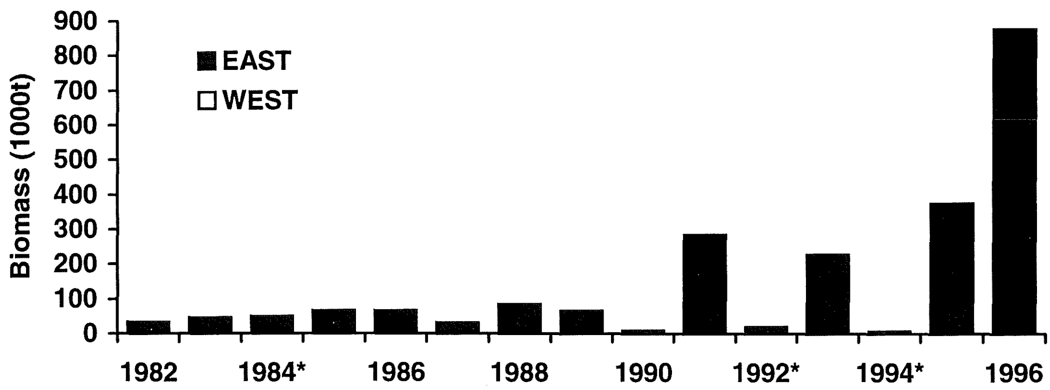


Figure 9.2.3 Deep sea *S. mentella* (≥17 cm). Survey biomass indices for East and West Greenland as derived from the German groundfish survey, 1982-96. *) incomplete survey coverage.

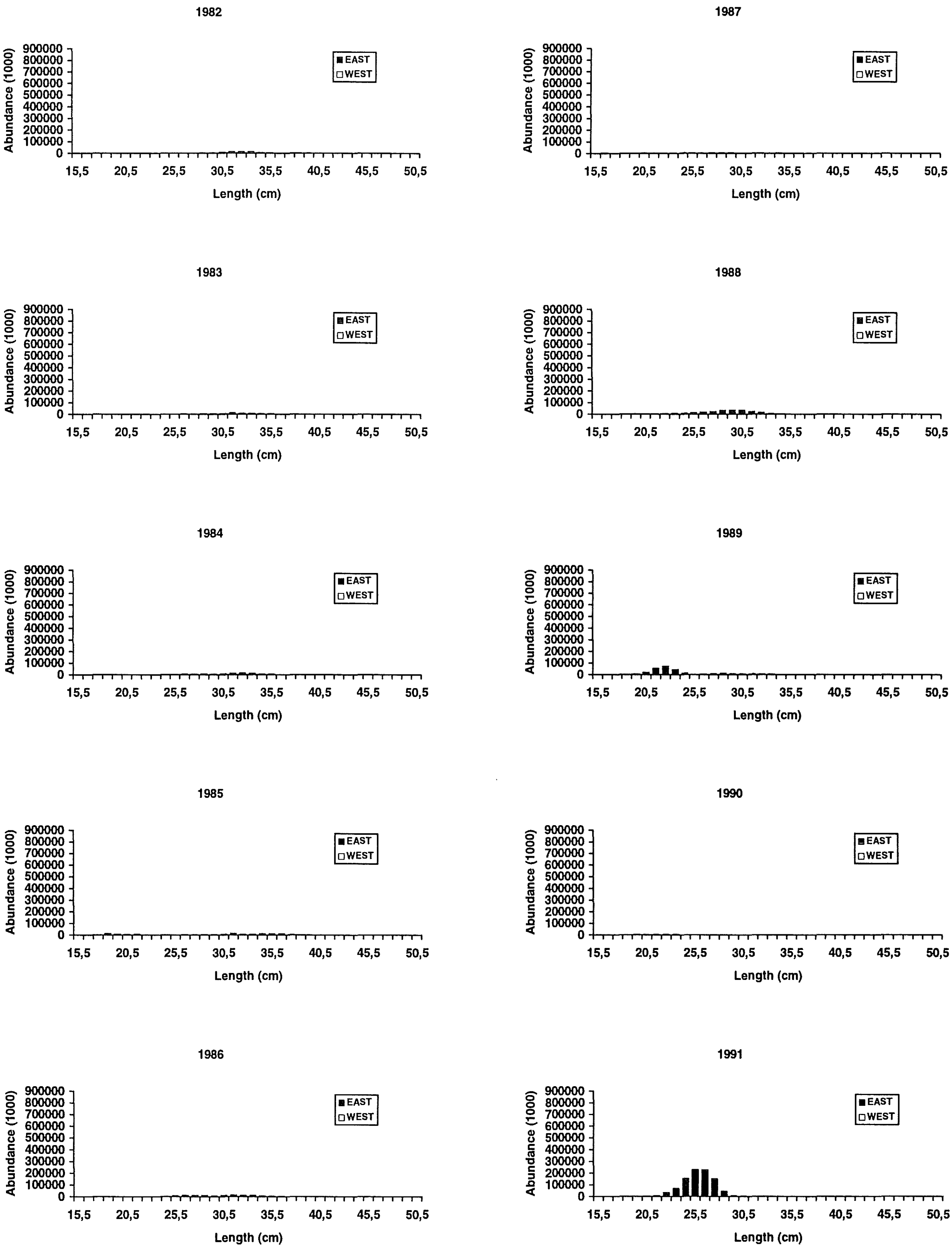


Figure 9.2.4 Deep sea *S. mentella* (≥17 cm). Length frequencies for East and West Greenland as derived from the German groundfish survey, 1982-91.

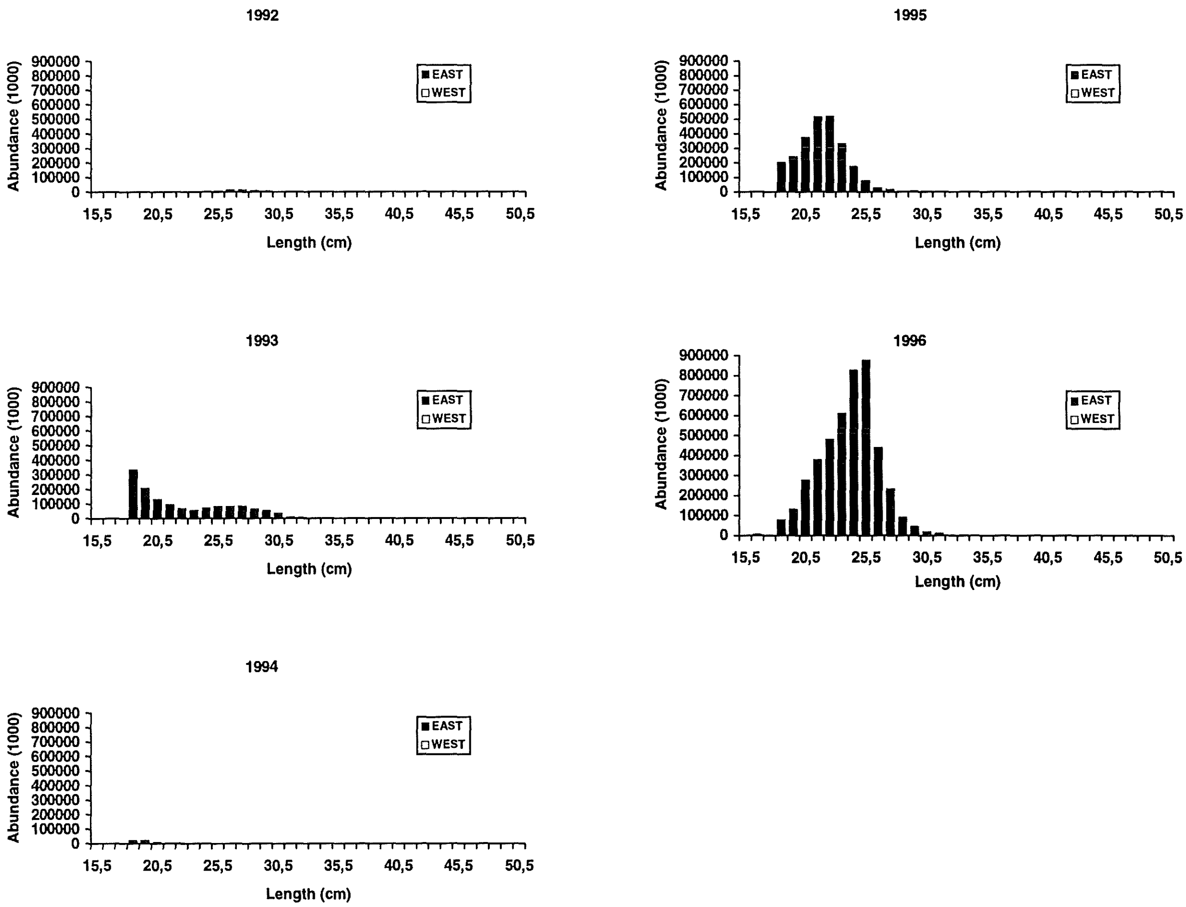


Figure 9.2.5 Deep sea *S. mentella* (≥17 cm). Length frequencies for East and West Greenland as derived from the German groundfish survey, 1992-96.

10 OCEANIC *SEBASTES MENTELLA*,

10.1 Fishery on oceanic *S. mentella*

10.1.1 Historical development of the fishery

Russian vessels 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 highest level in 1995 at 171 000 t (Tables 10.1.1-10.1.2).

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 1996, due to the implementation of the NEAFC fisheries regulations, the main fishing season occurred during the second and third quarters. Some fleets finished their fishery in November. 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 1996 at a depth range of 180 to 900 m, but mainly deeper than 600 m. Icelandic trawlers moved into the deeper layers during the fishery period 1989-1996 (Table 10.1.3 Figure 10.1.1)

10.1.2 Description of the various fleets in 1996.

Trawlers from at least 19 countries participated in the fishery in 1996. 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 table summarises the fleets fishing in the Irminger Sea in 1996:

Russia	30 factory trawlers of seven different types (ranged from 2000 hp to 4500 hp)
Iceland	32 mainly factory trawlers
Norway	3 factory trawlers
Spain	3 freezing trawlers
Germany	7 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*

Provisional catch data for 1995 was reported in 1996 to be about 123,800 t (Table 10.1.1-10.1.2), but more precise data for 1995 is considered to be about of 171,200 t because of the late reporting of some countries. In 1996, catches have been reported from 11 countries. Reportings from Bulgaria, Lithuania, Ukraine and Spain are lacking. Although the provisional catch data set by the Working Group for 1996 is 163,316 t, the Working Group recognize that the final catches in 1996 will be in the order of 190 000 t.

The landings statistics reported by Iceland and Norway account for discards, while other countries only report the quantity landed. During the NEAFC Annual Session, different discard percentages were announced (Norway - 3 %, Iceland - 16 %). The factors used for converting the weight of "Japanese-cut" fish and fillets into the round weight may cause errors in the statistics if these factors are incorrect and/or differ between countries. For converting the weight of e.g., a "Japanese-cut" fish into round weight, information available to the Working Group showed conversion factors in the range of 1.65-1.90. For converting fillet-weight (with skin and bones) into round weight, conversion factors in the range of 3.00-4.77 are being used. The Working Group strongly recommends 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 and made available for assessment purpose.

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 94,200 t and 127,500 t landed respectively. In 1996 the main part of the total catch was taken from Sub-area XIV - 129,800 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 4.862 t were landed there (Table 10.1.1). Canada reported landings of 650 t of oceanic redfish from NAFO Subarea 1F in 1996.

In Table 10.1.4 the CPUE historical series for Russian, Norwegian, Icelandic and Bulgarian fleets are given. Germany started to collect CPUE data in 1995 as well. The CPUE data is not used yet for assessment purposes because of changes in fishing depths, gears, fishing patterns during the period of observation. Table 10.1.5. shows catches, effort and CPUE by depth for the Icelandic fleet during the period 1989-1996. In Figure 10.1.2 the development of CPUE in three depth intervals is illustrated graphically.

Length distributions of oceanic *S. mentella* from German, Icelandic and Spanish landings were reported for 1996 and are given in Figure 10.1.3.

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 Germany, Iceland and Russia in June-July 1996 (ICES CM 1996/G:8, Ref.H). Approximately 250.000 square nm were covered in the traditional area of oceanic redfish distribution. The acoustic assessment yielded a stock size of about 1.6 million tonnes or 2.6 billion individuals which is considered to be an underestimation of the stock.

The main reasons for the such conclusion are as follows:

- in 1996 the temperature conditions were different from those observed during acoustic surveys in previous years. On average, the water temperature was somewhat higher than in 1994, and the 3.5°C isotherm reached to a greater depth than was observed in previous years.

- The vertical distribution of the oceanic redfish was deeper than in previous years.

- The sound scattering layer behaved differently from what was observed earlier. It was registered at least 50 m higher than expected in the central and western part of the surveyes area. It was the reason why the acoustic measurements of oceanic redfish were in general more affected by mixing with the scattering layer. (Magnusson *et al*, 1996)

10.2.2 Ichthyoplankton assessment

The traditional ichthyoplanktonic survey, conducted by Russia in 1982-1995 was not carried out in 1996. 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.

The 1996 acoustic survey, which covered a geographical area larger than ever before, estimated the fishable biomass to 1.6 million tonnes, i.e., 600 000-900 000 tonnes less than previous acoustic estimates (see text table below).

Year	*Acoustic estimate (thousand tonnes)*
1991	2235
1992	2165
1993	2556
1994	2190
1995	2481
1996	1600

Due to observed vertical changes in the hydrographical environment which may have caused a change in the behaviour of oceanic redfish itself and the disturbing scattering layer, the scientists responsible for the survey consider the acoustic estimate as an underestimate.

In three out of four fleets reporting CPUE from their commercial fishery, the CPUE has decreased in a similar manner during the last 2-3 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 more than 30%. The CPUE time series from one of the Russian fleets (accounting for 15-20% of the Russian catches) show a more stable situation. The Working Group realizes, however, that the fishery has moved gradually to deeper waters catching slightly bigger, less parasite infested and more valuable fish although the catch rates here may be lower. Nevertheless, CPUEs from the Icelandic fleet, which have reported by depth, show a CPUE decrease in most of the depths deeper than 600 meters.

Trial runs were made using an age-based production model (EXCEL spreadsheet format), similar to the approach used in the last five annual assessments (ICES 1993/Assess:18). It was, however, the opinion of the Working Group that it was difficult to rely on the prognosis from the stock production model due to the following:

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.

The model treats the acoustic estimate as an absolute measure of the fishable stock, and gives therefore a prognosis of the stock and catches in absolute amounts relative to this acoustic estimate, which may be an underestimate. However, if the acoustic estimate could be used as an index of the biomass in the entire water column, the Working Group would feel more confident in using the model. This would also have impact on the recruitment which is estimated to be constant and related to the acoustic estimated stock level.

10.3 Management considerations

Due to a lack of knowledge about a redfish type resembling deep-sea *S.mentella* caught pelagically in the Irminger Sea, it is the opinion of the Working Group that until such knowledge is available, and for practical purposes, we should continue to manage all pelagic redfish in the Irminger Sea as one stock unit, hitherto grouped as oceanic *S.mentella*, and separated from the adult continental shelf stock.

The Working Group found it difficult to rely on the stock production model, and the acoustic surveys do not cover the entire water column where the fishery occurs. However, the main strategy when setting the catch-levels for the oceanic *S. mentella* stock in the future should be to obtain sustainable yields.

Although the 1996 survey may be an underestimate, the Working Group is concerned that this lower survey estimate may indicate that we are already fishing beyond sustainable catch levels. Lower CPUEs may also support this concern. Nevertheless, due to lack of data the Working Group was unable to calculate sustainable catch levels.

10.4 Special comments

Even if the age-based production model was not used for assessment purposes for this stock it revealed some stock dynamics which are quite different from other groundfish stocks. The strong decline observed even though the fishing mortality is quite low is something one should be aware of when evaluating the fishing mortalities, which although they are low compared to other fish stocks, may have reached a critical level for a long-lived species such as redfish.

Due to the low acoustic estimate from the 1996 survey and signs of a decrease in the commercial CPUEs, the Working Group suggests the need for an international acoustic survey within the next years.

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 this 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.

The ichthyoplankton surveys do provide some information about the spawning stock. Although it is not possible to identify to which redfish type the larvae belong, it should be further investigated to see if surveys can provide a larval index useful to management.

It is recommended that the Study Group on Redfish Stocks be reestablished to discuss, plan and coordinate future redfish research.

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	7,868	17,088	24,956
1992	1,968	0	0	23,219	40,775	65,962
1993	2,603	0	0	70,988	39,639	113,230
1994	15,472	0	0	94,223	39,028	148,723
1995	1,543	0	0	127,452	42,172	171,168
1996 [1]	4862	0	0	21,926	136,528	163,316

1) Provisional data.

Table 10.1.2 Oceanic S. mentella. Landings (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		0	115	0	571	0	8,783					6,198	0		9,289				24,956
1992	628		1,810	3,765	2	6,447	9	15,478		780	6,656		14,654	0		15,733				65,962
1993	3,163		6,365	7,121	0	17,498	8	22,908		6,803	7,899		14,518	0		24,165		2,782		113,230
1994	3,600		17,875	2,896	606	17,152	0	53,332		13,205	7,404		7,391	0	1,887	17,814		5,561		148,723
1995	3,800	602 [4]	16,854	5,239	226	18,985	156	34,631	1,148	5,003	22,893	13	6,571	0	5,125	42,182	4,555	3,185		171,168
1996 [1]		650 [4]	7,092	6,239		21,288		64,570	415	1,084			6,363		2,379	45,748	7,229		260	163,316

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

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Table 10.1.3. Oceanic *S. mentella* landings (in tonnes) in 1996 by countries splitted on depth (Working Group figures and/or as reported to NEAFC).

	Total	not splitted	shallower than 600 m	deeper than 600 m
Canada	650		30	620
Estonia	7092		724	6368
Faroes	6240	6240		
Germany	21288	21288		
Iceland	64570		9750	54820
Japan	415		74	341
Latvia	1084			1084
Norway	6456		3053	3403
Portugal	2379	2379		
Russia	45748	45748		
Spain	7200	7200		
UK	260	260		
	163382	83115	13631	66636

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)
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]	-	1.45	1.75	1.75	1.30

1 Preliminary

2 1987-1990 reported as GDR (FVSIV)

Table 10.1.5 CPUE, Oceanic *s. mentella* trawling hours and catch from different depth intervals from the Icelandic fleet.

CPUE

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

Sum of Hours

Depth	89	90	91	92	93	94	95	96
100-199	299.67	843.60	1564.33	847.25		9.17		16.00
200-299	152.17	352.17	1009.42	1446.58		314.75	2019.47	924.57
300-399	99.33	332.83	738.17	1208.35	428.17	269.00	656.17	78.13
400-499	4.50	13.33	370.92	228.00	480.33	290.67	346.58	392.08
500-599			97.33	765.08	1109.67	2864.92	1432.02	2669.22
600-699				403.17	1107.00	5087.25	4252.63	7289.33
700-799				36.00	40.50	829.08	2992.88	10745.90
800-899						76.42	25.00	806.92
900+							45.50	317.92

Sum of Catch(tonnes)

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

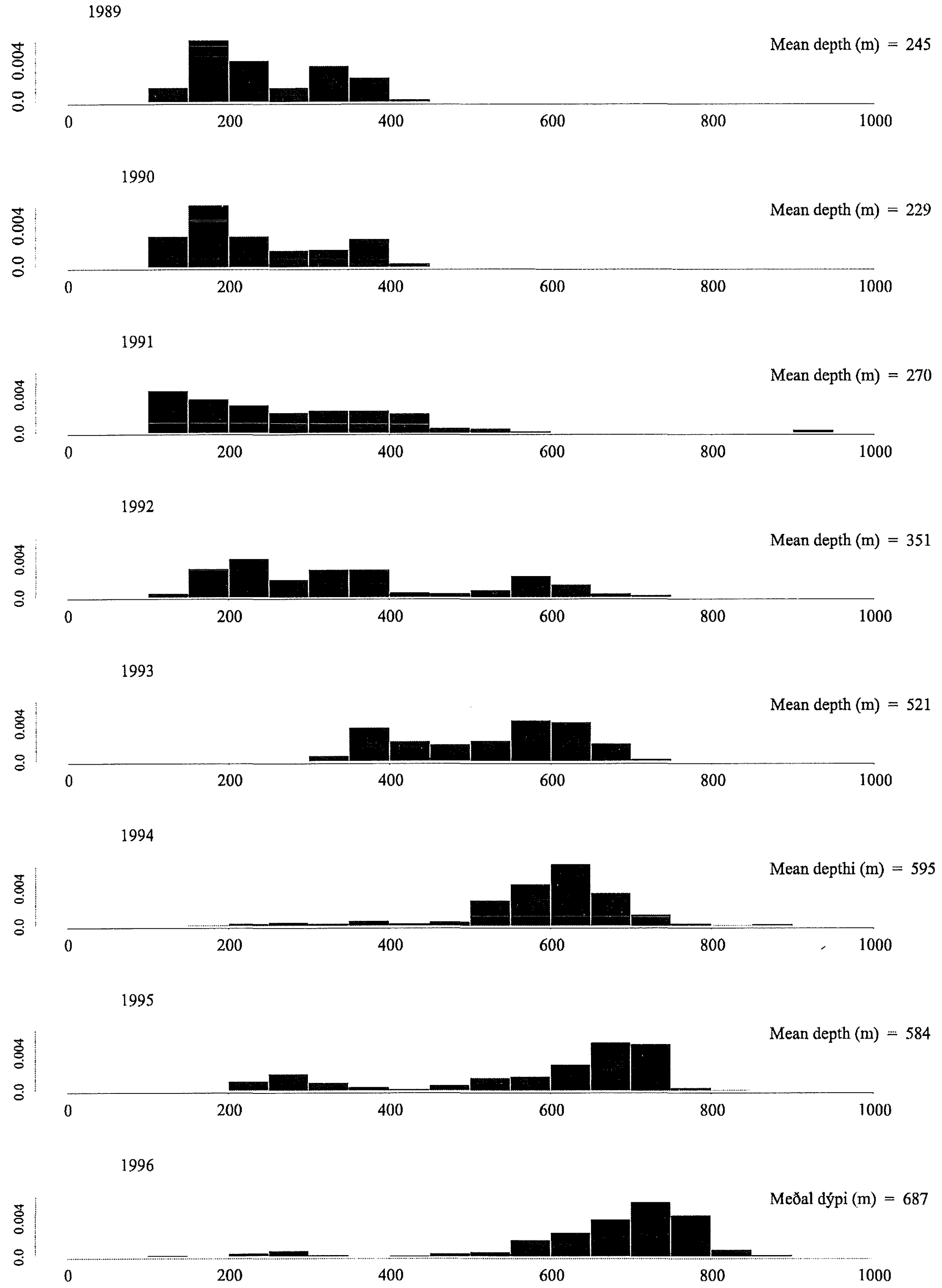

Figure 10.1.1.. Depth distribution of trawl hauls in the Irminger Sea in 1995 and 1996 from trawler log-books. Indicated depth as depth of the headline of the trawl.

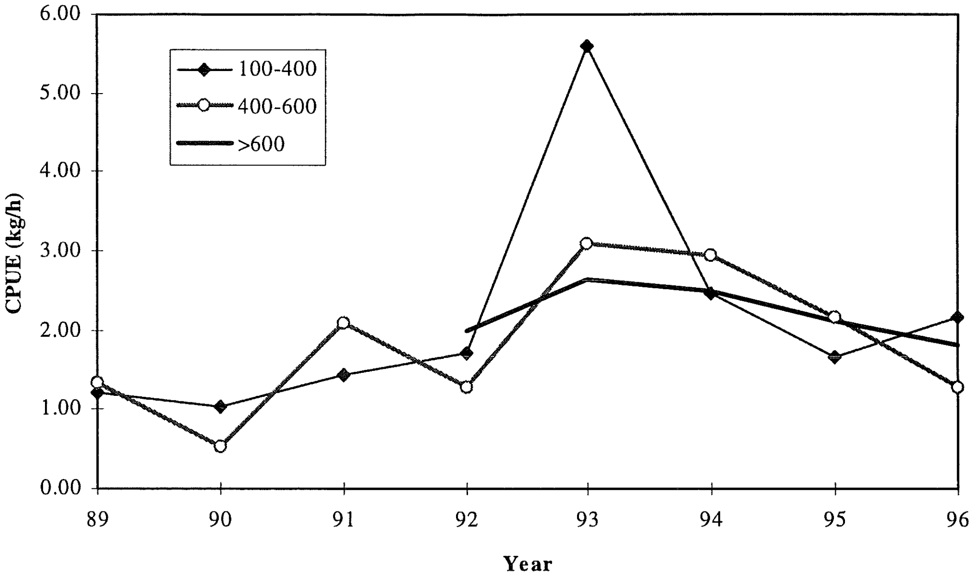

Figure 10.1.2 Catch per unit effort in the oceanic *S. mentella* from the Icelandic fleet for different depth intervals.

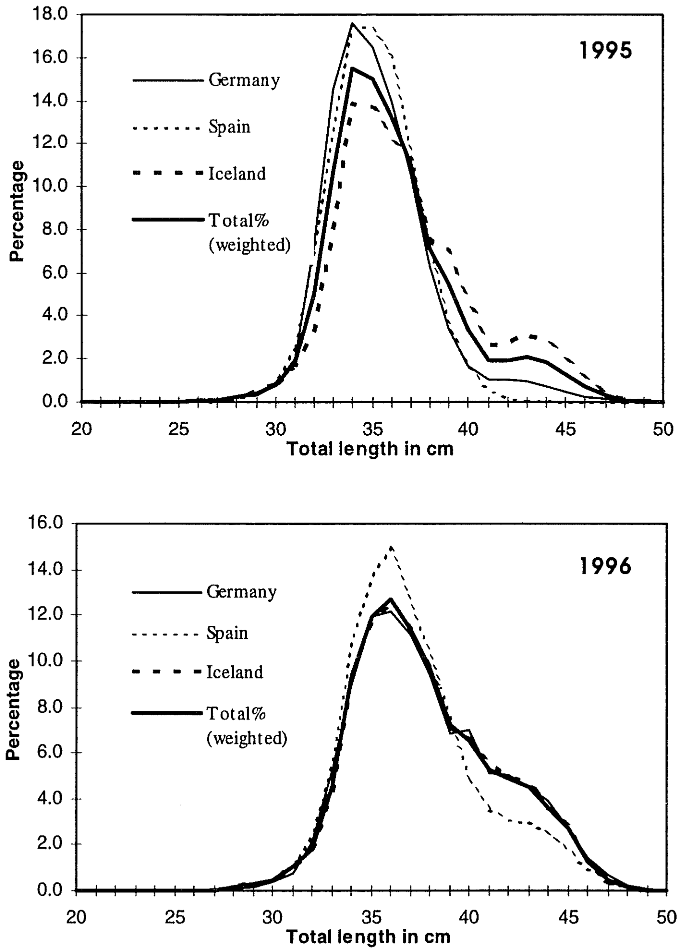

Figure 10.1.3. Length distributions from landings of oceanic *S.mentella* in 1995 and 1996.

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ANNEX 1

NORTH-WESTERN WORKING GROUP

ICES, Headquarters, 29 April - 7 May 1997

LIST OF PARTICIPANTS

NAME	ADDRESS	TELEPHONE	FAX	E-MAIL
Jákup Reinert (Chairman)	Fiskirannsóknarstovan Nóatún P.O. Box 3051 FR-110 Tórshavn Faroe Islands	+298 15092	+298 18264	jakup.reinert@ frs.fo
Jesper Boje	Greenland Institute of Natural Resources c/o Greenland Home Rule Pilestræde 52, P.O. Box 2151 DK-1016 Copenhagen K, Denmark	+45 33 13 42 24	+45 33 13 42 50	grfijbo@inet.u ni-c.dk
J. Scott Campbell	Department of Fisheries & Oceans Northwest Atlantic Fisheries Centre P.O. Box 5667 St. John's New foundland A1C 5X1 Canada	+1 709 772 2995	+1 709 772 6100	campbell @ athena. nwafc.nf.ca
Jens Jacob Engelstoft	Greenland Institute of Natural Resources P.O. Box 570 3900 Nuuk Greenland	+299 2 1095	+299 2 5957	Jen@centadm. natur. gr.gl
Agnes C. Gundersen	Møre Research Section of Fisheries P.O. Box 5075 6021 Aalesund Norway	+47 7011 1350	+47 701 38978	Agnes.Gunder sen @ als.moreforsk. no
Einar Hjörleifsson	Marine Research Institute Skúlagata 4 121 Reykjavik Iceland	+354 55 20240	+354 56 23790	einarhj@hafro. is
Jean-Jacques Maguire	1450 Godefroy Sillery Québec Canada G1T 2E4	+1 418 688 5501	+1 418 688 7924	jj_maguire@ compuserve.co m
Kjell H. Nedreaas	Institute of Marine Research P.O. Box 1870, Nordnes 5024 Bergen Norway	+47 55 238 500	+47 55 238 687	kjelln@imr.no
Árni Nicolajsen	Fiskirannsóknarstovan Nóatún P.O. Box 3051 100 Tórshavn Faroe Islands	+298 45092	+298 18264	arni.nicolajsen @frs.fo
H.J. Rätz	Institut für Seefischerei Aussenstelle Bremerhaven Am Fischkai 35 27572 Bremerhaven Germany	+49 471 73473	+49 471 73127	

NAME	ADDRESS	TELEPHONE	FAX	E-MAIL
Regin Reinert	Nansen Center Edvard Greigsvej 3a Bergen Norway			regin.reinert@n rsc.no http://www.nrs c. no:8001/~regin
Sigfús A. Schopka	Marine Research Institute Skúlagata 4 121 Reykjavik Iceland	+354 55 20240	+354 56 23790	sas@hafro.is
Torsteinn Sigurdsson	Marine Research Institute Skúlagata 4 121 Reykjavik Iceland	+354 55 20240	+354 56 23790	steini@hafro.is
Vladimir N. Shibanov	Knipovich Polar Research Institute of Marine Fisheries & Oceanography (PINRO) 6 Knipovich Street 183763 Murmansk Russia	+7 8152 573 461	+47 789 10518	inter@pinro. murmansk.ru
Bjørn Steinarsson	Marine Research Institute Skúlagata 4 121 Reykjavik Iceland	+354 55 20240	+354 56 23790	bjorn@hafro.is
Fran Saborido-Rey	Institute of Marine Research Eduardo Cabello 6 36208 Vigo Spain	+34 86 23 1930	+34 86 29 2762	fran@iim.csic.e s
Peter Steingrund	Fiskirannsóknarstovan Nóatún P.O. Box 3051 100 Tóshavn Faroe Islands	+298 15092		peturs.frs.fo
G. Stefánsson	Marine Research Institute P.O. Box 1390 Skulagata 4 121 Reykjavik Iceland	+354 1 20240	+354 1 623790	gunnar@hafro.i s
Rúni N. Vilhelm	Fiskirannsóknarstovan Nóatún P.O. Box 3051 100 Tórshavn Faroe Islands	+298 15092	+298 18264	runinord@frs.f o