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Status of Subarea 1 Cod and the Fisheries

An Extract of the Report of the ICES Working Group on Cod Stocks off East Greenland, Copenhagen, 22-28 February 1989.

Compiled and with footnote added by

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1 PARTICIPANTS

The Working Group on Cod Stocks off East Greenland met in Copenhagen from 22-28 February 1989, with the following participants:

H.P. Cornus	Fed. Rep. of Germany
H. Hovgård (Chairman)	Greenland
Sv.Aa. Horsted	Greenland
H. Lassen	Greenland
J. Messtorff	Fed. Rep. of Germany
K. Nygård	Greenland
F.F. Riget	Greenland
S.A. Schopka (until 26 February)	Iceland

2 TERMS OF REFERENCE

At the 1988 Statutory Meeting, it was decided (C.Res.1988/2:4:2) that the Working Group on Cod Stocks off East Greenland should meet at ICES Headquarters from 22-28 February 1989 to:

i) analyze the results of the latest groundfish survey;

ii) assess the status of and provide catch options for 1989 within safe biological limits for East Greenland cod.

Due to the interrelationship between the West Greenland and East Greenland cod stocks, it is necessary to use data derived from the assessment of the West Greenland cod stock in order to make a proper assessment of the East Greenland cod stock. In Section 3, the interrelationships of these two cod stocks are discussed, and it is obvious that there are sound scientific reasons for carrying out the two assessments simultaneously and presenting them in one report. There are also practical reasons for this.

The assessments in the two areas are based on data from a groundfish survey which is designed in almost the same way for both areas, and the scientists involved are the same.

Management advice on the two areas is given by two different international organizations. In the case of West Greenland, the Scientific Council of NAFO scrutinizes the assessment and formulates the advice; in the case of East Greenland, the ACFM of ICES handles the advice.

In 1988, the West Greenland assessment was not carried fully through (see Section 6.10), but fisheries and research data are given. The West Greenland part of the report will be presented by participants of the meeting as a working document to the NAFO Scientific Council for its further discussion and for assessment, catch projections, and management advice.

3 THE COD STOCK COMPLEX IN GREENLAND AND ICELANDIC WATERS

It has been known for several decades that there is an interrelationship between the cod stocks at West and East Greenland and at Iceland (Figure 3.1). Tagging experiments carried out at Greenland and Iceland show that a part of the mature cod at West Greenland migrates to East Greenland and some of them further to Iceland. Results of tagging experiments carried out in East Greenland waters also show that mature cod and sometimes immature cod from that area migrate to Iceland. At Iceland, tagging experiments show that migration of cod from Icelandic to Greenland waters hardly occurs and, therefore, the migrations from Greenland waters to Iceland can be regarded as one-way migration.

The magnitude of emigration from West Greenland to East Greenland and Iceland also seems to vary from year to year and between year classes. Up to 1984, the Working Group used an emigration coefficient of E = 0.05 for the West Greenland stock as a whole, which was based on results from tagging experiments carried out mainly in the period 1945-1970. Information from the groundfish surveys from 1982-1988 indicates that the emigration varies considerably from year to year and between year classes.

Also at East Greenland, the emigration to Iceland varies from year to year. From Danish tagging experiments, the North-Western Working Group concluded (Anon., 1971) that about 45% of the mature cod from East Greenland migrate to Iceland. However, the North-Western Working Group considered the East Greenland stock and the cod in NAFO Divisions 1E-F at West Greenland as being combined and estimated the coefficient of emigration as 0.29, which corresponds to an emigration of 25% per year.

It is also well known that larvae drift with currents from East to West Greenland and from Iceland via East Greenland waters to the banks off West Greenland.

The magnitude of this larval drift seems to vary much from year to year. In some years, the drift seems negligible, while in other years, as in 1973 and 1984, considerable numbers of cod larvae seem to have drifted from Iceland to East Greenland and to the southern part of West Greenland (Table 3.1).

4 ENVIRONMENTAL CONDITIONS IN 1988

In 1988, the air temperatures over the West Greenland area were below normal from April to October and in December with negative anomalies experienced in May-June of more than 2.0^{0}C below normal.

The surface layer temperatures were below normal throughout the year with about 0.5^{0}C. Surface layer salinities were slightly above normal during the first half of the year, while they were markedly below during the second half.

At medium depths west of the banks, there were clear signs of a great inflow of East Greenland polar water during spring and early summer.

From September to November, the water column below 200 m showed temperature and salinity values indicating the strongest inflow of warm, high salinity Irminger water experienced in recent years.

5 SURVEYS AND RESEARCH

5.1 The Federal Republic of Germany Groundfish Survey Design

The parameters of the standard bottom trawl used in all surveys remained the same as given in previous reports of the Working Group.

The true catchability coefficient is unknown. For the calculation of survey estimates, it was, however, taken as 1.0. Therefore, the results are expressed in terms of "trawlable biomass or abundance" and refer to the part of the offshore population available to the gear at the time of the survey.

The survey areas off East Greenland (ICES Division XIVb) and off West Greenland (NAFO Subarea 1) are shown in Figure 5.1.

The survey areas are composed of statistical rectangles (30' lat. x 1^0 long.), as used throughout the ICES area, which form the basis of the stratification schemes. However, according to area-specific reasons, the construction of strata is different in the two survey areas.

The stratification scheme of the West Greenland survey area as well as the procedures for random selection of fishing stations remained the same as given in previous reports of the Working Group. Strata areas (nm^2) are given in Table 5.1.1.

Groundfish surveys conducted in Division XIVb by the Federal Republic of Germany from 1980-1986 have been fairly consistent in terms of area covered, method of selection of fishing stations, and analysis. In 1980-1982, and in 1987, a 4-depth zone stratification was used.

For the time period 1983-1986, stratification was done by previously observed density distribution. In 1988, stratification was adjusted to that used off West Greenland (i.e., by regional areas and depth zones, Table 5.1.2).

5.2 Japanese Groundfish Survey

In 1988, a groundfish survey was carried out by the Japanese research trawler "Shinkai Maru" in a joint programme between the Japanese Marine Resources Research Centre (JAMARC) and the Greenland Home Rule Trawling Company (GHT).

The survey covered both East and West Greenland waters. The West Greenland survey was carried out in September and October covering the areas between 73^0 and $62^0$30'N latitude. Only in the northern part of the area were hauls made at depths lesser than 400 m. A total of 109 valid hauls was made. The survey showed that only very few cod were found below 400 m and in the northern part of the area covered.

In East Greenland, the areas between $65^0$30' and $63^0$30'N latitude was covered in July. The area was divided into four depth zones. A total of 34 valid hauls was made. The estimated abundance accounted for only 48% of the abundance found by the Federal Republic of Germany survey in the same area. However, the Japanese survey had a low coverage of high density areas. Therefore, the Working Group decided to base the assessment of East Greenland cod stocks on the survey results of the Federal Republic of Germany only.

5.3 Greenland Survey and Research

5.3.1 Shrimp survey

In 1988, a shrimp survey was carried out by the Greenland trawler "Elias Kleist". The purpose of the survey was to get an abundance estimate of the shrimp stocks, but all by-catches were recorded. The survey was carried out in July covering areas between $72^0$30' and $63^0$52.5'N latitude. The shrimp survey showed that only a few cod were found in the offshore area outside the survey area of the Federal Republic of Germany.

5.3.2 West Greenland longline survey

In October-November 1988, Greenland conducted a longline survey off West Greenland. The results were discussed in a working paper

presented at the meeting (Lehmann and Nygaard, 1989). The survey was carried out in inshore and offshore areas of NAFO Divisions 1C, 1D, and 1E, with the purpose of describing the relative distribution and abundance of cod inside and outside the area covered by the concurrent Federal Republic of Germany trawl survey.

Within the survey area, which included fjords, coast, and banks (offshore), fishing was conducted using a random stratification method of fishing site selection. Strata were selected within the depth range 0-300 m at 100-m depth intervals. There were some time restrictions which influenced the randomization of stations in that they had to be fished on a daily basis and be permitted sufficient fishing time on the bottom. This restricted the distance between stations covered the same day.

The offshore area was defined as the area outside the 3-mile limit, i.e., the same area as covered by the Federal Republic of Germany trawl survey. The coastal area was defined as being between the 3-mile limit and straight lines drawn across the entrance of the fjords. The area inside these lines was defined as fjords. The areas are given in Anon. (1988; Table 5.3.1.1).

The low catchability of small cod by the longline fishery causes problems when interpreting results, and small and large cod were treated separately to avoid bias. The division of the two groups was at age 4, as this separates the outstanding 1984 year class from the older cod.

Mean density (catch per 100 hooks) is given by all strata in Tables 5.3.2.1 and 5.3.2.2 for small and large cod, respectively.

5.3.3 West Greenland young cod survey

During July 1988, Greenland carried out a survey on young cod in three inshore areas of West Greenland: Qaqortoq (Division 1F), Nuuk (Division 1D), and Sisimiut (Division 1B). The results of the survey were presented in a working document at the meeting (Nygaard et al., 1989).

Links of gillnets containing separate sections with five different mesh sizes (16-33 mm, bar length) arranged in random order were used. With these mesh sizes, fish between 15 and 35 cm are efficiently caught, whereas the catchability of larger and smaller fish is substantially lower.

A total of 189 net settings was made. Nets were set at depths ranging from 2-35 m, and the mean catch rate (number caught per hour) for each age group was used as an index of abundance.

During the survey, a total of 1,979 cod was caught. Catches were dominated by 4- and 3-year-old cod, i.e., the 1984 and 1985 year classes. The 1984 year class was caught mainly in the northern area, whereas the 1985 year class was more evenly distributed. Age 2 cod (1986 year class) were caught in some numbers in Division 1B, whereas catches were lower in Division 1D and very low in Division 1F. Only one 1-year-old cod was taken in the survey.

In 1985 and 1986, only three mesh sizes were used, and for comparison, indices using the catch from both three and five mesh sizes were computed, as shown in the text table below:

		Indices of year-class strength	
	Survey	Age 1	Age 2
Three mesh sizes (16, 24, and 33 mm)	1985	0.74	+
	1986	0.09	1.61
	1987	+	0.36
	1988	+	0.09
Five mesh sizes (16, 18, 24, 28, and 33 mm)	1987	+	0.93
	1988	+	0.25

As 1-year-old cod (13-20 cm) are caught efficiently by this method (Hansen and Lehmann, 1986), the present results indicate a very low abundance of the 1987 year class at West Greenland.

The 1986 year class is estimated to be around 25% of the 1985 year class.

6 STOCK AT WEST GREENLAND (NAFO SUBAREA 1)

6.1 Trends in Catch and Effort

The fishery for cod in NAFO Subarea 1 is partly an offshore fishery carried out mainly by large trawlers, and partly a coastal and fjord fishery, usually dominated by pound net.

The nominal catch in 1988 was 61,618 t (provisional figures) (Tables 6.1.1 - 6.1.5), which is more than three times greater than the 1987 landings.

Greenland vessels landed 51,237 t or 83% of the total; the remainder was taken by the Federal Republic of Germany, UK, and Japan (only 2 t).

In 1987, a new statistics programme was introduced for vessels below 80 GRT. This programme supplied statistics of the landings by division, gear, and month. In 1988, this programme covered 80% of the landings from those vessels. The remaining landings were given by division and month only. The breakdown by gear given in Table 6.1.2 refers to the total reported landings of small vessels raised according to the data from the detailed, new programme.

Trawl catches constituted 66% of the total catch, whereas pound nets accounted for 21%, and longlines, handlines, and gillnets for less than 5% each.

The trawlers operated throughout the year and mainly in Divisions 1D and 1E. The overall catch per unit effort (Table 6.1.6) for the Greenlandic trawlers nearly doubled compared to 1987.

Pound nets were mainly used in the summer period (May-August) and mainly in Divisions 1B, 1D, 1E, and 1F. Longlines were used throughout the year with highest catches in May-July, whereas catches from handlines and gillnets were taken mainly from May-November. This fishery took place in all of the Divisions 1B-F.

6.2 Catch in Numbers at Age and Catch Composition

The catch statistics from the fisheries by Greenland now supply information on the gears used. The breakdown of catches by gears allows improved accuracy when converting catch by weight into catch by number. Further, more biological samples were taken in 1988 than in 1987.

The trawl fishery was well sampled in the first half of the year, while catches from the last two quarters were raised according to samples from December 1988 and January 1989. Pound nets and handlines were well sampled, whereas gillnets and longliners were covered by few samples only.

Trawl catches in the first quarter from Division 1F were dominated by age groups 4 (60%), 7, and 9, whereas in Divisions 1D and 1E, catches were almost exclusively age 4 (95%). For the last two quarters, age group 4 dominated in all divisions (80-90%), but in Divisions 1C, 1D, and 1F, age group 3 was also caught in some amounts.

Longline catches were dominated by the 1984 year class, the remaining part being older cod.

Pound net and handline catches were heavily dominated by the 1984 year class (more than 90% by number). There seems to have been a high rate of discard of fish below the Greenland minimum landing size (40 cm), mainly fish of the 1985 year class.

The 1984 year class seems to have accounted for about 90% (by number) of the nominal catch in 1988 (Tables 6.2.1 and 6.2.2). In terms of catch by weight, the year class accounted for about 86% of the landings.

Among the older year classes, only the 1979 year class is of some importance in the total catch (4% by weight).

6.3 Mean Weight at Age in the Catches

The mean weights at age of cod in the major fisheries in 1988 are listed in Table 6.3. For each gear, the mean weights were calculated by weighting the observed mean weights at age by the numbers in each age group in the catch represented by the individual

samples. Mean weight of the total was likewise calculated by weighting by the numbers caught in each gear and age group.

Mean weights in landings were highest for those from longlines and gillnets and lowest for those from German trawl and pound nets.

The mean weights found in 1988 are generally below those of last year, except for the 4-year-olds which are alike.

6.4 Maturity Ogive

Data on maturity by age were available from the commercial fishery of the Federal Republic of Germany in the first quarter of 1988. These data were smoothed by a sigmoid curve and given in the text table below:

Age	% mature
3	2
4	8
5	23
6	52
7	79
8	93
9	98
10+	99

6.5 Groundfish Survey Results

The number of randomly distributed fishing stations occupied during the surveys from 1982-1988 amounted to:

Year	1982	1983	1984	1985	1986	1987	1988
Total	111	153	162	133	155	150	176
Valid sets	98	142	158	114	142	140	162

Cod biomass and abundance estimates for the total survey area off West Greenland of 19,864 nm^2 in 1982 and 1983 and of 20,133 nm^2 after inclusion of stratum 4 since 1984 amounted to:

Year	Tonnes	Number ('000)	$\bar{w}$ kg
1982	189,934 ± 37.0%	109,039 ± 36.1%	1.65
1983	98,843 ± 28.5%	59,362 ± 26.5%	1.67
1984	24,945 ± 39.7%	16,104 ± 39.1%	1.55
1985	31,860 ± 60.1%	52,466 ± 33.3%	0.61
1986	76,220 ± 30.8%	134,716 ± 31.8%	0.57
1987	464,286 ± 47.0%	582,868 ± 42.6%	0.80
1988	547,566 ± 42.1%	563,601 ± 42.3%	0.97

The confidence intervals are given at the 95% level of significance.

The surveys were carried out in November-December in 1982, 1983, and 1985 and in October-November in 1984 and 1986-1988. The R/V "Walther Herwig" was used each year except in 1984 when, for technical reasons, she had to be replaced by R/V "Anton Dohrn". However, experience from a 13-year time series of bottom trawl surveys in Division 2J (Labrador) has confirmed that the fishing power of both vessels did not differ significantly provided that equal standard survey gears as well as towing speeds were used.

From 1982-1984, the survey results reveal a drastic decline in cod biomass and abundance which was observed not only for the whole survey area (Figure 6.5.1), but for all divisions, as shown in detail in Table 6.5.1 (See Footnote this page)

The total survey biomass and abundance, however, increased considerably since 1984 and very steeply in 1987 due to increasing recruitment, mainly of the outstanding 1984 year class.

Footnote added June 7, 1989 for NAFO presentation:
At the time of the meeting of the Working Group not all otoliths sampled during the survey were read. All otoiths are now read, and the 1988 age distribution is slightly revised. The difference from former figures is margarinal only (Messtorff, pers. comm.). Table 6.5.1 will be revised in next report of the Working Group.

The survey results of 1988 reveal a further increase in biomass of age 4 and younger cod by 122,000 t, but a decrease in age 5+ cod by 39,000 t. The resulting increase in total biomass of 83,000 t is less steep than in the previous year.

The recruitment mainly of the 1985 year class and younger cod caused an increase in abundance by 57 million fish in 1988. However, the number of 1984 year-class cod, as well as the 1983 and older year classes, decreased by 53 (10%) and 23 (74%) million fish, respectively. Although the resulting decrease in total abundance amounted to only 19 million cod, the proportional reduction in older fish from 31 million in 1987 to only 8 million in 1988 was extremely high and led to the lowest estimate of spawning stock level observed since 1982.

The regional distribution of cod biomass and abundance was low for Divisions 1B+C but very high for Division 1D.

The changes in length frequency distributions and age compositions of the West Greenland cod stock over the survey period from 1984-1988 are illustrated in Figure 6.5.2.

6.6 The Inshore Stock in Proportion to the Offshore Stock

In 1987, Greenland conducted a longline survey in inshore and offshore areas of Divisions 1C-E at the same time as the trawl survey of the Federal Republic of Germany took place off West Greenland.

The results of the longline survey were used to estimate that proportion of the total stock which occupies inshore areas not covered by the trawl survey. For 1987, it was found that the offshore cod biomass and abundance, as estimated from the trawl survey, accounted for only about 75% of the total stock size. Consequently, the trawl survey estimates for 1987 were raised by factors calculated for each division to correct for the stock proportions outside the trawlable areas. The raising factors are given in last year's report (Anon., 1988; Table 6.5.3), and the raised total abundance is given in Table 6.5.2 of last year's report.

In 1988, Greenland again carried out a longline survey in Divisions 1C-E at the same time as the Federal Republic of Germany conducted its trawl survey. The longline survey is described in Section 5.3.2 and the results are listed in Tables 5.3.2.1 and 5.3.2.2.

Trying to use the 1987 method on these results, the Working Group found that, for Divisions 1D-E, the stock outside the trawl survey area was of almost the same proportion as found last year. However, for Division 1C, the method of calculating a raising factor for 1988 seems to lead to quite unreasonable results.

The offshore longline survey effort in Division 1C is 10 sets, altogether 3,300 hooks, which gave a total catch of only 3 cod. Also, the trawl survey showed very low abundance in this area.

The inshore longline CPUE in Division 1C compared to that of Division 1D is quite high. Using the Division 1D comparison between the trawl survey and the longline survey would lead to about 200 million cod in the inshore areas of Division 1C. This result is not considered valid because the longline survey probably hit a high local concentration of cod close to Sukkertoppen.

During a period at the beginning of the trawl survey, high concentrations of cod were found off Sukkertoppen. Several trawlers operated here. However, when the research vessel covered this area only a few days later, no commercial fishing took place and cod density was very low (waste from the former fishery was caught during the survey (J. Messtorff, verbal information).

6.7 Distribution Pattern of the Stock

All evidence points to the fact that the commercially fishable stock (i.e., the 1984 and older year classes and to some extent the 1985 year class) is found offshore at West Greenland from the very southernmost part of Division 1C and southwards, including Division 1E. Further, it occurs at East Greenland south of 63°N although much less abundant than at West Greenland. The inshore distribution at West Greenland, however, seems to cover not only the same latitudes as the offshore distribution, but also the in-

shore area of Division 1C and Division 1B, at least its southern part (Holsteinsborg/Sisimiut), as evidenced by commercial catches (Table 6.1.2).

6.8 Future Recruitment

1985 year class

The 1988 trawl survey showed an abundance of the 1985 year class of 93 million fish. This corresponds to 18% of the survey abundance found for the 1984 year class when this age group was 3 years old. Although this is slightly below last year's estimate, the survey confirmed that the year class is above the average for the later years.

1986 year class

From the inshore young cod survey as well as from the trawl survey, the size of the 1986 year class can be estimated to be low, in the size range of 1-5% of the 1984 year class. However, in both surveys, this year class showed up in highest densities in the northernmost areas, and some proportion of this year class is probably not covered by the surveys. Nevertheless, the 1986 year class must be expected to be small.

1987 year class

The 1987 year class showed up in only small densities in both the young cod survey and the trawl survey, and it must, therefore, be considered small.

1988 year class

No 0-group cod were found in the Icelandic 0-group survey off East Greenland in August 1988 indicating that the larval inflow from Iceland must have been negligible. In the trawl survey off West Greenland, there were also no recordings of 0-group cod, and the year class must, therefore, be expected to be small.

6.9 Estimating the Size of the 1984 Year Class by Comparing the Catch Rates of 1988 With Those of 1977

The following section is based on a paper by Hovgård and Riget (1989).

The West Greenland cod is strongly dominated by the 1984 year class. The trawl survey estimate of that year class using a catchability coefficient of 1.0 is approximately 800 million at age 3. The NAFO Scientific Council (Anon., 1988) has analyzed the available data and concluded that the best available estimate is 500 million cod at age 3, thus implying a catchability coefficient of a little less than 2.

In 1988, the stock situation closely resembled that in 1977 with a strong year class (1984 and 1973, respectively) recruiting after years of very poor recruitment. These two year classes are the largest seen at West Greenland since the mid 1960s and both dominated the fisheries at age 4.

The Greenland Home Rule trawlers had a directed cod fishery in the first half of 1977 with a mean CPUE of 1.21 tons per hour. In the first half of 1988, the same trawlers had a mean CPUE of 2.30, i.e., 90% higher than that of 1977. There has been a change in the trawls used in the two periods. The trawls used in 1988 are estimated to be 10-20% more efficient than those in 1977. Also, there are differences in fishing sites between the two periods.

Assuming an emigration coefficient of 0.30 from age 6 and onwards and M = 0.2, the 1973 year class at age 3 was calculated to be 232 million applying VPA.

Using the CPUE ratio estimated above (1.9), the size of the 1984 year class is found to be 441 million, which compares well with the 500 million adopted by NAFO.

6.10 Conclusions

The Working Group noted that, for the assessment of the East Greenland cod in 1989, the estimate of the size of the stock at West Greenland was of minor importance since spawning migration is thought to occur only for the relatively few fish of age 6 and older, and individuals of the 1984 year class are, therefore, not likely to contribute much to spawning migration in 1989.

The Working Group, therefore, decided not to conduct a further assessment of the West Greenland stock component, but to leave that to the NAFO Scientific Council in June 1989 and to consider the migration from West to East Greenland as negligible in 1989. The Working Group is, however, aware of the great importance for the East Greenland assessment of estimates of the West Greenland stock and its spawning stock component and likely emigration from 1990.

8 REFERENCES

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Table 3.1 Abundance indices of 0-group cod from the international and Icelandic 0-group survey in the East Greenland/Iceland area, 1971-1988 (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	1,191
1974	2	-	-	22	30	+	54
1975	+	-	2	50	73	5	130
1976	5	9	30	102	2,015	584	2,743
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	1,772
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

Table 5.1.1 Strata areas in square nautical miles off West Greenland (NAFO Subarea 1).

Depth zone (meters)	Division/stratum number							Total (nm^2)
	1B	1C	1C	1C/D	1D	1E	1F[1]	
	1	2	3	4	5	6	7	
0-100	865	593	598	0	1,475	276	+	3,807+
101-200	1,256	1,574	1,902	17	875	1,662	+	7,268+
0-200	2,121	2,167	2,500	17	2,350	1,938	2,568	13,661
201-300	297	259	708	29	628	464	+	2,385+
301-400	209	54	280	45	390	278	+	1,256+
201-400	506	313	988	74	1,018	742	971	4,612
401-500	149	122	156	60	176	33	+	696+
501-600	215	293	78	118	83	24	+	811+
401-600	364	415	234	178	259	57	353	1,860
Total	2,991	2,895	3,722	269	3,627	2,737	3,892	20,133

[1] Strata areas only available by 200-m depth zones.

Table 5.1.2 Strata areas in square nautical miles off East Greenland (ICES Division XIVb).

Stratum	Substrata = depth zones (m)				
	0-200	201-400	401-600	601-800	Total
1	25	3,073	998	345	4,441
2	322	5,160	1,826	334	7,642
3	1,562	2,495	1,011	226	5,294
Total	1,909	10,728	3,835	905	17,377

Table 5.3.2.1 NAFO Subarea 1 cod. Mean catch per unit of effort (100 hooks) for small cod (ages 3-4). Number of valid sets in brackets.

Division		0-100 m	100-200 m	200-300 m
1C	Bank	0.29 (4)	0.00 (5)	0.00 (1)
	Coast	8.81 (10)	4.19 (7)	2.83 (3)
	Fjord	1.35 (3)	1.64 (3)	0.18 (2)
1D	Bank	6.60 (7)	7.50 (8)	2.30 (4)
	Coast	3.79 (10)	2.29 (12)	0.47 (2)
	Fjord	0.14 (2)	0.04 (4)	0.14 (2)
1E	Bank	21.57 (1)	- (0)	0.00 (2)
	Coast	0.00 (1)	0.00 (2)	0.06 (1)
	Fjord	2.60 (1)	0.00 (1)	- (0)

Table 5.3.2.2 NAFO Subarea 1. Cod. Mean catch per unit of effort (100 hooks) for large cod (age 5+). Number of valid sets in brackets.

Division		0-100 m	100-200 m	200-300 m
1C	Bank	0.00 (4)	0.00 (5)	0.00 (1)
	Coast	0.56 (10)	0.16 (7)	0.10 (3)
	Fjord	0.19 (3)	0.05 (3)	0.00 (2)
1D	Bank	3.15 (7)	3.43 (8)	1.03 (4)
	Coast	3.20 (10)	0.94 (12)	0.14 (2)
	Fjord	0.00 (2)	0.09 (4)	0.00 (2)
1E	Bank	1.80 (1)	- (0)	0.00 (2)
	Coast	0.30 (1)	0.00 (2)	0.81 (1)
	Fjord	0.93 (1)	0.00 (1)	- (0)

Table 6.1.1 Nominal catches of cod in NAFO Subarea 1 (1979-1988).

Country	1979	1980	1981	1982	1983
Faroe Islands	38	-	-	-	1,339
Fed. Rep. of Germany	1,344	1,024	417	8,139	10,158
France - M	139	-	-	-	-
Greenland	46,384	45,838	53,039	47,693	44,970
Japan	-	-	-	-	-
Norway	-	-	-	-	-
United Kingdom	-	-	-	-	1,174
Total	47,905[1]	46,862[1]	53,456[1]	55,832[1]	57,641
Working Group estimate	99,000	54,000	-	-	-

Country	1984	1985	1986[4]	1987[4]	1988[4]
Faroe Islands	-	-	-	-	-
Fed. Rep. of Germany	8,941	2,170	37	68	6,352
France - M	-	-	-	-	-
Greenland	22,041	12,319	6,546	18,477	51,237
Japan	13	-	-	9	2
Norway	5	-	-	-	-
United Kingdom	-	-	-	-	1,027
Total	31,000[2]	14,544[3]	6,583	18,554	58,618
Working Group estimate	-	-	-	-	61,618

[1] ICNAF/NAFO Statistical Bulletin.
[2] NAFO SCS Doc. 85/22.
[3] NAFO SCS Doc. 86/22.
[4] Provisional data.

Table 6.1.2 NAFO Subarea 1 Cod. Nominal catch by division and gear in 1988 (Working Group estimate) (provisional figures in tonnes).

Division	Pound net	Longlines	Handlines	Gillnet	Otter trawl	Total
1A	2	-	-	-	-	2
1B	3,869	393	1,036	790	214	6,302
1C	706	145	199	129	2,336	3,515
1D	2,159	562	453	245	17,134	20,555
1E	3,455	780	832	297	13,330	18,694
1F	2,626	81	603	493	6,173	9,976
1NK	-	-	-	-	2,574	2,574
Total	12,817	1,963	3,123	1,954	41,761	61,618

Table 6.1.3 NAFO Subarea 1 Cod. Nominal catches 1988 (Working Group estimate) (provisional figures in tonnes) per month and division.

Month	1A	1B	1C	1D	1E	1F	1NK	Total
Jan	-	56	1	280	826	4,050	-	5,213
Feb	-	13	-	18	1,092	240	-	1,363
Mar	-	13	-	12	984	466	-	1,475
Apr	-	15	-	2,455	841	840	-	4,151
May	-	255	79	3,423	1,466	853	-	6,076
Jun	-	1,782	524	1,608	2,943	858	-	7,715
Jul	-	2,282	286	2,420	1,450	901	-	7,339
Aug	-	464	144	995	1,296	923	-	3,822
Sep	-	418	83	1,540	1,132	232	365	3,770
Oct	-	311	2,324	1,256	182	179	-	4,252
Nov	-	466	59	3,586	2,459	171	2,207	8,948
Dec	-	227	16	2,962	4,026	260	-	7,491
NK	2	-	-	-	-	-	-	2
Total	2	6,302	3,515	20,555	18,697	9,973	2,572	61,618

Table 6.1.4 NAFO Subarea 1 Cod. Nominal catches 1988 (Working Group estimate) (provisional figures in tonnes) by gear per month.

Month	Pound net	Longlines	Handlines	Gillnet	Otter trawl	Total
Jan	-	197	8	19	4,956	5,180
Feb	-	103	13	14	1,352	1,482
Mar	-	159	11	11	1,412	1,593
Apr	-	138	78	45	3,691	3,952
May	2,103	270	171	299	3,251	6,094
Jun	3,989	281	268	276	2,883	7,697
Jul	4,175	404	447	299	2,013	7,338
Aug	1,847	131	975	129	740	3,822
Sep	591	61	587	50	2,481	3,770
Oct	110	63	274	192	3,613	4,252
Nov	-	88	217	468	8,172	8,945
Dec	-	68	74	152	7,197	7,491
NK	2	-	-	-	-	2
Total	12,817	1,963	3,123	1,954	41,761	61,618

Table 6.1.5 Nominal catches of NAFO Subarea 1 cod for 1977-1988 ('000 t).

Category	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Trawlers	46[3]	53[3]	57[3]	16	14	29	42	18	7	1[4]	6[4]	42[6]
Other	27	20	42	38	39	26	16	12	8	4[4]	13[4]	20[4]
Total	73[3]	73[3]	99[3]	54[3]	53	55	58	30	15	5[4]	19[4]	62[6]
TAC	31[2]	-[1]	-[1]	20[1]	50[1]	62	62	68	28.5	12.5[5]	12.5	53

[1] Catches limited to Greenlander's fishery and to by-catches.
[2] Quota for offshore fishery only.
[3] Estimates used for stock assessments.
[4] Provisional data.
[5] Direct trawling prohibited. Ban on pound net fishing (with some exemptions) from mid-July.
[6] Provisional data. Estimates used for stock assessments.

Table 6.1.6 NAFO Subarea 1 cod. Effort (hours fished) and catch per unit effort (CPUE = kg/hour) for Greenland trawlers (500-999 GRT class) in 1975-1988. Only figures for directed cod fishing are used.

Year	1B		1C		1D		1E		1F		Total	
	Hours	CPUE	Hours	CPUE	Hours	CPUE	Hours	CPUE	Hours	CPUE	Hours	CPUE
1975	1,132	57	6,666	1,467	4,896	293	3,154	422	243	346	16,091	789
1976	236	38	5,071	594	5,912	541	6,319	753	-	-	17,538	626
1977	-	-	2,432	1,019	1,531	986	3,446	1,584	121	2,421	7,530	1,293
1978	-	-	3,562	3,314	815	2,962	873	3,743	70	3,029	5,320	3,327
1979	-	-	2,983	2,155	1,163	3,083	365	1,948	9	2,667	4,520	2,378
1980	727	2,461	1,513	1,088	1,983	892	1,092	1,277	31	613	5,346	1,238
1981	-	-	1,279	3,326	1,856	2,533	952	4,602	5	-	4,092	3,259
1982	100	1,330	1,937	2,077	4,084	1,760	3,221	2,903	17	647	9,359	2,212
1983	927	315	593	948	4,039	984	6,295	1,808	114	982	11,968	1,364
1984	51	20	19	+	1,926	1,004	2,248	1,055	317	584	4,561	985
1985	10	-	-	-	378	370	2,050	760	113	982	2,551	709
1986[1]	-	-	-	-	-	-	-	-	-	-	-	-
1987	4	1,549	1	5,794	457	1,704	11	804	-	-	473	1,690
1988[2]	-	-	564	2,185	4,679	2,765	1,634	3,149	337	4,398	7,212	2,883

[1] No directed trawl fishery for cod allowed in 1986.
[2] Provisional data.

Table 6.2.1 COD OFF WEST GREENLAND - CATEGORY: TOTAL.

CATCH IN NUMBERS UNIT: thousands

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
3	1530	1727	3764	662	49	272	51	131	343	275	10760	634
4	7872	15091	7976	12399	2768	2519	10039	2302	1079	3595	4026	46649
5	62130	30457	36670	8709	10342	10172	9786	16378	2384	2677	2243	6053
6	26941	61848	29824	27433	6465	9283	12020	3065	6938	1803	1216	1515
7	5915	24562	34591	14664	13985	5237	4081	2605	1135	5855	302	618
8	4955	2700	10005	12411	4365	9158	2550	1406	1806	1388	1594	425
9	6912	1996	1725	4784	2810	2077	2660	1203	800	619	139	446
10	1289	5237	833	513	1280	1841	624	552	194	291	148	168
11	283	352	2348	237	149	953	954	165	177	84	53	79
12	130	93	187	704	85	78	709	237	152	38	27	88
13	981	166	37	41	201	51	130	93	272	9	17	22
14	139	453	42	62	27	134	57	37	147	12	14	1
15+	247	85	303	8	41	56	122	44	11	10	26	1
TOTAL	119324	144767	128305	82627	42567	41831	43783	28218	15438	16656	20565	56699

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
3	287	286	2999	12	1204	77	595	456	12	8626	832
4	5494	10656	4513	16864	1210	12356	2018	1266	113	2474	49766
5	30039	12505	4580	6374	17960	2011	10384	1303	706	415	1060
6	1004	18970	1978	2391	2965	17228	688	4915	318	1001	497
7	509	709	8014	1053	2078	1581	3656	161	1193	641	646
8	83	400	125	3382	807	995	106	750	12	1037	519
9	41	78	60	45	610	344	365	42	332	11	744
10	13	52	24	65	45	343	97	140	80	45	21
11	7	55	1	1	88	3	69	15	13	2	83
12	7	80	16	1	9	22	0	8	35	3	0
13	7	5	3	0	4	0	3	0	0	0	0
14	1	5	1	0	1	2	0	0	0	1	0
15+	1	16	2	7	13	19	0	14	0	17	0
TOTAL	37493	43817	22316	30195	26994	34981	17981	9070	2814	14273	54168

Table 6.2.2 West Greenland Cod, NAFO Sub-area 1. Total international catches by age groups. Jan-Oct and Nov-Dec 1988. Numbers in '000.

Age	Jan-Oct	Nov-Dec	Total
3	642	190	832
4	37,354	12,412	49,766
5	735	325	1,060
6	364	133	497
7	472	174	646
8	439	80	519
9	675	69	744
10+	88	16	104
Total	40,769	13,399	54,168

Table 6.3 Mean weight at age in the main fisheries at West Greenland in 1988 (kg whole, round fish).

Age	German trawl	Greenland trawl	Long-line	Gill-net	Pound net	Handling	Weighted total[1]
2	0.216	-	-	-	-	-	0.216
3	0.461	0.700	0.810	0.810	0.713	0.740	0.550
4	0.868	1.114	1.402	1.267	1.053	1.209	1.081
5	1.208	1.349	1.970	2.000	1.078	1.430	1.279
6	1.318	1.964	2.274	1.910	1.346	1.420	1.893
7	2.086	2.643	2.658	2.850	1.508	2.770	2.381
8	2.060	2.491	3.238	3.280	-	2.428	2.661
9	2.603	2.847	3.839	3.610	2.328	2.904	3.128
10	3.095	3.970	3.961	4.720	-	-	4.073
11	3.060	-	-	-	-	-	3.060
Weighted mean[1]	0.929	1.173	1.921	1.838	1.053	1.212	1.143

[1] Weighted by catch in numbers in each age group and gear category.

Table 6.5.1 West Greenland cod. Autumn survey abundance estimates (no. x 10^3) by age and division, 1982-1988. The respective survey biomass estimates (tonnes) and mean weights are below.

Age	Divisions 1B+C							Division 1D						
	1982	1983	1984	1985	1986	1987	1988	1982	1983	1984	1985	1986	1987	1988
0	-	-	104	124	-	32	-	-	-	68	131	-	13	-
1	60	-	-	18,148	1,193	363	244	16	-	4	7,765	2,752	23	12
2	610	166	78	725	35,014	6,774	1,911	90	395	11	349	33,830	8,237	782
3	3,686	228	29	249	737	142,759	1,522	18,862	2,915	282	300	1,582	227,042	65,102
4	292	352	36	133	43	2,745	470	4,151	15,059	847	898	197	4,012	388,499
5	96	4	107	64	51	1,267	3	21,238	683	3,203	1,340	482	1,903	3,038
6	11	13	7	74	31	1,811	+	3,903	2,779	151	2,766	363	3,801	730
7	2	-	80	3	85	222	2	1,082	203	625	81	512	501	767
8	-	-	-	13	1	330	+	270	271	20	155	8	1,431	325
9	-	-	36	-	20	-	1	335	60	97	-	25	-	688
10	-	-	-	-	1	30	-	30	52	7	-	2	150	-
11	-	-	-	-	-	-	-	75	-	-	-	-	-	-
12	-	-	-	-	-	-	-	70	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	15	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NK	-	-	-	-	-	-	-	39	27	-	-	-	-	-
Total	4,757	763	477	19,533	37,176	156,333	4,133	50,161	22,459	5,315	13,785	39,753	247,113	459,943
Tonnes	2,387	393	789	2,378	13,333	131,909	1,188	60,757	29,666	8,383	11,447	19,483	198,252	452,870
w (kg)	0.502	0.515	1.654	0.122	0.359	0.844	0.287	1.211	1.321	1.577	0.830	0.490	0.802	0.985

Note: The age compositions for the northern Divisions 1B+C and 1D and for the southern Divisions 1E and 1F are based on separate age/length keys comprising ageing material from the respective groups of divisions.

(cont'd)

Table 6.5.1 (cont'd)

Age	Division 1E							Division 1F						
	1982	1983	1984	1985	1986	1987	1988	1982	1983	1984	1985	1986	1987	1988
0	-	-	10	149	-	3	-	-	-	40	438	-	-	-
1	65	-	-	4,622	3,488	-	10	19	-	-	3,856	2,797	-	14
2	15	658	5	195	26,096	10,072	-	7	516	4	146	13,056	12,582	18
3	8,951	111	826	37	768	108,967	9,887	5,191	72	850	11	580	34,754	16,052
4	2,854	9,302	333	3,503	188	4,377	32,452	3,523	6,733	241	1,195	146	1,597	39,114
5	6,214	2,463	3,172	599	4,037	707	309	11,241	2,709	2,635	195	3,051	328	566
6	2,613	3,718	299	2,510	256	2,342	13	7,091	6,448	350	945	270	1,424	34
7	627	752	586	122	1,062	307	191	3,046	1,268	768	145	1,429	197	183
8	115	393	30	180	27	955	71	661	508	36	260	68	651	65
9	227	157	49	4	91	-	254	1,443	158	59	18	316	-	246
10	22	84	4	5	3	50	15	74	62	11	13	14	86	11
11	5	-	2	-	6	23	12	5	-	2	-	17	-	8
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	21	-	-
14	-	-	-	-	-	-	-	13	-	-	-	-	-	-
NK	67	8	-	-	-	-	-	32	20	-	-	-	-	-
Total	21,775	17,646	5,316	11,926	36,022	127,803	43,214	32,346	18,494	4,996	7,222	21,765	51,619	56,311
Tonnes	29,599	31,056	7,526	11,934	23,675	96,433	40,698	87,191	37,728	8,247	6,101	19,729	37,692	52,810
w (kg)	1.359	1.760	1.416	1.001	0.657	0.755	0.942	2.696	2.040	1.651	0.845	0.906	0.730	0.938

(cont'd.)

Table 6.5.1 (cont'd)

Age	Total						
	1982	1983	1984	1985	1986	1987	1988 x)
0	-	-	222	842	-	48	-
1	160	-	4	34,391	10,230	386	260
2	722	1,735	98	1,415	107,996	37,665	2,711
3	36,690	3,326	1,987	597	3,667	513,522	92,563
4	10,820	31,446	1,457	5,729	574	12,731	460,535
5	38,789	5,859	9,117	2,198	7,621	4,205	3,916
6	13,618	12,958	807	6,295	920	9,378	777
7	4,757	2,223	2,059	351	3,088	1,227	1,143
8	1,046	1,172	86	608	104	3,367	461
9	2,005	375	241	22	452	-	1,189
10	126	198	22	18	20	316	26
11	85	-	4	-	23	23	20
12	70	-	-	-	-	-	-
13	-	15	-	-	21	-	-
14	13	-	-	-	-	-	-
NK	138	55	-	-	-	-	-
Total	109,039	59,362	16,104	52,466	134,716	582,868	563,601
Tonnes	179,934	98,843	24,945	31,860	76,220	464,286	547,566
w (kg)	1.650	1.665	1.549	0.607	0.566	0.797	0.972

x) See footnote on page 8.

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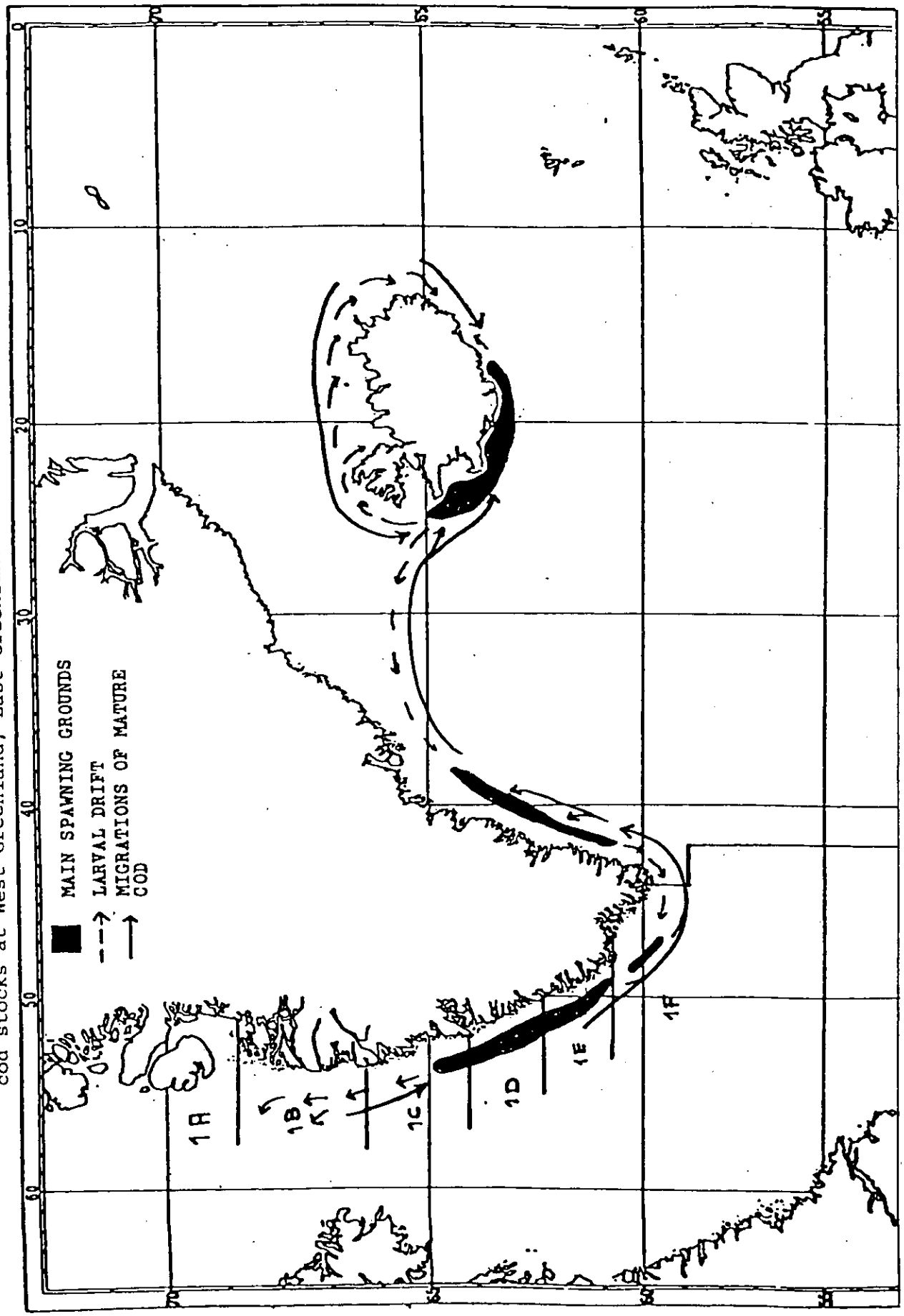

Figure 3.1 Main spawning grounds, migrations of mature fish and larval drift of the cod stocks at West Greenland, East Greenland and Iceland.

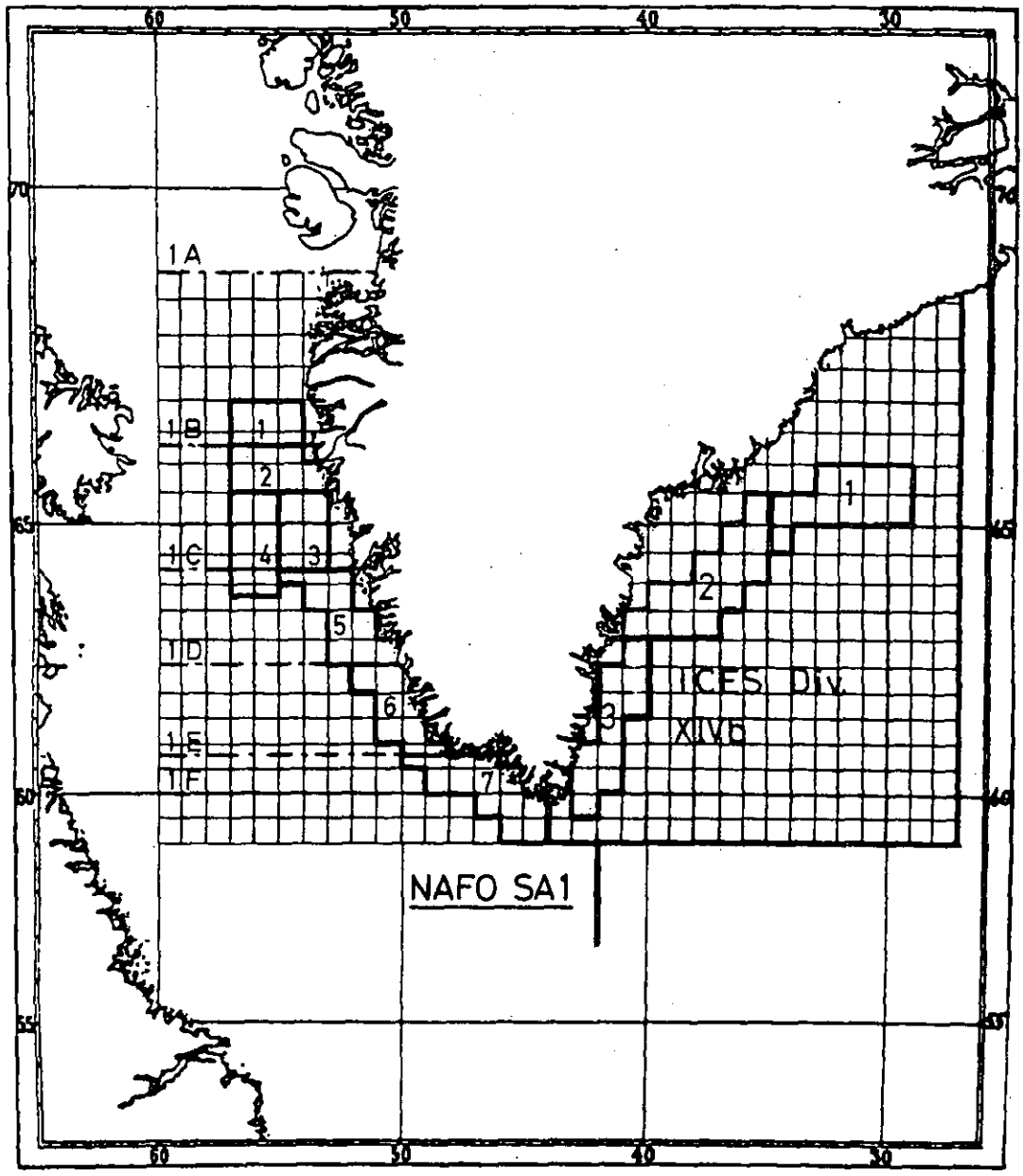

Figure 5.1 Survey areas and stratification off East and West Greenland.

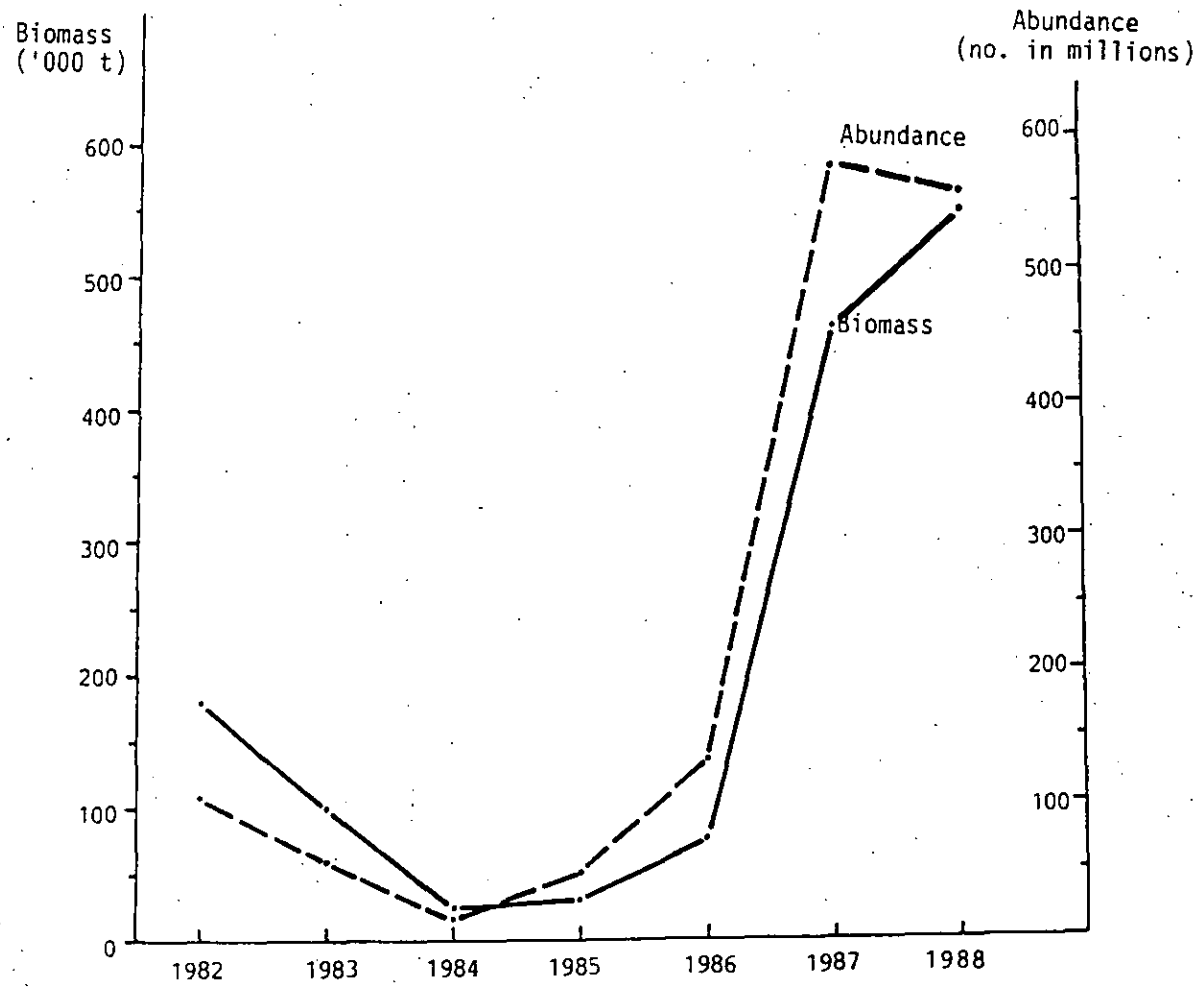

Figure 6.5.1 West Greenland cod. Trends in survey biomass and abundance estimates, 1982-1988.

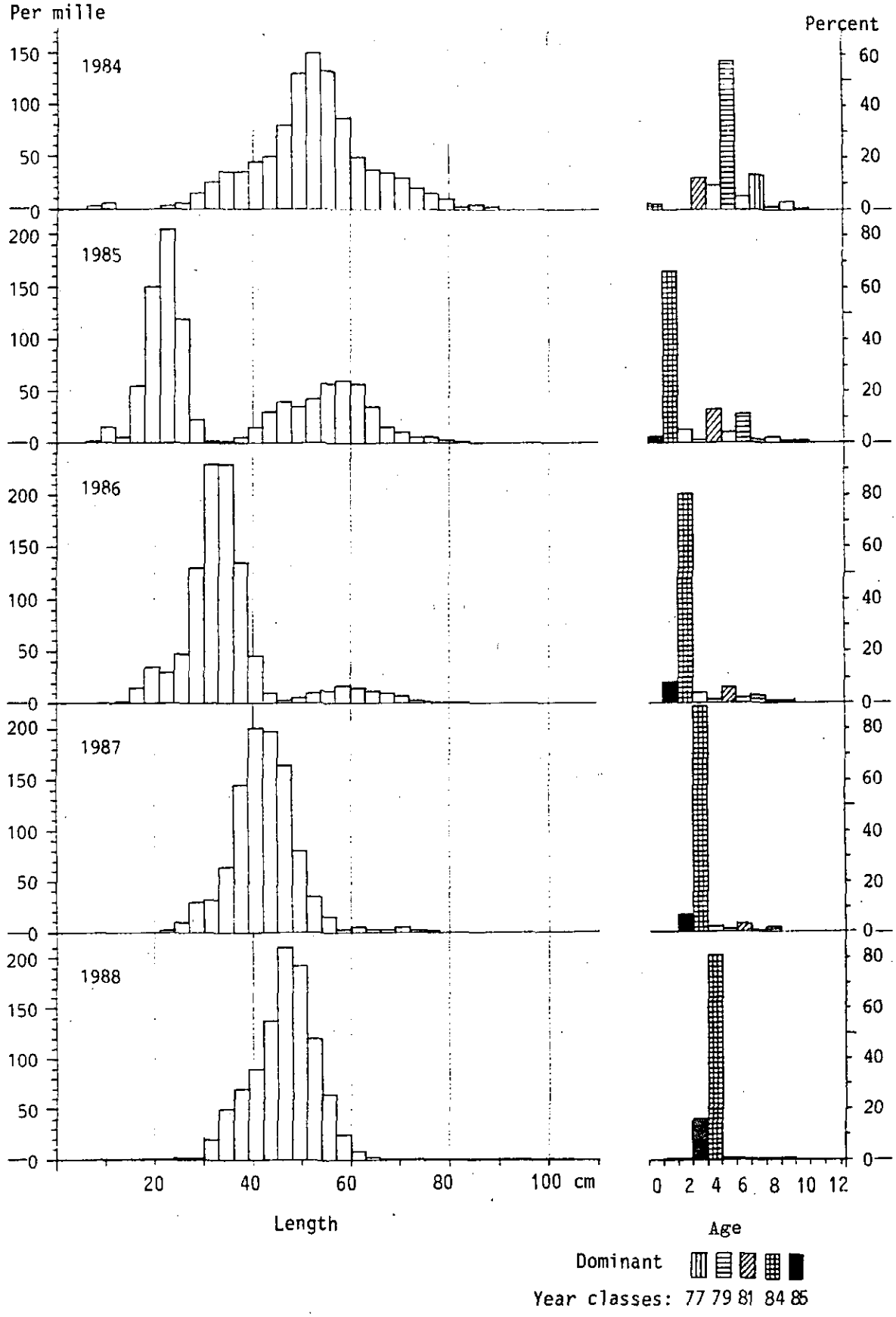

Figure 6.5.2 West Greenland cod. Length frequencies (per mille) and age compositions (percent) from survey results, 1984-1988.