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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, 28 January-03 February 1987)

compiled by

A. Schumacher

Institut fur Seefischerei, Palmaille 9
D-2000 Hamburg 50, Federal Republic of Germany

NOTE

The following pages contain extracts from the ICES Working Group on Cod Stocks off East Greenland, Copenhagen, 28 January-03 February 1987.

1 PARTICIPANTS

The ICES Working Group on Cod Stocks off East Greenland met in Copenhagen, 28 January - 3 February 1987 with the following participants:

H.P. Cornus	Federal Republic of Germany
H. Hovgård Hansen	Denmark
Sv. Aa. Horsted	Denmark
K. Hoydal (Chairman)	Faroe Islands
J. Messtorff	Federal Republic of Germany
K. Nygård	Denmark
J. Møller Jensen	Denmark
S.A. Schopka	Iceland
A. Schumacher	Federal Republic of Germany

Dr E.D. Anderson, the ICES Statistician, attended part of the meeting.

2 TERMS OF REFERENCE

At the 1986 Statutory Meeting, it was decided (C.Res.1986/2:5:1) that the Working Group on Cod Stocks off East Greenland should meet at ICES headquarters 28 January - 3 February 1987 to:

i) analyze the results of the latest groundfish survey;

ii) assess the status and provide catch options for 1987 within safe biological limits for East Greenland cod.

In order to be able to make the assessment of East Greenland cod, it is necessary to use data derived from the assessment of the West Greenland cod. 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 the two 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.

As in 1986, both assessments are presented in one report. This Working Group report contains the full assessment of the West Greenland stock, with the exception of the catch projections and management options, which are a matter for the Scientific Council of NAFO. The West Greenland part of the report will be presented by the participants of the meeting as a research document to the NAFO Scientific Council for its further discussion and for 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 from that area migrate to Iceland. This may also sometimes be the case for immature cod found in the East Greenland area closest to Iceland. On the other hand, in some years, immature cod seem to

migrate from East Greenland to West Greenland. 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 a one-way emigration.

However, the interrelationship between the stocks is not only a matter of adult and immature cod migrating and mixing, but also a matter of recruitment to one area originating from spawning in another area. As far as this question is concerned, larval drift with currents from East to West Greenland and from Iceland via East Greenland waters to the banks off West Greenland seems evident.

The magnitude of this drift and the survival rate of the larvae seem to vary much from year to year. In some years, the drift seems negligible, while in other years (e.g., in 1963, 1973, and 1984), considerable numbers of larvae seem to have drifted from Iceland to East Greenland and to the southern part of West Greenland.

This variation is reflected by the abundance indices from the Icelandic 0-group survey in East Greenland waters (Table 3.1).

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 to 1986 indicates that the emigration varies considerably from year to year and within 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 migrated 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.

Another attempt to estimate the migration from Greenland to Iceland was made by the Joint ICES/ICNAF Working Group on Cod stocks in the North Atlantic in 1972 (Anon., 1973). The result of that exercise confirmed previous findings (24%).

4 ENVIRONMENTAL CONDITIONS IN 1986

The air temperatures over the West Greenland area have been fluctuating around the long-term average in 1986, but it should be noted that the winter of 1985-1986 was relatively mild (temperature anomalies between $+2^0$ and $+7^0$ C). The surface layer of the West Greenland waters was, therefore, not cooled as much as normal, which resulted in surface temperatures slightly above normal throughout the year. The mid-June temperature over the top of Fylla Bank was 2.18^0 C.

The deeper layers (150-600 m) west of the fishing banks showed temperatures well above normal, indicating a strong influence of the Irminger current component also in 1986.

5 GROUNDFISH SURVEYS AND RESEARCH

As information available from the commercial fishery does not adequately reflect the situation and the development of the East West Greenland cod stocks, groundfish survey programmes were designed and introduced off East and West Greenland in 1980 and 1982, respectively, by the Federal Republic of Germany and have

been continued since in order to obtain reasonable annual estimates of the trawlable biomass and abundance of cod in both areas.

In addition in 1986, small-scale surveys were made by Greenland, and working papers on young cod abundance and distribution as well as the inshore abundance and distribution of cod were presented at the meeting. Moreover, results of research on tagging, net selection, and the use of parasites as natural tags were presented.

5.1 Design of the Federal Republic of Germany Survey

The surveys were designed according to the stratified random sampling method by applying the "swept-area" method to the survey results. The trawl parameters of the standard bottom trawl used in all surveys are as follows:

Gear:	140' bottom trawl equipped with a small-mesh (30-mm) liner inside the codend
Horizontal net opening:	22-m wing spread
Vertical net opening:	3.5-m headline height (not considered in the calculations)
Trawling speed:	4.5 knots
Towing time:	30 minutes

The true catchability coefficient is unknown. For the calculation of survey estimates, it was, however, taken as 1.0 to avoid overestimation of the stock biomass and abundance. Therefore, the results are expressed in terms of "minimum 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. Trial surveys during different seasons proved that cod in both areas were most evenly distributed in the autumn and, therefore, give smaller variances of the survey estimates than at other times of the year.

The survey areas are composed of statistical rectangles (0.50^0 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 both survey areas.

Since 1983, the stratification of the East Greenland survey area has been based on mean densities of cod per statistical rectangle derived from the previous surveys. So far, substantial changes in the relative density distribution have not occurred in the survey series. A set of five strata was constructed for five increasing ranges of density distribution. Each stratum is composed of Statistical rectangles for which the same range of mean relative density distributions has been computed. Consequently, the strata are different in size depending on how many of the whole survey area's 36 statistical rectangles are allocated to them. For the 1986 survey, the allocation of statistical rectangles to strata 1-5 is shown in Figure 5.1, and the corresponding area composition is given in Table 5.1.1.

The West Greenland survey area lies within 51 statistical rectangles containing the shelf outside the 3-mile limit and the continental slope down to 600-m depth extending from the southern part of NAFO Division 1B (south of 67^0 N Latitude) southward as illustrated in Figure 5.1. The area consists of seven main strata equal to NAFO Divisions 1B-F or parts thereof. The main strata

are each subdivided by 100-m depth zones between 0-600 m into six substrata, except in Division 1F (stratum 7) where, due to the lack of suitable bathymetric charts, a substratification was possible only by 200-m depth zones. Strata areas (nm^2) are given in Table 5.1.2.

For the purpose of random selection of fishing stations, each statistical rectangle is divided into unit areas equivalent to 7.5' Latitude x 15' Longitude rectangles, with each of these further subdivided into nine smaller random units (2.5' x 5' rectangles). The random units are numbered consecutively but separrately inside each main stratum. Of the total number of fishing stations planned for each survey, 50% are allocated proportionally to the stratum sizes and correspondingly inside each stratum to the substrata areas. The remaining half is allocated proportionally to the mean relative densities within each stratum and substratum as derived from previous surveys.

5.2 Summary of Working Papers on Other Surveys and Research

Young cod survey

Two papers discussing the results from the Greenland inshore young cod survey were presented at the meeting (Hansen, 1987a, 1987b). Catches in this survey were dominated by the 1984 year class. The size of the 1985 year class was estimated to be approximately 20% of the 1984 year class.

Inshore distribution and abundance

One paper discussing inshore distribution and abundance was presented (Nygård and Hansen, 1987). A possible high abundance of cod in coastal areas was demonstrated. This part of the stock is not covered by the groundfish trawl survey.

The inshore areas (inside 3 nm off the baseline and including the fjords) have approximately a size of 50% of the trawl survey area. Assuming the same density of cod inshore as offshore, the estimate of stock size will increase significantly. This will further affect the estimates of fishing mortality and migration coefficient, whereas total mortality will be unchanged.

The Working Group recommended that this work should be continued and expanded in order to obtain a better estimate of the inshore abundance and distribution of cod. It should also be related to the offshore survey.

Updating of East Greenland tagging results

The provisional result from the tagging experiments in 1982 and 1983, carried out in the inshore area behind the town Angmagssalik at East Greenland, was presented in a working paper (Jensen, 1987).

In September 1982 and 1983, 2,149 cod were tagged, of which 643 were reported recaptured. From the tagging area, 577 were reported and 317 of these were taken during the tagging years. A total of 13 were reported from the bank area of East Greenland, 1 from West Greenland, and 8 from Greenland (NK). From Iceland, 44 were reported.

The recaptures were grouped into 10 cm groups (according to the tagging length), and the experiments showed that some recaptures from all the 10-cm groups (30-69 cm) were taken at Iceland during the first year after the tagging, whereas from previous West Greenland tagging experiments, recaptures at Iceland, especially of small fish, were usually not obtained until the second year after tagging or later.

6 THE COD STOCK AT WEST GREENLAND (NAFO SUBAREA 1)

6.1 Trends in Catch and Effort (Figure 6.1)

In general,the fishery for cod in NAFO Subarea 1 is partly an offshore fishery, carried out by large trawlers, and partly a coastal and fjord fishery, of which the main part of the landings usually is taken by pound nets.

In 1986, no directed trawl fishery for cod was, however, allowed, and further the pound net fishery was banned from mid-July with only a few exemptions. These regulations were introduced in order to protect small cod, especially the 1984 year class.

The nominal catch in 1986 was 5,284 tonnes (provisional figures) (Tables 6.1.1-6.1.4), which is approximately 40% of the 1985 landings and the lowest on record in the last fifty years.

Greenland vessels landed 5,247 t or 99% of the total; the remainder (37 t) was taken by the Federal Republic of Germany.

All cod taken in trawls were by-catches in the redfish fishery in NAFO Divisions 1E and 1F (Table 6.1.2), and most of the cod landings from longlines or gillnets also came from Divisions 1E and 1F. Only about 700 t seem to have been taken by pound nets.

No effort data for the directed cod fishery are available (Table 6.1.5).

6.2 Catch in Numbers at Age and Catch Composition (Tables 6.2.1 and 6.2.2)

Due to the fisheries regulations in 1986, the two components of the cod fishery which are most easily sampled (trawl and pound net catches) represent a relatively small part of the catch. The major part of the landings in 1986 is the small-boat miscellaneous-gear component landed in relatively small quantities at a number of landing places. Gear used is generally not reported in the catch statistics for that fishery, but some information has been obtained by interviews[1]. Furthermore good coverage in the sampling of these catches is difficult to achieve, and although samples are available for most gears and divisions, it has been necessary in several cases to use individual samples on catches for other months or even divisions or gear than those of the sample. The breakdown of the 1986 catches into age groups is, therefore, to be considered as a very rough estimate.

However, it seems clear that the 1979 year class, which made up about 60% of the 1985 catches (in number as well as weight) has continued to be the major one in 1986, accounting for about 44% in number and 47% in weight. The 1977 year class also continued to be relatively important, partly because the longline and gillnet fisheries tend to catch higher proportions of big fish than the other gears used and were relatively more important in 1986 than in most recent years. The 6- and 5-year-old fish (1980 and 1981 year classes) accounted for 11% and 23% (in number), respectively, while 3- and 4-year-old fish were landed only in very small numbers, supporting the expectance of these year classes as being very poor ones.

[1] During the meeting, but after most tables and calculations had been completed, some further information on catch by gear for the West Greenland fisheries was received. However, since a revision based on this information would have only marginal effects on the assessment for East Greenland, and since further information is likely to become available before the West Greenland data are to be presented to NAFO in June, the Working Group considered that a revision of the tables for West Greenland cod should await such further information and be revised accordingly shortly before or at the June 1987 meeting, of the Scientific Council of NAFO.

6.3 Mean Weight at Age in the Catches

The mean weight at age of cod in the major Greenlandic fisheries in 1986 is listed in Table 6.3. For each gear, mean weights were calculated by weighing the mean weight in the samples with the corresponding catch figures. Mean weight in the total catch was subsequently calculated by weighing with catch figures for the various gears. Multiplying the final mean weights with numbers caught (SOP check) gave a difference of +5%.

The mean weight at age generally exceeded last year's values by 20 - 25%. However, it should be noted that a substantial decrease in weight has continuously occurred during previous years. (Hansen, 1987c).

The overall mean weight (nominal catch/numbers caught) was 2.27 kg in 1986 as compared to 1.67 in 1985. This increase may partly be explained by the decrease in the pound net catch relative to the total catch, since that gear usually catches a higher proportion of small fish than the longlines and gillnets.

6.4 Maturity Ogive

A maturity ogive was calculated (Figure 6.4) based on data from the 1986 groundfish survey. This ogive is different from the one previously used and also confirmed by 1985 data. It shows an increase in the maturation rate for age groups 5-8. The increase in growth observed for the respective age groups is interpreted as supporting evidence for this development since maturation is more related to fish length than to age. The maturity rates for 1983, 1985, and 1986 are given in the text table below.

	Calculated % maturity		
Age	1983	1985	1986
3	1	-	<1
4	3	2	3
5	15	11	27
6	48	42	81
7	83	82	98
8	96	96	100
9	99	99	100
10+	100	100	100

6.5 Groundfish Survey Results

The number of randomly distributed fishing stations occupied during the surveys from 1982 to 1986 amounted to 111, 153, 162, 133, and 155, respectively. The results were based on 98, 142, 158, 114, and 142 valid sets.

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	Nos. ('000)	w(kg)
1982	179,934 ± 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	35,213 ± 68.7%	55,886 ± 34.7%	0.63%
1986	76,220 ± 30.8%	134,716 ± 31.8%	0.57%

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

The surveys in 1982, 1983, and 1985 were carried out in November-December and those in 1984 and 1986 in October-November. The vessel used was the R/V "Walther Herwig", except in 1984 when, for technical reasons, she had to be replaced by the 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 does not differ significantly provided that equal standard survey gears as well as towing speeds are used.

From 1982 to 1984, the survey results reveal a drastic decline in cod biomass and abundance which was observed not only for the whole survey area, illustrated in Figure 6.1, but for all divisions, as shown in detail in Table 6.5. Confirmation of the reduced stock size in 1983 and 1984 was also obtained from continuous echosounder recordings throughout the survey area and from the trends in commercial catch and effort (Figure 6.1). The survey results obtained at the end of 1985 and 1986 indicate a stabilization of the age 4+ biomass at about the low level of 1984. The total stock biomass has increased since 1984 by a factor of 3 because of the good 1984 year class and, to a lesser extent, the 1985 year class.

According to the 1986 survey results, the year classes predominating in numbers among age 4 and older cod were those of 1981 (59%), 1979 (24%), and 1977 (3.5%). Whereas the 1981 year class even showed a slight increase in abundance in 1986, the 1979 and 1977 year classes underwent a considerable reduction.

The length frequency distributions of cod obtained since 1982 from the survey are presented in Figure 6.5. In contrast to the two previous years, no O-group cod were recorded in the survey catches of 1986.

6.6 Future Recruitment

1983 year class

Although survey data indicate a higher abundance at age 3 for this year class than that observed for the 1981 year class, the 1983 year class is still considered to be small.

1984 year class

The 1986 survey results confirmed the 1984 year class as being the strongest since the 1973 year class. Survey abundance estimates increased from 37 million fish in 1985 to 108 million in 1986. The year class was also observed to be highly abundant in inshore areas during 1985 and 1986.

1985 year class

The abundance index of O-group cod off East Greenland from the Icelandic O-group survey in August 1985 was the third highest observed since 1973, but considerably lower than those of 1973 and 1984 (Table 3.1). The catches of O-group cod in the bottom trawl survey off West Greenland in November-December 1985 were 4 times higher than in 1984. The survey abundance estimate at age 1 in 1986 was, however, only a third of the age 1 abundance estimate of the 1984 year class. From inshore young cod surveys, the 1985 year class was estimated to be approximately 1/60 the size of the 1984 year class.

1986 year class

The abundance index obtained from the Icelandic O-group survey off East Greenland in August 1986 was extremely low. No O-group cod were observed in the bottom trawl survey catches off East and West Greenland in the autumn of 1986.

6.7 Assessment Results (Table 6.7)

The stock in numbers at age at the end of 1986 has been calculated from the abundance estimate of the October-November survey by applying 2/12 of the natural mortality and deducting the November-December catch in numbers at age. Total mortality (Z) was calculated from this estimate and the corresponding one from the 1985 survey for each age group resulting in negative or low Z values for age groups 3-5 while Z on older ages is considerably higher.

The total mortality estimates were apportioned to:

i) Natural mortality (0.2)

ii) Fishing mortality

iii) Emigration coefficient

The average fishing mortality in 1986 for age 6 and older was estimated to be 0.31, i.e., about 55% below that of the previous year (0.69). This reduction in F corresponds to the reduction in catch in 1986.

For the younger age groups (3-5), the emigration coefficients as well as the Z-values are negative. This can be interpreted as additional recruitment to the stock covered by the survey.

The estimated emigration coefficients for ages 6-8 are higher than the value of 0.05 tradionally used in catch projections which was derived from earlier tagging experiments at a time when mature cod were more evenly distributed in all NAFO divisions. In recent years, nearly the whole stock of mature cod has been found in the southernmost NAFO divisions. It has been shown from earlier tagging experiments that cod tagged in the southern areas migrate out of the area to a much larger extent than cod in the northern part of the area. The combined estimate for age 6 and older in 1986 is 0.3 and this value was used to calculate the number of emigrants in 1987 used in the projection for the East Greenland stock.

The emigration coefficients referred to above are associated with about 1.9 million fish of age 6 and older emigrating in 1986. This order of magnitude is less than half the estimate from the assessment of the East Greenland stock which indicates that about 4.9 million cod immigrated to that stock from West Greenland.

The historic development shows a declining spawning stock biomass from the high level at the beginning of the 1960s to very low levels in the mid-1970s. This trend has been reversed after 1976 when the very abundant 1973 year class reached spawning size. However, the slight recovery of the spawning stock was terminated due to exploitation and emigration, particularly during 1983 and 1984. The results of the more recent assessments based on grounfish surveys are given in the text table below.

Year	SSB	$F_{(6-9)}$	Catch
1983	110	0.46	58
1984	55	0.54	31
1985	15	0.69	15
1986	22	0.27	5
1987	23	0.31	-

Weights in '000 t.
SSB refers to the beginning of the year.

The survey biomass estimates show a significant increase from 1985 to 1986 as a result of the abundant 1984 and 1985 year classes now making up more than half of the estimated biomass (Figure 6.1). The exploitable biomass at West Greenland, however, is still at a very low level and too early exploitation of the recruiting year classes would waste their growth potential and reduce their potential contribution to the spawning stock.

8.2 Recommendation

The Group recommends that the groundfish surveys undertaken inshore by Greenland be continued, expanded, and related to the offshore surveys undertaken by the Federal Republic of Germany.

9 REFERENCES

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Nygård, K.H. and Hansen, H.H. 1987. On inshore distribution and abundance of the West Greenland cod stock, autumn 1986. NAFO SCR Doc. 87/?? (to be presented at NAFO meeting 1987).

Table 3.1 Abundance indices of 0-group cod from the international and Icelandic 0-group survey in the East Greenland/Iceland area, 1971-1986 (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

Table 5.1.1 East Greenland survey area. Trawlable area in the depth range 0-800 m. Area in nautical square miles. Stratification for 1986 survey.

No.	Stratum 1		Stratum 2		Stratum 3		Stratum 4		Stratum 5		Total area
	Code	Area	Code	Area	Code	Area	Code	Area	Code	Area	
1	49 A2	48	48 A1	515	49 A1	872	50 A2	222	53 A2	797	-
2	50 A1	642	51 A2	508	53 A3	398	52 A2	817	54 A3	426	-
3	55 B0	330	52 A3	49	56 B0	797	55 A3	710	57 B2	731	-
4	55 B1	85	56 B1	797	56 B2	697	-	-	-	-	-
5	58 B5	161	56 B3	214	57 B3	738	-	-	-	-	-
6	59 B4	754	57 B4	296	59 B5	754	-	-	-	-	-
7	55 B2	22	58 B3	768	59 C0	25	-	-	-	-	-
8	-	-	58 B4	703	60 B7	732	-	-	-	-	-
9	-	-	59 B6	487	60 B8	741	-	-	-	-	-
10	-	-	59 B7	100	60 B9	741	-	-	-	-	-
11	-	-	59 B8	122	60 C0	404	-	-	-	-	-
12	-	-	59 B9	174	-	-	-	-	-	-	-
Total		2,042		4,733		6,899		1,749		1,954	17,377
No. of rectangles		7		12		11		3		3	36

Low density ——————————— High density

Table 5.1.2 Strata areas in square nautical miles off West Greenland (NAFO Subarea 1).

Depth zone (meters)	Division/Stratum number							Total (nm^2)
	1B	1C	1C	1 C/D	1D	1E	1F	
	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

Table 6.1.1 Nominal catches of cod in NAFO Subarea 1 (1977-1986).

Country	1977	1978	1979	1980	1981
Faroe Islands	7,346	-	38	-	-
Fed.Rep. of Germany	2,609	1,057	1,344	1,024	417
France - M	-	-	139	-	-
Greenland	24,220	37,420	46,384	45,838	53,039
Japan	-	-	-	-	-
Norway	1,683	4	-	-	-
Portugal	1,052	-	-	-	
Spain	-	-	-	-	-
United Kingdom	-	-	-	-	-
USSR	1,086	-	-	-	-
Total	37,996[1]	38,531[1]	47,905[1]	46,862[1]	53,456[1,2]
Estimate of the Working Group	73,000	73,000	99,000	54,000	-

Country	1982	1983	1984	1985	1986[4]
Faroe Islands	-	1,339	-	-	-
Fed.Rep. of Germany	8,139	10,158	8,941	2,170	37
France - M	-	-	-	-	-
Greenland	47,693	44,970	22,041	12,319	5,247[5]
Japan	-	-	13	-	-
Norway	-	-	5	-	-
Portugal	-	-	-	-	-
Spain	-	-	-	-	-
United Kingdom	-	1,174	-	-	-
USSR	-	-	-	-	-
Total	55,832[1]	57,641	31,000[2]	14,544[3]	5,284
Estimate of the Working Group	-	-	-	-	-

[1] ICNAF/NAFO Statistical Bulletin.
[2] NAFO SCS Doc. 85/22.
[3] NAFO SCS Doc. 86/22.
[4] Provisional data.
[5] Including 31 t by chartered vessels

Table 6.1.2 NAFO Subarea 1 cod. Nominal catch in 1986 (provisional figures) in tonnes. Apart from the information that 362 t were taken by longliners above 80 GRT (assumed to be offshore) and 922 t by trawlers, only scattered information on gear used is available. Based on this information and on previous years' trends, the breakdown of figures on gears is very roughly estimated. The miscellaneous gear catches may include some catches taken by lines, gillnets and pound nets, so figures given for these gears are thought to be minimum figures. See also footnote in Section 6.2.

Division	Otter trawl offshore	Longlines offshore	Gillnet inshore and offshore	Miscellaneous gear inshore and offshore	Pound net inshore	Total
1A	-	-	-	53	-	53
1B	-	-	-	367	207	574
1C	-	-	-	157	72	229
1D	-	-	459	46	250	755
1E	908	-	1,032	-	158	2,098
1F	140	-	865	144	40	1,189
1NK	24	362	-	-	-	386
Total	1,072	362	2,356	767	727	5,284

Table 6.1.3 NAFO Subarea 1 cod. Nominal catches 1986 (provisional figures, and no information on Greenland small-boat catches for December) per month and division. Figures in brackets are estimates.

Month	1A	1B	1C	1D	1E	1F	1NK	Total
Jan	-	29	1	7	42	5	-	84
Feb	-	1	2	34	74	14	-	125
Mar	2	1	4	72	270	60	-	409
Apr	6	23	7	72	393	68	-	569
May	1	22	33	93	77	31	-	257
Jun	1	172	67	68	50	51	-	409
Jul	-	156	44	82	161	62	-	505
Aug	1	39	6	190	104	51	-	391
Sep	4	16	9	28	257	517	-	831
Oct	18	44	28	44	310	227	-	671
Nov	15	55	18	45	260	67	2	462
Dec	(5)	(16)	(10)	(20)	(100)	(36)	11	11+(187
NK	-	-	-	-	11	-	362	373
Total	53	574	229	755	2,109	1,189	375	5,284

Table 6.1.4 Nominal catches of NAFO Subarea 1 cod for 1975-1986 ('000 t).

Category	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Trawlers	28	19	46[3]	53[3]	57[3]	16	14	29	42	18	7	1
Other	20	14	27	20	42	38	39	26	16	12	8[4]	4[4]
Total	48	33	73[3]	73[3]	99[3]	54[3]	53	55	58	31	15	5
TAC	51[2]	45[2]	31[2]	-[1]	-[1]	20[1]	50[1]	62	62	68	28.5	12.5[5]

[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.

Table 6.1.5 NAFO Subarea 1 cod. Effort (hours fished) and catch per unit effort (CPUE = kg/hour) for Greenland trawlers (500 - 999 GRT class) in 1975-1986. 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]	-	-	-	-	-	-	-	-	-	-	-	-

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

Table 6.2.1 ~~SUM OF PRODUCTS CHECK~~ CATCH NO AT AGE

COD OFF WEST GREENLAND
CATEGORY: TOTAL

CATCH IN NUMBERS UNIT: thousands

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
3	1550	1727	3764	662	49	272	51	131	543	275	10760	634
4	7872	15091	7976	12589	2708	2519	10159	2392	1079	3595	4026	46649
5	62150	30457	36670	6709	10542	10172	9746	16576	2534	2677	2243	6053
6	26941	61848	29524	27435	6465	9265	12020	5065	6958	1803	1216	1515
7	5915	24562	54591	14664	13985	5237	4081	2605	1135	5355	502	618
8	4955	2700	10005	12411	4565	9158	2550	1496	1306	1588	1594	425
9	6912	1996	1725	4784	2410	2077	2660	1205	800	619	139	446
10	1239	5257	955	515	1290	1841	624	552	194	291	148	168
11	245	352	2548	257	149	953	954	165	177	84	53	79
12	159	95	187	704	85	78	709	257	152	58	27	88
13	961	156	37	41	201	51	150	95	272	9	17	22
14	159	455	42	62	27	154	57	37	147	12	14	1
15+	247	85	203	8	41	56	122	44	11	10	26	1
TOTAL	119324	144767	128505	82627	42567	41351	45785	23218	15438	16056	20565	58099

	1978	1979	1980	1981	1982	1983	1984	1985	1986
3	287	286	2997	12	1204	77	595	456	11
4	5494	10656	4515	10164	1210	12556	2013	1266	70
5	30039	12595	4536	8574	17960	2011	10534	1393	559
6	1004	13970	1978	2591	2965	17223	688	4915	289
7	509	709	8014	1053	2079	1581	5656	161	1024
8	85	400	125	5312	807	995	100	750	11
9	41	78	60	45	619	344	565	42	277
10	15	52	24	65	45	343	97	140	65
11	7	55	1	1	88	3	69	15	11
12	7	80	16	1	9	22	0	8	27
13	7	5	3	0	4	0	3	0	1
14	1	5	1	0	1	2	0	0	0
15+	1	16	2	7	13	19	0	14	0
TOTAL	37493	43837	22510	30195	26994	34981	17931	9070	2554

Table 6.2.2 Total international catches by age group. West Greenland cod, NAFO Subarea 1, January-October and November-December 1986. Numbers in '000.

Age	Jan-Oct	Nov-Dec	Total
3	8	3	11
4	66	13	79
5	453	86	539
6	243	46	289
7	863	161	1,024
8	9	2	11
9	233	44	277
10	55	10	65
11	9	2	11
12	23	4	27
13	1	-	1
14	-	-	-
15+	1,963	371	2,334

Table 6.3 Mean weight at age in the main Greenlandic fisheries at West Greenland in 1986 (kg whole, round fish).

Age	Trawl	Miscellaneous gear inshore and offshore	Longline	Gillnet	Poundnet	Weighted total[1]
3	0.79	-	-	-	0.48	0.66
4	1.04	0.94	0.93	0.98	0.94	0.98
5	1.53	1.45	1.49	2.13	1.41	1.79
6	2.19	2.01	1.89	2.44	2.09	2.24
7	2.76	2.28	2.39	2.39	2.19	2.43
8	3.50	2.59	2.66	-	-	3.08
9	4.45	4.98	3.69	3.13	-	3.62
10+	-	-	4.67	2.71	-	3.17

[1] Weighted by the proportion of the total catch taken by the gear.

Table 6.5 West Greenland cod. Autumn survey abundance estimates (nos. x 10^3) by age and division, 1982 - 1986. The respective survey biomass estimates (tonnes) and mean weights are given below.

Age	Division 1B+C					Division 1D					Division 1E				
	1982	1983	1984	1985	1986	1982	1983	1984	1985	1986	1982	1983	1984	1985	1986
0	-	-	104	124	-	-	-	68	170	-	-	-	10	146	-
1	60	-	-	18,311	1,193	16	-	4	9,343	2,752	65	-	-	4,788	3,488
2	610	166	29	478	35,014	90	395	11	277	33,830	15	658	5	150	26,096
3	3,686	228	36	230	737	18,362	2,915	282	336	1,582	8,951	111	826	49	768
4	292	352	107	124	43	4,151	15,059	847	1,180	197	2,854	9,302	333	4,444	188
5	96	4	7	71	51	21,238	683	3,203	1,950	482	6,214	2,463	3,172	304	4,037
6	11	13	80	53	31	3,903	2,779	151	3,215	363	2,613	3,718	299	1,987	256
7	2	-	-	-	85	1,082	203	625	88	512	627	752	586	69	1,062
8	-	-	36	18	1	270	271	20	199	8	115	393	30	170	27
9	-	-	-	-	20	335	60	97	-	25	227	157	49	4	91
10	-	-	-	-	1	30	52	7	-	2	22	84	4	-	3
11	-	-	-	-	-	75	-	-	-	-	5	-	2	-	6
12	-	-	-	-	-	70	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NK	-	-	-	-	-	39	27	-	-	-	67	8	-	-	-
Total	4,757	763	477	19,409	37,176	50,161	22,459	5,315	16,758	39,753	21,775	17,646	5,316	12,111	36,022
Tonnes	2,387	393	789	2,368	13,333	60,757	29,666	8,383	14,236	19,483	29,599	31,056	7,526	12,297	23,675
$\bar{W}$ (kg)	0.502	0.515	1.654	0.122	0.359	1.211	1.321	1.577	0.850	0.490	1,359	1.760	1.416	1.015	0.657

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.

Table 6.5 cont'd.

Age	Division 1F					Total				
	1982	1983	1984	1985	1986	1982	1983	1984	1985	1986
0	-	-	40	462	-	-	-	222	902	-
1	19	-	-	4,146	2,797	160	-	4	36,588	10,230
2	7	516	4	113	13,056	722	1,735	98	1,018	107,996
3	5,191	72	850	13	580	36,690	3,326	1,987	628	3,667
4	3,523	6,733	241	1,529	146	10,820	31,446	1,457	7,277	574
5	11,241	2,709	2,635	109	3,051	38,789	5,859	9,117	2,434	7,621
6	7,091	6,448	350	832	270	13,618	12,958	807	6,087	920
7	3,046	1,268	768	135	1,429	4,757	2,223	2,059	292	3,088
8	661	508	36	248	68	1,046	1,172	86	635	104
9	1,443	158	59	17	316	2,005	375	241	21	452
10	74	62	11	4	14	126	198	22	4	20
11	5	-	2	-	17	85	-	4	-	23
12	-	-	-	-	-	70	-	-	-	-
13	-	-	-	-	21	-	15	-	-	21
14	13	-	-	-	-	13	-	-	-	-
NK	32	20	-	-	-	138	55	-	-	-
Total	32,346	18,494	4,996	7,608	21,765	109,039	59,362	16,104	55,886	134,716
Tonnes	87,191	37,728	8,247	6,312	19,729	179,934	98,843	24,945	35,213	76,220
$\bar{W}$ (kg)	2.696	2.040	1.651	0.830	0.906	1.650	1.665	1.549	0.630	0.566

Table 6.7 NAFO Subarea 1 Cod, Assessment table 1986

Age	Year class	Survey stock	Catch Dec	A Stock Size 1 Jan	B Stock Size 31 Dec	C 1986 catch	D Z	E F	F M	G E	H Losses due to M	I Losses due to E
3	1983	3,667	3	1,001	3,544	11	-1.264	0.005	0.2	-1.470	402	-2,956
4	1982	574	13	618	542	79	0.131	0.136	0.2	-0.205	116	-119
5	1981	7,621	86	7,137	7,287	539	-0.021	0.075	0.2	-0.296	1,442	-2,131
6	1980	920	46	2,360	845	289	1.027	0.196	0.2	0.631	295	931
7	1979	3,088	161	5,845	2,828	1,024	0.726	0.246	0.2	0.280	831	1,162
8	1978	104	2	281	99	11	1.043	0.063	0.2	0.780	35	136
9+	<1978	516	60	628	440	381	0.356	0.721	0.2	-0.565	106	-299
Total 3+				17,870	15,585	2,334	0.285	0.206	0.2	-0.121	3,227	-3,276
Total 6+				9,114	4,212	1,705	0.788	0.307	0.2	0.282	1,267	1,930

[1] From 1985 survey.
Catch and stock numbers in thousands.

Steps in the calculations:

1. Calculation of col.B from 1986 October - November survey estimate.
2. Calculation of Z: ln(col.A / col.B).
3. Calculation of col.H: col.A * 0.2/Z(1-exp-Z).
4. Calculation of col.I: col.A - col.B + col.C + col.H.
5. Calculation of col.E and G: Allocation of Z proportionally to cols. C, H, and I.

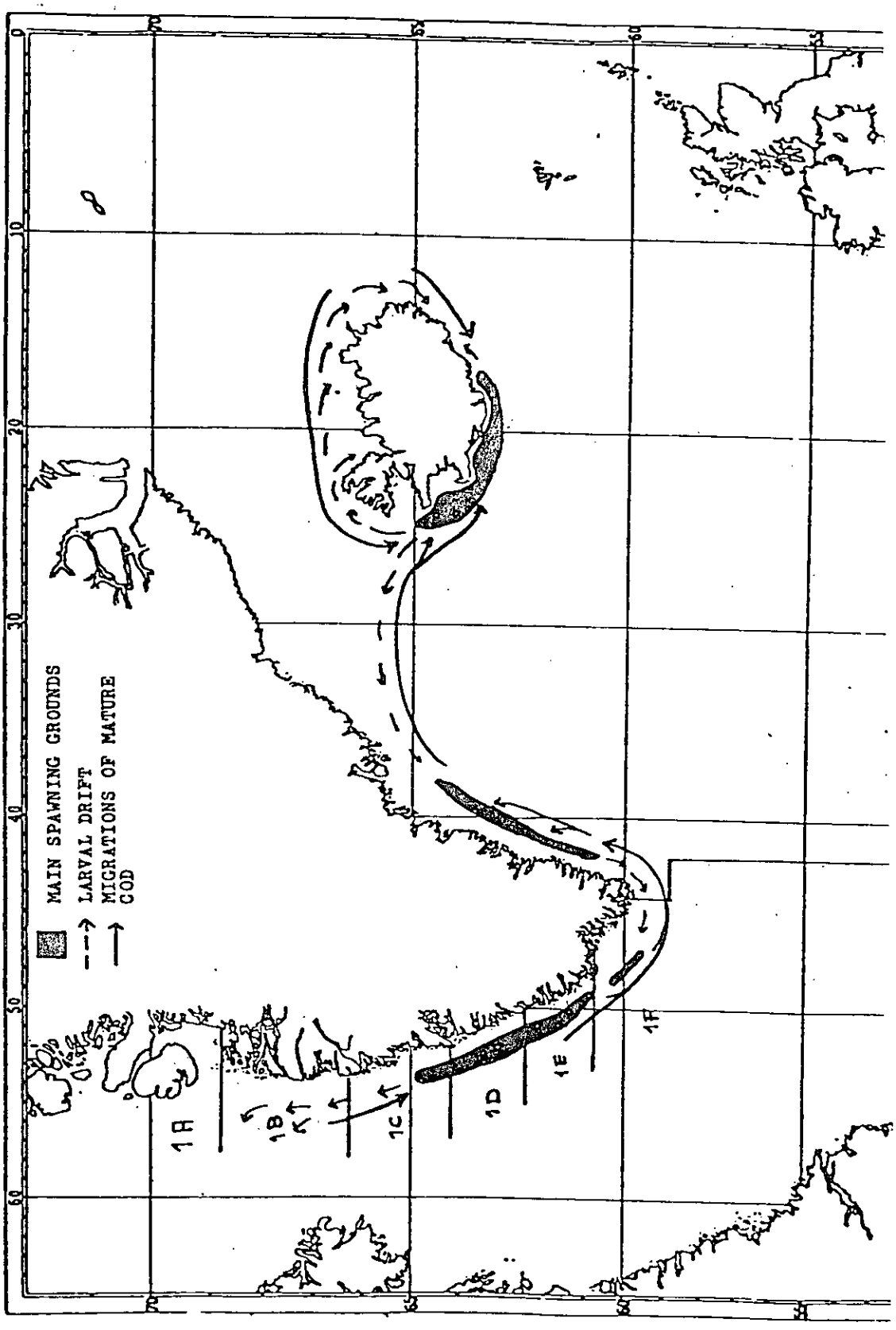


Figure 3.1 Main spawning grounds, migrations of mature fish and larval drift of the cod stocks at West Greenland, East Greenland and Iceland.

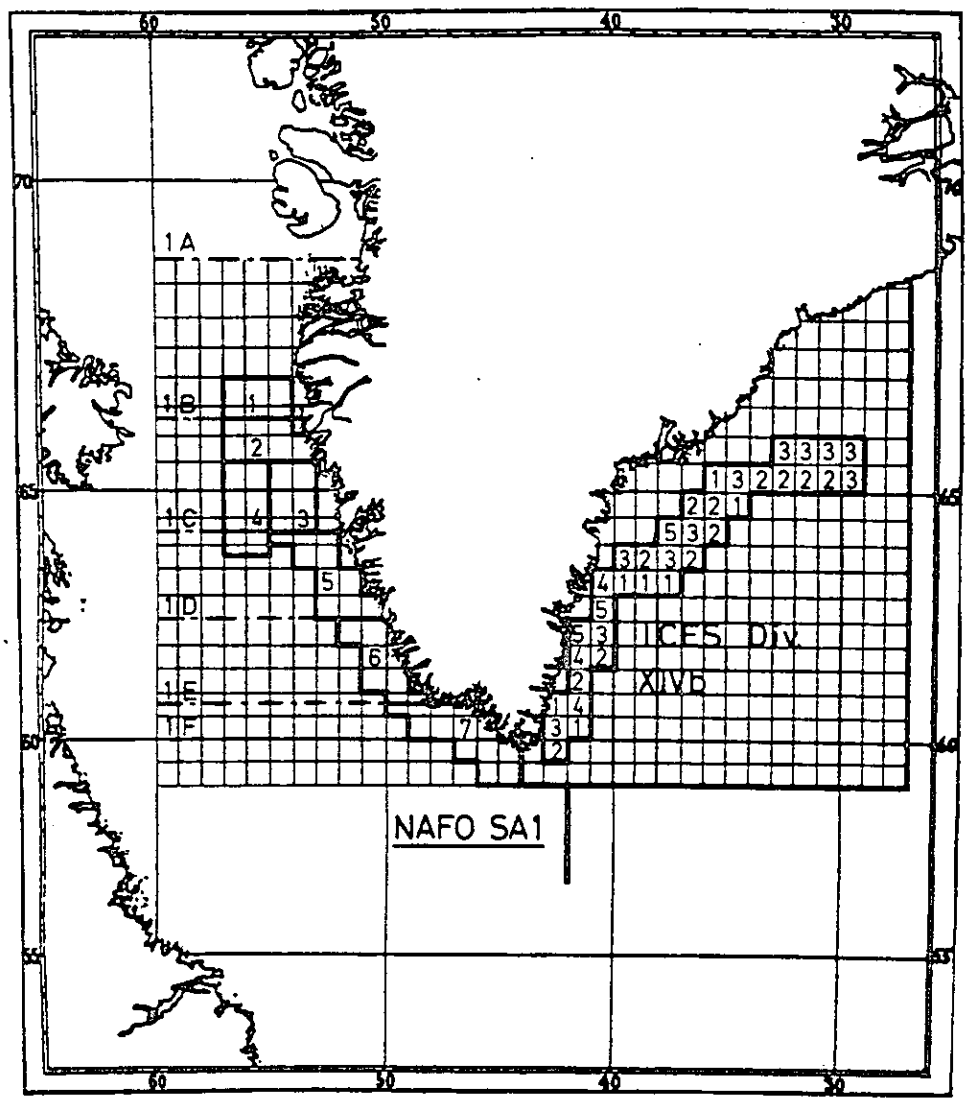


Figure 5.1 Survey areas and stratification off East and West Greenland. Numbers off East Greenland indicate the stratum to which the rectangles are allocated.

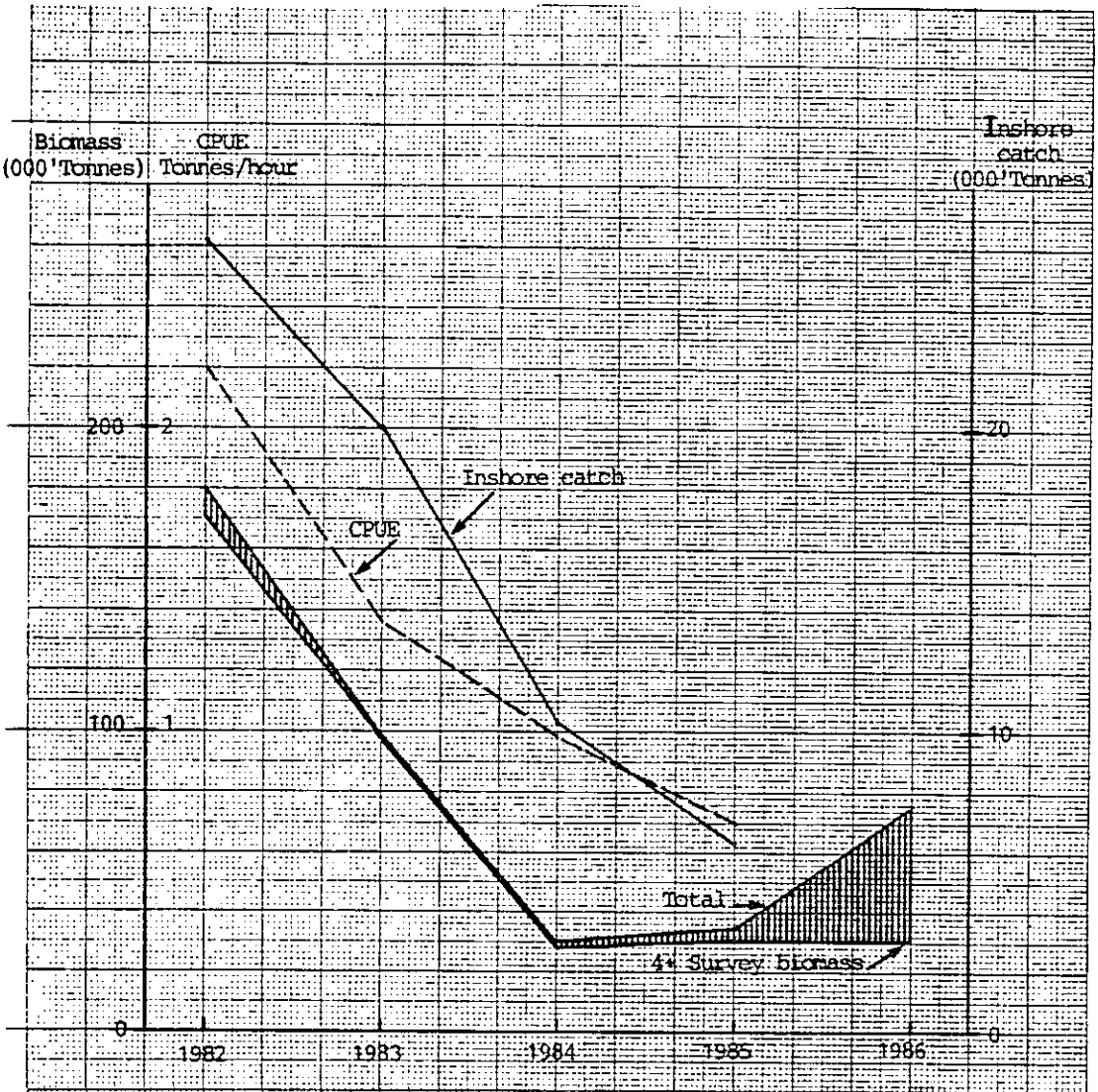
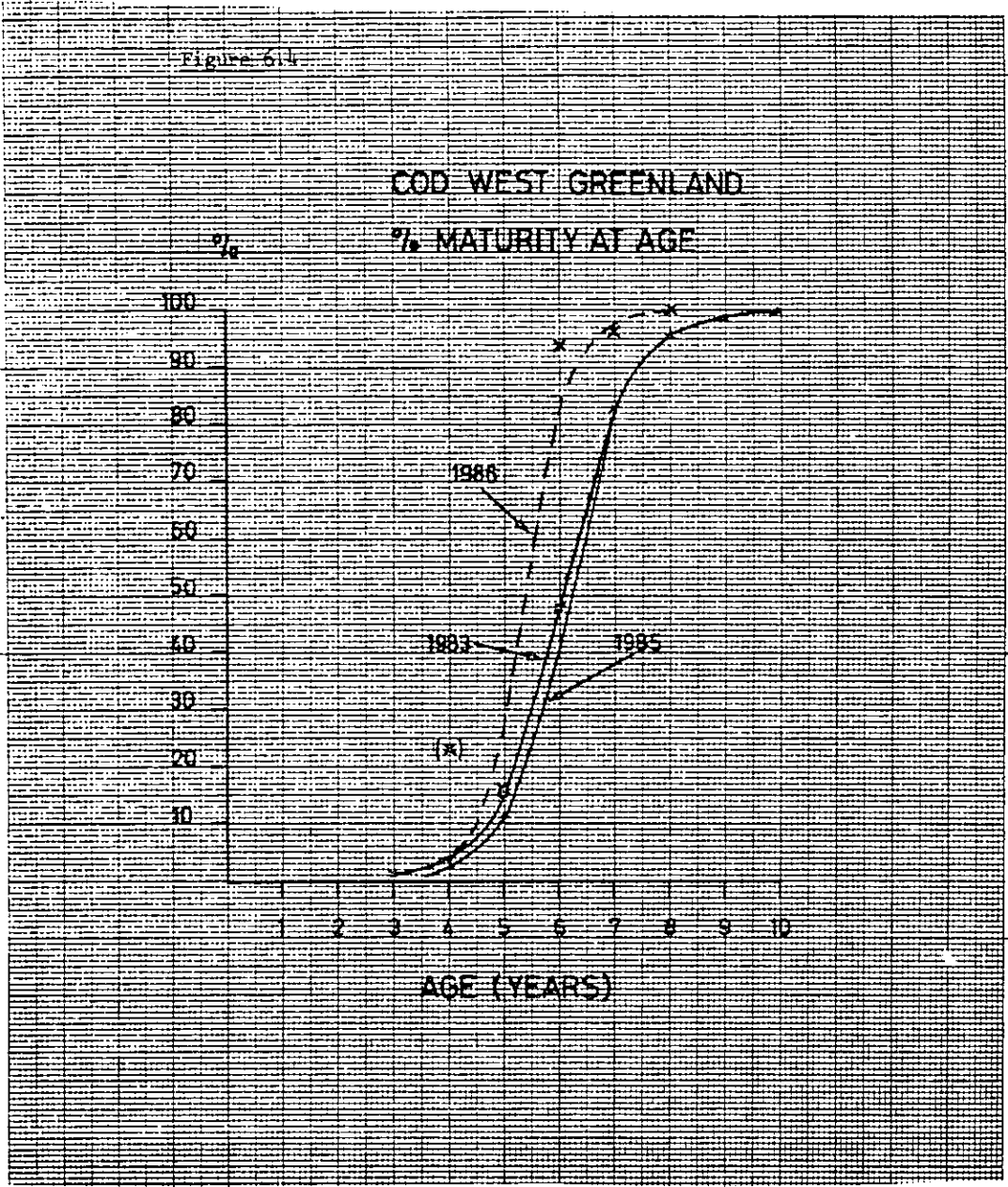


Figure 6.1. West Greenland cod. Trends in the total and 4+ survey biomass, CPUE of Greenland trawlers and inshore catches, 1982-1986. Because of the imposed restrictions on the commercial fisheries in 1986, the indices from the commercial fisheries have not been continued.

Figure 6.4


COD WEST GREENLAND
% MATURITY AT AGE
%
100
90
80
70
60
50
40
30
20
10
1986
1983
1985
1 2 3 4 5 6 7 8 9 10
AGE (YEARS)

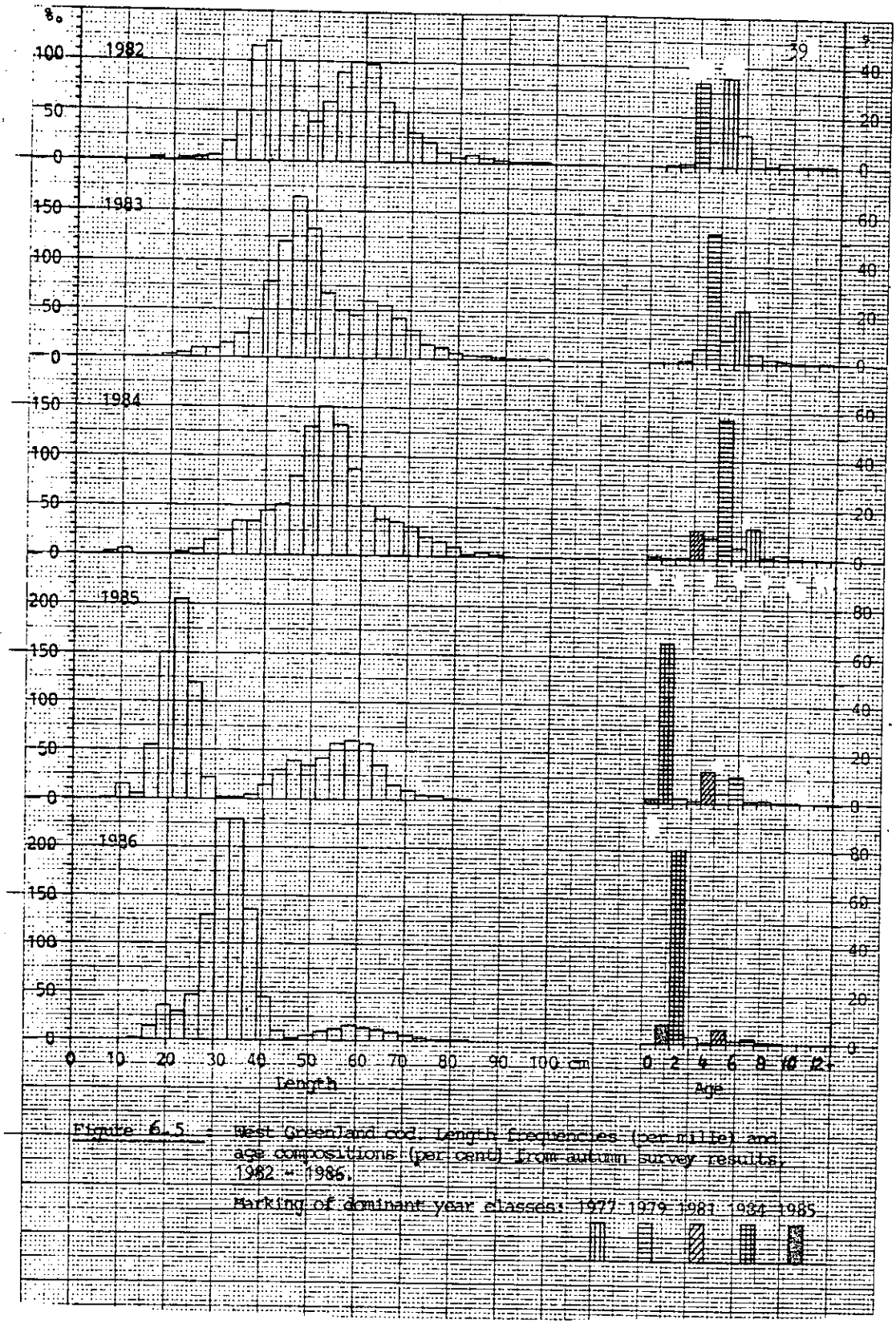


Figure 6.5 - West Greenland cod. Length frequencies (per mille) and age compositions (per cent) from autumn survey results, 1982 - 1986.

Marking of dominant year classes: 1977 1979 1981 1984 1985