This Report not to be quoted without prior reference to the Council[x)]

International Council for the
Exploration of the Sea
https://doi.org/10.17895/ices.pub.9354

C.M.1981/G:6
Demersal Fish Committee

THÜNEN
Digitalization sponsored
by Thünen-Institut

REPORT OF THE WORKING GROUP ON COD STOCKS OFF EAST GREENLAND

Copenhagen, 3 - 10 March, 1981

This document is a report of a Working Group of the International Council for the Exploration of the Sea and does not necessarily represent the views of the Council. Therefore, it should not be quoted without consultation with the General Secretary.

x) General Secretary,
ICES,
Palægade 2-4,
DK-1261 Copenhagen K,
Denmark.

TABLE OF CONTENTS

-o-o-o-

REPORT OF THE WORKING GROUP ON COD STOCKS OFF EAST GREENLAND

1. PARTICIPANTS

The ICES Working Group on Cod Stocks off East Greenland met in Copenhagen from 3-10 March 1981 with the following participants:

Sv. Aa. Horsted	Denmark
J Møller Jensen	Denmark
B W Jones	England
J Messtorff	Germany, Fed.Rep.of
S A Schopka (Chairman)	Iceland
A Schumacher	Germany, Fed.Rep.of

The ICES Statistician, V Nikolaev, also attended the meeting.

2. TERMS OF REFERENCE

At the 1980 Statutory Meeting it was decided (C.Res.1981/2:5) that a new Working Group on Cod Stocks off East Greenland should meet with the following terms of reference:

"(i) to evaluate and collate data necessary to assess the state of the stock including migrations and sources of progeny,

(ii) to provide advice on a TAC for this stock in 1982,

(iii) to assess the short-term losses and long-term gains which would result from an increase in mesh size up to 140 mm".

3. MIGRATIONS IN GREENLAND-ICELAND WATERS (Figure 3.0.1)

Stock analyses carried out for cod at West Greenland and at Iceland separately have shown results which indicate that there is an emigration of mature fish from the West Greenland area, whereas the stock at Iceland receives immigrants of fish which join the spawning stock at Iceland.

Tagging experiments have proved this general pattern of migration. They show that emigrants from West Greenland may go not only to East Greenland but also to Iceland, and that some of the fish undertaking such long-distance migrations may move rather quickly, some fish tagged at West Greenland having been recaptured at Iceland in the calendar year following that of their release at West Greenland.

Tagging experiments at Iceland show that a migration of adult fish from Icelandic to Greenland waters occurs very seldom and could be ignored in stock assessments. Likewise, the migration of old fish from East to West Greenland waters seems negligible, although some seasonal

migration eastwards as well as westwards is likely to occur in the boundary area round Cape Farewell.

So far as young, pre-recruit cod are concerned some year classes seem to have a considerable migration from East Greenland waters to the southern area of West Greenland. There is no evidence of migration of pre-recruit cod older than 0-group from Icelandic waters to East Greenland, but there does seem to be a feed-back of eggs and larvae from Iceland to East Greenland, although the magnitude of this egg and larval drift and the survival of larvae seem to vary considerably from year to year. Likewise, it is most likely that some eggs and larvae are carried to West Greenland from spawning areas off the southern part of East Greenland.

In this section only the migration of cod recruited to the fishery is considered in further detail.

3.1 Migration of West Greenland Cod to East Greenland/Iceland

Although the migration of West Greenland cod to East Greenland/Iceland may be somewhat counterbalanced by seasonal migration of adult fish in the boundary area round Cape Farewell, the situation, as far as stock models for the West Greenland area are concerned, seems relatively simple. The emigration can simply be allowed for by adding an additional coefficient of emigration to the natural mortality coefficient for the relevant age groups, and the problem is limited to obtaining a measure of the emigration rate. Tagging experiments at West Greenland have been the general source of information for the judgment on the immigration rate. Results of extensive Danish tagging experiments carried out in the period 1946-65 were presented to the ICES North-Western Working Group at its meeting in 1970 (Anon., 1971), and results of experiments in 1966-72 at a meeting of the same Group in 1976 (Anon., 1976). Results of experiments in 1972-78 were made available for the present meeting. However, the scale of material in these latter experiments was very small and - as was also the case in 1976 - did not allow the Working Group to make any revision to the findings of the 1970 meeting. The conclusion drawn at that meeting was that the actual overall proportion of mature fish at East Greenland and in the southern part of West Greenland (NAFO Div. 1E - 1F) emigrating to Iceland was about 25% per year, corresponding to a coefficient of emigration (E) of 0.29. For cod in the northern part of West Greenland (NAFO Div. 1A - 1D) the emigration to East Greenland/Iceland was considered so insignificant that it could be ignored in assessments.

So far as emigration from Div. 1E - 1F to East Greenland is concerned no direct measurements were given in the reports mentioned. Nevertheless, from these areas separately, the emigration to Iceland of mature fish was found to be about 14%. If some of the emigrants from Div. 1E - 1F travel only as far as East Greenland, the overall loss from Div. 1E - 1 F could be greater than the 14% estimated for the proportion emigrating to Iceland. However, since some seasonal backward migration of adult fish from Southeast Greenland to Div. 1E - 1 F is likely to occur, the Working Group felt that for the present analyses it could adopt the values used in recent years' assessments by ICNAF/NAFO of West Greenland cod, i.e. an overall coefficient of emigration of a value = 0.05 for West Greenland cod considered as a whole (Div. 1A - 1F). This value of 0.05 was arrived at in ICNAF assessments as a rough estimate of an overall, weighted mean between E = 0.0 for Div. 1A - 1D and E = 0.15 for Div. 1E - 1F.

The Working Group did, however, feel a need of checking or updating the emigration rate for the various parts of the West Greenland stock, especially because of the changes in areal distribution of the stock during the 1970s. The Working Group also emphasizes that it would be highly desirable to apply values of E which vary between year classes. It is, for instance, most likely that the emigration from West to East Greenland/Iceland of mature fish of the 1973 year class has been significantly higher than the overall E value of 0.05 quoted.

3.2 Migration of East Greenland Cod to Iceland

As already mentioned, tagging experiments at Iceland show that migration of mature fish from Iceland to Greenland waters is virtually non existant. Migrations from East Greenland waters to Iceland can thus be regarded as a one-way migration. However, the fact that East Greenland does receive immigrants from West Greenland complicates the calculations of the emigration rate to Iceland. Stock analyses for East Greenland cod separately may not by themselves give any indication of emigration if immigration and emigration counterbalance each other.

Apart from some Danish tagging experiments carried out at East Greenland in the Skjoldungen-Angmagssalik area around 1960, tagging experiments in this region have generally been carried out on trawl-caught cod. The recaptures from such experiments confirm the migrations to Iceland, but the very limited number of recaptures do not allow a quantification of the migration. From the Danish experiments

the North-Western Working Group concluded in 1970 that as much as 45% of mature cod from the East Greenland tagging area migrated to Iceland. However, the North-Western Working Group did not consider the East Greenland cod separately but as being combined with cod occurring in Div. 1E - 1F at West Greenland. For that combined stock the North-Western Working Group did, as mentioned, find that a coefficient of migration equal to 0.29 would reflect the contribution of mature fish to the stock at Iceland.

The ICES/ICNAF Working Group on Cod Stocks in the North Atlantic at its meeting in 1972 (Anon., 1973) made another attempt to estimate the migrations from Greenland to Iceland. This attempt was made by applying the virtual population technique in back-calculation to age 3 of mature age groups and of immature age groups, respectively. The difference between the two sets of resultant figures at age 3 was regarded as the number of 3 year old fish in the Div. 1E - 1F plus East Greenland stock which would ultimately migrate to Iceland at maturity.

The results of this analysis gave a value of migration from the area quoted of 24%, practically the same as the value (25%) found by the North-Western Working Group.

Since then no detailed analyses of the quantity of Greenland immigrants in the spawning stock at Iceland have been made. Recent years' tagging experiments seem not to form a sufficient basis for such analyses.

As their best guideline the Working Group therefore considered that a value for the net emigration rate from the whole of East Greenland to Iceland was about 25%, equal to a coefficient of E = 0.29. Again, the Working Group stresses the need for keeping this parameter under constant and critical review since it is likely to differ considerably between years and year classes.

3.3 Evidence of Larval Drift from Iceland to Greenland Waters

It has been known for a long time that in some years cod eggs and larvae from the spawning areas off the south and southwest coast of Iceland drift with the currents into East Greenland waters. In the ICNAF NORWESTLANT (1963) survey, cod eggs were found in an almost continuous belt from Iceland to East Greenland, along the East Greenland coast, round Cape Farewell and over the banks at West Greenland (Anon.,1969). During this survey larvae were only found to be concentrated in two

areas, one at West Greenland with larvae of West Greenland origin and the other in the Dohrn Bank area. As the 1963 year class was of great importance to the fishery at both West and East Greenland and no larvae could be detected at Southwest Greenland (Divisions 1E and 1F) it is likely that this year class at Southwest Greenland and East Greenland originated from larval concentrations found in the Dohrn Bank area between Iceland and East Greenland in July. When this year class became mature, large numbers of fish from West and East Greenland waters appeared in the spawning area off the southwest coast of Iceland.

Since 1970, international, and later on Icelandic, 0-group surveys have been carried out in the Iceland-East Greenland area. During the years 1970-75, and again in 1980 (Vilhjálmsson et al., 1980), no 0-group cod were found along the East Greenland coast from 64°N to 60°N. In the years 1976-79 (Anon., 1976; Anon., 1977; Anon., 1978; Anon., 1979) some cod were found off the East Greenland coast, but the magnitude was very small in comparison with the total outcome of the whole East Greenland-Icelandic area. In the Dohrn Bank area 0-group indices have also been very low with the exception of 1973, when more than 10% of the total 0-group cod, possibly from the Icelandic spawning, were found in the Dohrn Bank area (Table 3.3.1) (Vilhjálmsson et al., 1976). This particular year class has been very important to the fisheries both off West and East Greenland in recent years. Results of the Icelandic tagging experiments carried out in East Greenland waters and the Danish tagging experiments in the West Greenland area indicate, that mature fish of this year class migrated from East Greenland to the spawning grounds at Iceland in 1979 and from West Greenland to Iceland, particularly in 1980.

From the 0-group surveys it becomes quite evident that the drift of young cod from the Iceland spawning grounds to the different nursery grounds at Iceland varies from year to year. The same applies to the drift of young cod from Iceland to East Greenland waters. In some years no larval drifts to the Greenland area seem to have been taking place, while in the other years there were some, and in some years, like 1963 and 1973, considerable numbers drifted to East Greenland waters.

The drift of eggs, larvae and 0-group fish seems to be more or less dependent on hydrographical and meteorological conditions in the Iceland-East Greenland area. Particularly off the west coast of Iceland the influx of Atlantic water and the dominant wind direction

during spring are likely to be the two major factors which determine the direction of the currents in the upper layers and hence the larval drift.

4. RECENT TRENDS IN THE FISHERY

4.1 Fleet

At present the fishery for cod in East Greenland waters can be divided into two components: an inshore and coastal fishing for cod in the Angmagssalik area, and a trawl fishery on the offshore banks and along the slope of the Greenland Shelf from Dohrn Bank southwards to Cape Farewell. This trawl fishery is to a great extent a mixed fishery on cod and redfish.

The coastal fishery is carried out mainly by hand- and longlines from small boats (< 50 GRT). Annual landings from this fishery have generally been less than a thousand tonnes prior to 1977, and thereafter between one and two thousand tonnes. In 1980, pound nets were introduced in the fishery. This may well lead to an increase in the relative importance of the inshore component of the fishery, and a possible consequent increase in fishing mortality on the younger fish.

The offshore fleet accounted for more than 90% of the landings prior to 1977. This component of the fleet consists of wetfish trawlers as well as freezer trawlers mainly in the size categories 1 000 - 1 999 GRT and 2 000 - 3 999 GRT, respectively. Participation by wetfish trawlers in the 500 - 999 GRT category was much more pronounced previously, but these vessels have been gradually disappearing, except the Greenland trawlers.

4.2 Catches and Fishing Effort

Landings of cod from Sub-area XIV fluctuated without trend during the period 1962-71 (Table 4.2.1) from 13 000 tonnes to 36 000 tonnes, with an average of 22 000 tonnes. From 1971 there was a rapid decline in landings from 32 200 tonnes to 6 000 tonnes in 1975. Observations of year class strengths at East Greenland indicated that this decline was mainly due to the small size of recruiting year classes resulting in a very low abundance of both the fishable stock and the spawning stock. The Council of the European Economic Communities (EEC) decided that from 1977 to 1980 there should be no directed cod fishing at East Greenland except for a small quantity to be taken by Greenland vessels. In 1981, there is a permission for vessels, other than Greenlandic, to catch cod in a directed fishery.

The stock size began to improve with the recruitment of the somewhat more abundant 1972 year class and the strong 1973 year class. Catches officially reported from East Greenland have continued to be low, but there has been additional unauthorised fishing from 1977, the catches of which have not been officially reported to ICES. Table 4.2.1 includes estimates of unreported landings for the years 1977-80 (Horsted et al., 1980) and shows that the estimated total catches increased to a peak value of 34 000 tonnes in 1979 sustained mainly by the 1972 and 1973 year classes.

A more effective control of fishing activity in 1980 seems to have led to decreased effort and a decrease in catches compared to those estimated for the years 1977-79. As a result of a more effective control and the by-catch regulation of only 10% for cod in the redfish fishery considerable discarding of marketable cod took place in 1980. An allowance of 2 000 tonnes for discarded fish was included in the Working Group's estimate of total catch in 1980.

The Working Group was unable to derive any figures for fishing effort on cod. The fishery at East Greenland exploits both cod and redfish, and it is not possible to divide the total effort figures into the components directed towards redfish and cod. In addition, non-reporting of unauthorised fishing in recent years would make any estimate of fishing effort very unreliable.

5. ASSESSMENTS OF EAST GREENLAND COD STOCKS

5.1 Biomass Estimates from Surveys

The Federal Republic of Germany has commenced a programme of groundfish surveys off East Greenland. These are intended to be conducted according to a stratified random sampling design. The first survey, conducted in September/October 1980, did not meet all desirable requirements, mainly because the design of a suitable stratification scheme for the East Greenland shelf area was not completed in time. The area of the main distribution of cod, however, was covered more or less at random by 100 standard sets of 30 min. duration at the towing speed of 4 knots using a standard survey bottom trawl (horizontal opening 22 m) fitted with a small meshed liner (30 mm) inside the cod end. Meanwhile the stratification scheme has been completed in so far as the areas per 200 m depth zones in square nautical miles (nm^2) are now available for all strata-blocks (30'latitude x 1° longitude).

At the time of the above-mentioned survey cod appeared to be more or less evenly distributed in the area and in any case did not form dense local concentrations. Therefore it seemed to be justified to use those survey results for a first rough estimation of the trawlable biomass of cod off East Greenland. The total area for which the biomass was estimated is illustrated in Figure 5.1.1.

The results of the survey (Table 5.1.1) gave the stock biomass estimate of 92 000 tonnes with an 80% confidence interval of 61 000 - 123 000 tonnes. This is not inconsistent with the stock biomass estimate from VPA of 77 000 tonnes.

5.2 Weight at Age

The following values for weight at age were used in the present analysis:

Age	Mean weight (kg)
2	0.12
3	0.40
4	1.13
5	1.39
6	2.26
7	3.21
8	4.38
9	5.52
10	7.09
11	8.20
12	8.70
13	9.30
14+	9.70

These mean weights at age were calculated from the corresponding mean lengths at age as obtained from the age composition in numbers of the total catch taken off East Greenland in 1980 by applying the following length-weight equation:

$$W = 0.000010755 \times L^{2.952}$$

The basic data for the calculation of the above regression were obtained from individual weight at length data sampled during a research vessel survey off East Greenland by the Federal Republic of Germany in September/October 1980.

The mean lengths at age calculated from the combined age composition for both catch components served as a basis for the mean weight at age calculation. Because of some inconsistencies, however, in mean weight at age for cod of age 11 and older due to the low representation of these age groups in the catches the corresponding values had to be smoothed.

There are discrepancies between the actual catch weights and the catch weights derived by multiplying catch numbers at age and the corresponding average weight (SOP) (Table 5.2.1). Since these discrepancies are very small for 1980, it was decided to use the average weight at age figures given above for catch predictions. In order to adjust both the total and the spawning biomass figures resulting from VPA for earlier years, a factor, derived from the nominal catches divided by the estimated catches, is applied for each year.

5.3 Selection of a Suitable Measure of Fishing Mortality

The Working Group studied the problem of selecting a suitable measure for fishing mortality which could be expressed as a single figure for each year.

The method of using an average F over some age groups weighted by stock in numbers was rejected for the East Greenland cod, since this method tends to result in bias due to considerable fluctuations in year class strength.

The average over the older age groups (> 10) for which F is generally high represents only a relatively small component of the total catch, particularly in recent years. The F values for older age groups fluctuate greatly and, in addition, they may be biased by the choice of the starting F for the oldest age groups in the VPAs.

The Working Group considered the possibility of relying on the F values for the age groups which are contributing most to the catches but which are outside the range of groups, which are likely to be affected by possible changes in exploitation pattern due to changes in mesh size. Examination of accumulated catches, in percentage of total catch, for different combinations of age groups (Table 5.3.1) showed that in general more than 2/3 of the total catch is covered by at least 5 age groups beginning with ages 5 or 6.

Since age group 6 will be only slightly affected by possible changes in mesh size up to 155 mm, and in view of the problems discussed above in relation to older fish (> 10 years old), the Working Group decided to use the average unweighted fishing mortality on age groups 6 to 10 as reference F in the presentation of the assessments. Where used, this index of F is indicated as $\bar{F}_{(6-10)}$.

5.4 Virtual Population Analysis (VPA)

In conventional VPA, emigration of fish from the East Greenland area can be simulated by incorporating an additional coefficient for emigration,

and this can be combined with the natural mortality coefficient for the appropriate age groups. However, a computer program was available for VPA corrected for migration and this was used by the Group. The program was that used and described by Jones (1978). In the present analysis, the catch age composition data used in the analysis were those for East Greenland and Iceland. In the migration model the calculation for the stock experiencing emigration (East Greenland) is the same as that described above for conventional VPA. The use of the migration model, however, did permit the Group to make an estimate of the number and biomass of migrants from East Greenland that are present at Iceland in each year.

The age composition data for the Iceland area used in the model were taken from Schopka (1980) with the addition of provisional data for 1980 (Table 5.4.1). The catch age composition data for East Greenland were the same as those used by Horsted et al. (1980) with the exception that data for 1980 were updated (Table 5.4.2). The age composition for the 1980 offshore trawler catches was determined from quarterly age/length keys and length sampling of commercial landings of the Federal Republic of Germany. That for the Greenland inshore catches was based on selected German research vessel age compositions obtained in September/October 1980 in the appropriate areas.

The emigration rate adopted for age groups seven and older at East Greenland was E = 0.29 (see Section 3.2). The fishery at Iceland also receives immigrants from West Greenland, but no attempt has been made to correct for these in the present analysis and therefore the results will be biased. However, as far as the East Greenland fishery is concerned, any bias is not expected to be large.

For the VPA, input F values for the Iceland area are given in Table 5.4.1. Some of these values (those for the oldest age groups in 1970 and 1978) are atypically low, but these values had to be used to obtain a numerical solution for the year classes concerned. For the East Greenland area, input F values are shown in Table 5.4.3. The Working Group had very little additional information to guide it in its choice of input F values for 1980 and the values used by Horsted et al. (1980) were adopted. Tables 5.4.4 and 5.4.5 give the calculated stock numbers and stock biomass respectively.

A value for the coefficient of natural mortality of M = 0.2 has been used throughout.

Results of VPA show that the average year class strength at three years old for the year classes 1962-74 was 21.7 x 10^6 (Table 5.4.6). The abundant year classes of 1961, 1962 and 1963 were succeeded by a series of mainly poor year classes until the recruitment of the 1972 year class, which was a little above the average strength, and the abundant 1973 year class. Subsequent year classes all appear to be of below average size.

As a series of abundant year classes passed out of the fishery from about 1973, fishing mortality became reduced as the fishery became increasingly less attractive. However, with the recruitment of the 1972 and 1973 year classes in 1976 fishing increased again and fishing mortality appears to have reached a high level mainly as a result of unauthorised fishing by vessels from outside Greenland.

Adult stock biomasses (age groups 7 and older) reached its lowest recorded level in 1977-78 (Table 5.4.6, Figure 5.4.1), but the recruitment of the 1972 and 1973 year classes to the adult stock in 1979 and 1980 has resulted in a temporary improvement. Because of the unauthorised fishing, these two year classes will not make as great a contribution to the spawning stock as had been hoped for. Two lines are shown in Figure 5.4.1 for estimates with and without SOP correction. The effect of the correction is very small compared to the temporal changes in the biomass.

From the migration model VPA the numbers of East Greenland migrants present in the stock at Iceland at the beginning of each year have been estimated. The results are given in Table 5.4.7. Using the East Greenland weight at age data, the stock biomass of East Greenland migrants at Iceland has been calculated and included in Table 5.4.7. Also shown for comparison are the annual estimates of the adult stock biomass at East Greenland (age groups 7-14+). The annual estimates of the percentage of East Greenland migrants at Iceland vary from 13 to 40% of the biomass (when expressed as a percentage of the stock at East Greenland and the migrants at Iceland combined) with an average value of 22%.

6. CATCH PREDICTIONS AND MANAGEMENT OPTIONS

Input data for catch predictions are given in Table 6.1. Since there is no clear indication of what the catch in 1981 is likely to be, the Working Group prepared catch predictions for 1982 for two assumed values of the catch in 1981, i.e. of 8 000 tonnes and 12 000 tonnes, respectively. To take

these catches in 1981 would require fishing mortalities of $\bar{F}(6-10)$ = 0.265 and 0.425 respectively. Catches for 1982 have been calculated for a range of values of fishing mortality. The results are plotted in Figures 6.1 and 6.2 and some management options for 1982 are given in the text table below.

Management options for 1982

A. If the 1981 catch equals 8 000 tonnes:

1981					1982				1983	
Stock biom.	Spawning stock biom.	$\bar{F}(6-10)$	Catch	Management option for 1982	Stock biom.	Spawn. stock biom.	$\bar{F}(6-10)$	Catch	Stock biom.	Spawning st[illegible] bio[illegible]
68	36	.265	8	$F_{0.1}$	63	26	.40	10.4	61	25
				F_{max}						
				$F_{82}=F_{80}$			.27	7.4	64	28
				$F_{82}=F_{81}$			.265	7.3	64	28
				TAC = 6 000 t			.21	6	66	30

Weights in thousand tonnes.

B. If the 1981 catch equals 12 000 tonnes:

1981					1982				1983	
Stock biom.	Spawning stock biom.	$\bar{F}(6-10)$	Catch	Management option for 1982	Stock biom.	Spawn. stock biom.	$\bar{F}(6-10)$	Catch	Stock biom.	Spawning stock biom.
68	36	.425	12	$F_{0.1}$	59	23	.40	9.2	59	23
				F_{max}						
				$F_{82} = F_{80}$			.27	6.5	61	25
				$F_{82} = F_{81}$			.425	9.7	58	23
				TAC = 6 000 t			.24	6	64	26

Weight in thousand tonnes

The present (1980) fishing mortality value is $\bar{F}_{(6-10)} = 0.27$ which is below $F_{0.1} = 0.4$. However, at present, probably the most important consideration in relation to management options is the maintenance of a viable spawning stock. In addition to a possible dependence on spawning stock size, recruitment at Greenland appears to be very dependent on environmental temperature. Another uncertain factor is the contribution to recruitment at East Greenland which might result from spawning at Iceland. Spawning stock biomass at East Greenland reached its lowest recorded level of about 25 000 tonnes in 1977-78. Heavy fishing on the 1972 and 1973 year classes prevented them from making more than a temporary improvement to the spawning stock. These two year classes will have made their maximum contribution to the spawning stock in 1980. In subsequent years a downward trend in spawning stock is to be expected unless there is an improvement in the general level of recruitment. If recruitment at age 3 was maintained at about 8×10^6 fish an equilibrium spawning stock biomass of about 24 000 tonnes would be expected with the current exploitation pattern and with fishing mortality at the 1980 level of $\bar{F}_{(6-10)} = 0.27$. Higher levels of fishing mortality would result in spawning stocks of even lower size. If fishing was to be stopped completely, an annual recruitment of 8×10^6 fish would be expected to produce an equilibrium long-term spawning stock biomass of only about 44 000 tonnes. Thus, an increase in the spawning stock above this level would require the recruitment of more abundant year classes and the high levels of spawning stock biomass in former years have been the result of one or more abundant year classes rather than a low level of fishing. It would appear that the best opportunity of increasing spawning stock biomass would be to take advantage of abundant year classes when they occur by preventing an increase in fishing when an abundant year class recruits to the fishery. At present, however, there is a need to restrict fishing to prevent the spawning stock size from declining any further in order to ensure a reasonable probability of good recruitment when environmental conditions are favourable.

In 1980 considerable discarding took place as a result of stringent by-catch regulations. An estimated amount of these discards has been incorporated into the assessments. The predicted catches for 1982 for different levels of F refer to total removals from the stock, i.e. catches in directed fisheries, by-catches in fisheries for other species and discards. If management is aiming at a certain level of fishing mortality, provisions are to be made to solve the discarding problem in order to achieve the management objective.

7. MESH CHANGE ASSESSMENT

The effects of a change in the trawl cod end minimum mesh size to both 140 mm and 155 mm were calculated. It was assumed that the effective mesh size currently in use is 120 mm. No selection experiments have been carried out at East Greenland but the Working Group considered that results from experiments in NAFO Division 1D would be applicable to East Greenland. Experiments by Bohl (1967) indicated that an average selection factor of 3.4 was applicable to cod. On the basis of selection curves, modified exploitation patterns were calculated corresponding to minimum mesh sizes of 140 mm and 155 mm (Table 7.1). Yield per recruit curves were calculated for the three exploitation patterns (Figure 7.1) to estimate the long-term change in yield per recruit which would be expected from the use of the larger mesh sizes.

The results indicate that there would be very little long-term change in yield from increasing the minimum mesh size up to 155 mm at any likely levels of fishing mortality. This is because the present exploitation pattern is determined more by availability than by selection. The short-term effects on yield of mesh changes within the range considered would be so small as to be insignificant. The long-term effects on spawning stock biomass per recruit are also indicated in Figure 7.1. For a mesh size of 140 mm a long-term improvement in spawning stock biomass of about 6% would be expected at present levels of F, and for a 155 mm mesh the increase would be about 10%.

Although there is no gain in yield to be expected from a mesh increase to 140 mm or 155 mm with the present exploitation pattern, there is always the possibility of developments in the fishery which could adversely change the exploitation pattern. Such a change could result, for example, from an increase in fishing in inshore waters where more small fish would be expected to be available to capture. Thus an increase in mesh size at the present time could be beneficial if there is any possibility of a future adverse change in the exploitation pattern. No short-term losses in the cod fishery would be expected from a mesh increase while the present exploitation pattern prevails; however, possible effects on the redfish fishery should not be overlooked.

8. PROPOSALS ON FUTURE RESEARCH IN THE AREA

The fact that cod is migrating into and out of East Greenland waters makes it necessary to continue the tagging experiments in Greenland

waters in order to monitor migration rates. At West Greenland, tagging has been carried out regularly since the end of World War II, but at East Greenland tagging experiments have been undertaken only occasionally.

The Group therefore recommends that tagging experiments should be resumed, and coordinated, by the nations concerned. The Group further recommends that the existing sampling of the age composition of landings should be continued and extended to cover all fisheries in the area.

The Group recommends that analyses of genetic studies of cod in the Greenland/Iceland area should be reported to ICES as soon as possible.

REFERENCES

Anon., 1969. ICNAF Spec. Publ. No.7, Part I. Environmental Surveys. NORWESTLANT, 1-3., 1963.

Anon., 1971. Report of the Northwestern Working Group 1970. ICES, C.M. 1971/F:2 (mimeo).

Anon., 1973. Report of the ICES/ICNAF Working Group on Cod Stocks in the North Atlantic. ICES Coop.Res. Rep., No.33.

Anon., 1976. Report of the Northwestern Working Group. ICES, C.M. 1976/F:6.

Anon., 1976. Preliminary report on the O-group fish survey in Iceland and Greenland waters,July-August 1976. ICES, C.M. 1976/H:39.

Anon., 1977. Report on the O-group fish survey in Icelandic and Greenland waters August 1977. ICES, C.M. 1977/H:22.

Anon., 1978 Report on O-group fish survey in Icelandic and East Greenland waters, August 1978. ICES, C.M.1978/H:66

Anon., 1979. Report on the O-group fish survey in Iceland and East Greenland waters August-September 1979, ICES, C.M. 1979/H:31.

Bohl, H. 1967. Recent selection experiments with the approved ICNAF topside chafer. Redbook, Int. Comm. NW Atlant. Fish., 1966 (3).

[illegible]ed, Sv. Aa., Jensen, J.M, Jones, B. W, Messtorff, J and Schumacher, A. 1980. An assessment of the Cod Stock at East Greenland. ICES, C.M. 1980/G:49.

Jones, B. W. 1978. The potential contribution of Cod from Greenland to the fishery at Iceland. ICES, C.M. 1978/G:17.

Schopka, S. A, 1980. The recent changes in fishing pattern in Icelandic waters and their effects on the yield of cod and haddock stocks. ICES, C.M. 1980/G:42

Vilhjálmsson, H and E Fridgeirsson, 1976. A review of O-group surveys in the Iceland-East Greenland area in the years 1970-75. ICES, Coop. Res. Rep., No. 54.

Vilhjálmsson, H, J. V. Magnusson and E Fridgeirsson. L980. Report on the O-group fish survey in Icelandic and East Greenland waters, August 1980. ICES, C.M. 1980 /H:64.

Table 3.3.1 Abundance indices of 0-group cod from the international and Icelandic 0-group survey in the East Greenland/Iceland area, 1970-80 (except 1972).

Year class	SW Iceland	W Iceland	Dohrn B. E. Greenl.	N Iceland	E Iceland	SE Iceland	Total
1970	0	23	+	848	0	+	873
1971	9	60	+	214	0	0	283
1973	107	96	135	757	86	10	1 191
1974	0	22	2	30	+	0	54
1975	2	50	+	73	5	0	130
1976	30	102	5	2 015	584	9	2 743
1977	+	26	7	305	94	2	435
1978	+	169	2	335	47	0	552
1979	1	22	2	345	+	+	370
1980	+	38	1	507	10	2	557

Table 4.2.1 Nominal catches (in tonnes) of COD in Sub-area XIV, 1962-80.
(Data for 1962-79 broken down by countries are from Bulletin Statistique)

Country	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980 x)
Canada	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-
Faroe Islands	-	-	-	-	-	-	-	-	-	-	924	167	652	581	440	1 407	6	-	-
German Dem.Rep.	-	-	101	52	39	38	-	333	358	730	186	8	15	326	-	-	-	-	c)
Germany,Fed.Rep.	14 299	13 877	30 623	10 965	7 786	12 117	8 323	12 635	13 930	25 644	21 592	9 262	2 309	1 552	7 075	3 564	3 936	1 062	3 466 a)
Greenland	903	904	1 120	887	880	753	628	627	501	533	279	191	68	224	372	1 833	1 347	2 755	1 367
Iceland	298	1 804	2 846	4 713	3 977	10 474	6 723	4 473	5 461	4 580	3 195	1 446	3 009	785	3 133	25	13	3	9
Norway	-	-	-	-	-	-	-	-	-	-	-	-	-	1 864	364	537	17	-	-
Poland	-	-	-	-	-	-	-	-	841	419	318	17	1	18	-	-	-	-	-
U.K.(Engl.&Wales)	1 745	728	958	932	227	1 383	27	-	140	28	184	661	499	575	1 514	1 393	41	-	-
U.K.(Scotland)	50	47	30	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
U.S.S.R.	-	5 697	-	-	-	5	-	36	34	312	137	-	-	-	127	16	-	-	-
Total	17 295	23 507	35 678	17 549	12 909	24 770	15 701	18 104	21 265	32 246	26 815	11 752	6 553	5 925	13 027	8 775	5 362	3 820	4 842
WG Total including estimates of unreported catches																18 000	26 000	34 000	12 000 b)

x) Preliminary

a) July to December catch estimates based on information from fishing vessels

b) Including 2 000 tonnes of estimated discards

c) From Data Form 5

Table 5.1.1 Estimate of trawlable biomass of cod off East Greenland from survey data.

Depth zone m	Area nm^2	Number of sets	Mean density of cod t/nm^2	Confidence limits at 60% level	Trawlable biomass (in t)		
					average	minimum	maximum
0 - 200	1 909	19	14.6	± 30.17%	27 871	19 463	36 280
200 - 400	10 728	66	5.8	± 33.63%	62 222	41 297	83 148
400 - 600	3 835	15	0.5	± 71.14%	1 918	553	3 282
0 - 600	16 472	100			92 011	61 313	122 710

Table 5.2.1 East Greenland COD.
Nominal catch weight and sum of products (SOP) check.

Age	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	0.00	11.20	0.00	0.00	0.00	0.00	0.00	0.00	1.60
4	148.03	23.73	163.85	117.52	35.03	74.58	28.25	30.51	28.25
5	48.65	653.30	419.78	875.70	350.28	105.64	237.69	118.15	273.83
6	205.66	201.14	5301.96	1134.52	1918.74	1130.00	359.34	574.04	284.76
7	2821.59	439.77	1810.44	8041.05	2471.70	4940.19	3373.71	946.95	802.50
8	2895.18	4690.98	919.80	1042.44	9211.14	4642.80	16578.30	5689.62	359.16
9	8191.68	1981.68	7131.84	342.24	938.40	9466.80	8721.60	17575.68	3919.20
10	418.31	2963.62	3488.28	1020.96	269.42	1680.33	9401.34	5799.62	6799.31
11	221.40	188.60	3042.20	565.80	672.40	262.40	1402.20	3854.00	1820.40
12	1209.30	26.10	321.90	234.90	591.60	548.10	165.30	1183.20	626.40
13	269.70	251.10	158.10	46.50	223.20	446.40	37.20	241.80	176.70
14+	1726.60	349.20	785.70	242.50	834.20	261.90	135.80	514.10	67.90
A) SOP	18156.10	11780.42	23543.85	13664.13	17516.11	23559.14	40440.73	36527.67	15160.01
B) NOMINAL	17549.00	12909.00	24770.00	15701.00	18104.00	21265.00	32246.00	26815.00	11752.00
(B/A)%	96.66	109.58	105.21	114.91	103.36	90.26	79.74	73.41	77.52

Age	1974	1975	1976	1977	1978	1979	1980
3	1.60	22.80	102.80	0.00	0.00	2.00	5.60
4	71.19	64.41	197.75	523.55	482.51	163.85	88.14
5	30.58	471.21	225.18	1674.95	9463.12	1645.76	326.65
6	1102.88	194.36	1333.40	1159.38	4131.28	10622.00	503.98
7	564.96	2513.43	731.88	2092.92	603.48	8843.55	7479.30
8	810.30	678.90	6771.48	911.04	897.90	3490.86	3044.10
9	287.04	452.64	872.16	2340.48	612.72	667.92	425.04
10	2332.61	148.89	822.44	1162.76	1971.02	361.59	63.81
11	2123.80	541.20	434.60	631.40	1066.00	147.60	16.40
12	565.50	452.40	113.10	252.30	809.10	95.70	43.50
13	102.30	148.80	279.00	83.70	520.80	9.30	9.30
14+	19.40	38.80	19.40	9.70	184.30	9.70	58.20
A) SOP	8012.16	5727.84	11903.19	15556.18	20742.23	26059.83	12064.02
B) NOMINAL	6553.00	5925.00	13027.00	18000.00	26000.00	34000.00	12000.00
(B/A)%	81.79	103.44	109.44	115.71	125.35	130.47	99.47

Table 5.3.1 COD off East Greenland (ICES Sub-area XIV), 1971-80. Accumulated catch in number (thousands) over different age groups in % of total catch.

Age Groups	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
5 - 7	17	10	21	41	70	29	30	87	88	78
5 - 8	62	29	25	53	79	76	33	89	96	97
5 - 9	81	77	51	56	84	81	38	90	98	99
5 - 10	97	89	87	76	85	84	40	93	98	99
5 - 11	99	96	95	91	89	86	41	94	98	99
6 - 8	60	28	17	51	60	71	17	22	84	90
6 - 9	79	76	44	54	64	76	23	23	86	92
6 - 10	95	88	80	74	66	79	25	26	86	93
6 - 11	97	95	88	90	69	81	26	27	86	93
6 - 12	97	97	91	94	73	81	26	28	86	93
7 - 9	77	72	39	25	59	58	16	5	38	86
7 - 10	93	84	75	45	61	62	18	8	38	87
7 - 11	95	91	83	60	64	63	19	9	38	87
7 - 12	96	93	86	64	68	64	20	10	38	87
7 - 13	96	94	87	65	68	64	20	11	38	87
8 - 10	81	80	66	34	15	55	10	6	10	22
8 - 11	83	87	74	50	17	56	11	7	10	22
8 - 12	83	89	77	54	22	57	11	8	10	22
8 - 13	83	89	77	54	23	58	12	9	10	22
9 - 11	37	67	71	39	10	10	8	5	2	2
9 - 12	37	69	73	42	13	10	9	6	2	3
9 - 13	37	70	74	43	14	11	9	7	2	3
Total catch in numbers (thousands)	8 305	6 647	2 673	1 656	1 718	3 330	7 917	10 143	9 789	3 675

Table 5.4.1 Input data used in migration model VPA for the Iceland area.

Age	Provisional Catch 1980 (thousands)	Input F 1980
3	4 195	
4	31 226	
5	34 121	
6	14 374	0.5
7	27 562	0.7
8	7 157	0.8
9	2 068	0.8
10	729	0.8
11	313	0.8
12	106	0.8
13	60	0.8

Year	Input F for Age-group 13
1964	1.1
1965	1.1
1966	1.1
1967	1.1
1968	1.1
1969	1.1
1970	0.5 *
1971	1.3
1972	1.3
1973	1.2
1974	1.3
1975	1.3
1976	1.3
1977	1.0
1978	0.05*
1979	0.8

* Low value necessary to obtain a numerical solution

Table 5.4.2 COD off East Greenland.
Input catch data for VPA ('000)

Age	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	0	28	0	0	0	0	0	0	4
4	131	21	145	104	31	66	25	27	25
5	35	470	302	630	252	76	171	85	197
6	91	89	2346	502	849	500	159	254	126
7	879	137	564	2505	770	1539	1051	295	250
8	661	1071	210	238	2103	1060	3785	1299	82
9	1484	359	1292	62	170	1715	1580	3184	710
10	59	418	492	144	38	237	1326	818	959
11	27	23	371	69	82	32	171	470	222
12	139	3	37	27	68	63	19	136	72
13	29	27	17	5	24	48	4	26	19
14+	178	36	81	25	86	27	14	53	7
A) TOTAL	3713	2682	5857	4311	4473	5363	8305	6647	2673

Age	1974	1975	1976	1977	1978	1979	1980
3	4	57	257	0	0	5	14
4	63	57	175	4635	427	145	78
5	22	339	162	1205	6808	1184	235
6	488	86	590	513	1828	4700	223
7	176	783	228	652	188	2755	2350
8	185	155	1546	208	205	797	695
9	52	82	158	424	111	121	77
10	329	21	116	164	278	51	9
11	259	66	53	77	130	18	2
12	65	52	13	29	93	11	5
13	11	16	30	9	56	1	1
14+	2	4	2	1	19	1	6
A) TOTAL	1656	1718	3330	7917	10143	9789	3675

Table 5.4.3 COD off East Greenland.
Fishing mortalities from VPA (M = 0.2; E = 0.29 on ages ≥ 7)

Age	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01
5	0.00	0.01	0.01	0.01	0.02	0.01	0.03	0.02	0.02
6	0.03	0.01	0.08	0.03	0.02	0.05	0.04	0.06	0.03
7	0.12	0.06	0.10	0.13	0.06	0.06	0.15	0.10	0.09
8	0.12	0.28	0.17	0.08	0.21	0.14	0.29	0.39	0.05
9	0.46	0.12	0.95	0.09	0.10	0.37	0.44	0.62	0.55
10	0.23	0.31	0.33	0.35	0.10	0.26	0.82	0.63	0.55
11	0.12	0.18	0.74	0.10	0.48	0.16	0.42	1.26	0.50
12	0.52	0.02	0.69	0.14	0.18	1.40	0.19	1.08	1.02
13	0.25	0.25	0.25	0.25	0.25	0.25	0.40	0.60	0.60
14+	0.25	0.25	0.25	0.25	0.25	0.25	0.40	0.60	0.60
F(6-10),U	0.19	0.16	0.33	0.13	0.10	0.18	0.35	0.36	0.26
F(6-10),W	0.17	0.12	0.14	0.08	0.07	0.11	0.29	0.39	0.22

Age	1974	1975	1976	1977	1978	1979	1980
3	0.00	0.00	0.01	0.00	0.00	0.00	0.00
4	0.01	0.01	0.01	0.13	0.11	0.05	0.01
5	0.01	0.10	0.04	0.08	0.28	0.47	0.10
6	0.06	0.05	0.26	0.15	0.17	0.32	0.15
7	0.07	0.14	0.23	0.59	0.09	0.49	0.30
8	0.13	0.11	0.67	0.47	0.54	0.96	0.30
9	0.06	0.10	0.21	0.55	0.74	1.12	0.30
10	0.81	0.04	0.28	0.51	1.46	1.58	0.30
11	0.40	0.53	0.18	0.43	1.69	0.45	0.30
12	0.37	0.18	0.26	0.19	3.54	0.99	0.30
13	0.60	0.20	0.20	0.40	1.00	1.00	0.30
14+	0.60	0.20	0.20	0.40	1.00	1.00	0.30
F(6-10),U	0.22	0.09	0.33	0.46	0.60	0.89	0.27
F(6-10),W	0.10	0.12	0.41	0.36	0.21	0.41	0.28

Table 5.4.4 COD off East Greenland.
Stock size in numbers from VPA.

Age	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	41047	74777	22626	8860	8736	7756	17751	3365	5830
4	51670	33607	61197	18525	7254	7153	6350	14534	2755
5	11296	42185	27496	49973	15073	5911	5796	5176	11875
6	3676	9217	34114	22239	40345	12113	4771	4591	4161
7	10151	2928	7466	25814	17754	32265	9466	3763	3530
8	7339	5541	1688	4138	13883	10281	18577	4990	2078
9	5021	3986	2574	872	2351	6889	5482	8482	2066
10	366	1947	2165	612	487	1309	2911	2156	2790
11	297	179	873	950	255	269	620	789	703
12	422	161	92	256	529	100	140	250	137
13	164	153	96	28	136	272	15	71	52
14+	1008	204	459	142	487	153	53	145	19
TOTAL	132456	174884	160844	152409	107301	84472	71953	48311	35994
SPAWN. ST.(7+)	24767	15099	15412	52813	35892	51539	37264	20645	11573

Age	1974	1975	1976	1977	1978	1979	1980
3	7652	25723	52071	5719	4253	10568	15454
4	4770	6245	21009	42400	4682	3482	8648
5	2233	3848	5061	17043	30536	3448	2720
6	9544	1808	2845	3997	12866	18880	1762
7	3293	7374	1403	1798	2811	8887	11234
8	1970	1882	3914	684	608	1577	3351
9	1209	1064	1033	1231	261	217	371
10	728	701	589	512	435	76	43
11	982	199	413	272	189	62	10
12	262	404	72	212	108	21	24
13	30	111	208	34	108	2	5
14+	5	28	14	4	37	2	29
TOTAL	32658	49386	88631	73906	56892	47223	43651
Spawn.St.(7+)	8479	11761	7645	4747	4554	10845	15067

Table 5.4.5 COD off East Greenland.
Stock biomass from VPA.

Age	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	16419	29911	9050	5544	5494	3102	7101	1346	2332
4	58387	37975	69152	20933	8197	8082	7175	16423	3113
5	15701	58637	38219	69462	20951	8217	8057	7195	16506
6	8308	20830	77097	50260	91180	27375	10783	10376	9404
7	32586	9598	23964	82862	56992	103571	30386	12078	11331
8	32145	24270	7392	18126	60808	45033	81367	21854	9099
9	27718	22004	14208	4815	12930	38029	30260	46822	11404
10	2592	13806	15352	4342	3450	9283	20641	15283	19780
11	2432	1465	7159	7793	2174	2204	5087	6469	5761
12	3068	1400	798	2225	4602	871	1218	2173	1189
13	1527	1421	895	263	1264	2527	140	662	484
14+	9774	1977	4448	1373	4722	1483	513	1407	186
TOTAL	211257	223094	267735	265997	270814	249777	202728	142089	90588
SPAWN. ST. 7+	112442	75741	74216	121798	146991	203000	169612	106748	59233

Age	1974	1975	1976	1977	1978	1979	1980
3	3053	10289	20829	2287	1701	4227	6182
4	5390	7056	23740	47912	5291	3935	9772
5	3104	5549	7035	23689	42446	4793	3781
6	21570	4087	6429	9034	29078	42668	3982
7	10571	23670	4503	5773	9022	28528	36062
8	8626	8241	17144	2998	2665	6906	14677
9	6675	5873	5703	6798	1441	1199	2049
10	5158	4968	4173	3627	3071	542	508
11	8055	1630	3387	2228	1548	506	79
12	2277	3517	624	1846	938	185	210
13	280	1030	1931	316	1002	18	45
14+	53	269	134	37	355	19	281
TOTAL	74813	75979	95631	106545	98557	93527	77427
SPAWN. ST.7+	41697	49198	37598	23622	20042	37903	53711

Table 5.4.6 East Greenland COD.
Spawning stock biomass ('000 tonnes) at the beginning of each year and recruitment estimates from VPA (millions of 3 year olds of each year class).

Year/Year class	Spawning stock biomass (age groups 7-14+)	Recruitment
1962	-	41
1963	-	75
1964	-	23
1965	112	9
1966	76	9
1967	74	8
1968	122	18
1969	147	3
1970	203	6
1971	170	8
1972	107	26
1973	59	52
1974	42	6
1975	49	(4)
1976	38	-
1977	24	-
1978	20	-
1979	38	-
1980	54	-

Table 5.4.7 Numbers of migrants from East Greenland surviving in the COD stock at Iceland at the beginning of each year.

Age/Year	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	Average weight (kg)
8	419	1 046	4 235	2 763	5 479	1 412	469	481	429	1 003	192	178	383	1 033	4.38
9	1 514	401	696	3 981	2 644	5 756	1 269	457	371	332	580	152	119	305	5.52
10	888	888	215	369	1 755	1 628	3 357	725	295	200	234	286	97	69	7.09
11	740	346	193	114	247	629	609	961	266	111	112	150	146	55	8.20
12	44	225	86	69	73	55	186	159	223	55	39	70	83	25	8.70
13	23	27	40	84	34	28	11	71	50	44	24	52	34	54	9.30
14	81	16	11	25	79	9	11	6	17	18	32	10	54	12	9.70
Adult biomass ('000 t) A. Of East Greenland migrants at Iceland	24	18	27	39	55	55	40	20	11	10	7	6	6	8	
B. At East Greenland (Ages 7-14+)	74	122	147	203	170	107	59	42	49	38	24	20	38	54	
[A]/A+B Biomass at Iceland as % of total	24	13	16	16	24	34	40	32	18	21	23	23	14	13	Av.=22

Table 6.1 COD off East Greenland.
Input data for catch predictions.

Age group	Relative F based on average 1973-76	Average weight kg	Stock number (thousands)		
			1981	1982	
				Catch 1981 8 000 t	Catch 1981 12 000 t
3	0.006	.40	8 000	8 000	8 000
4	0.024	1.13	12 640	6 530	6 519
5	0.095	1.39	7 010	10 226	10 153
6	0.24	2.26	2 015	5 475	5 321
7	0.31	3.21	1 242	1 465	1 363
8	0.57	4.38	5 099	652	594
9	0.55	5.52	1 521	2 354	1 984
10	1	7.09	168	709	681
11	1	8.20	20	63	46
12	1	8.70	4	7	6
13	1	9.30	11	1	1
14+	1	9.70	15	10	7

(M = 0.2, E = 0.29 for age groups $\geq$ 7)

Table 7.1 COD off East Greenland.
Mesh change assessment - exploitation patterns.

Age	1973-76 Average F	Relative F (120 mm)	Modified Relative F	
			140 mm	155 mm
3	.0025	.006	0	0
4	.01	.024	.012	.007
5	.04	.095	.06	.04
6	.10	.24	.24	.24
7	.13	.31	.31	.31
8	.24	.57	.57	.57
9	.23	.55	.55	.55
10	.4	1	1	1
11	.4	1	1	1
12	.4	1	1	1
13	.4	1	1	1
14+	.4	1	1	1

(M = 0.2. E = 0.29 for age groups $\geq$ 7.)

Figure 3.0.1 Main spawning grounds, migrations of mature fish and larval drift of the cod stocks at West Greenland, East Greenland and Iceland.

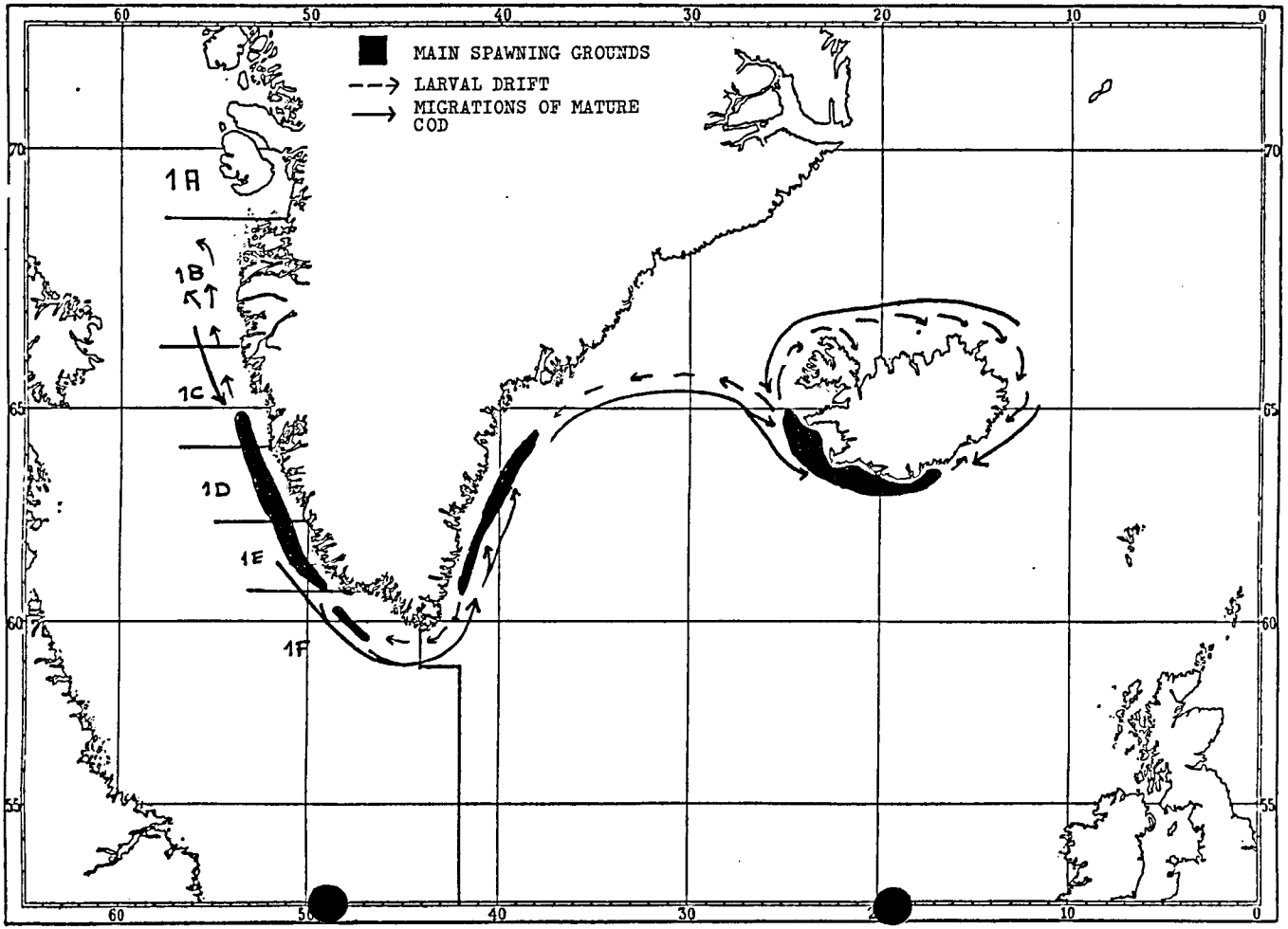
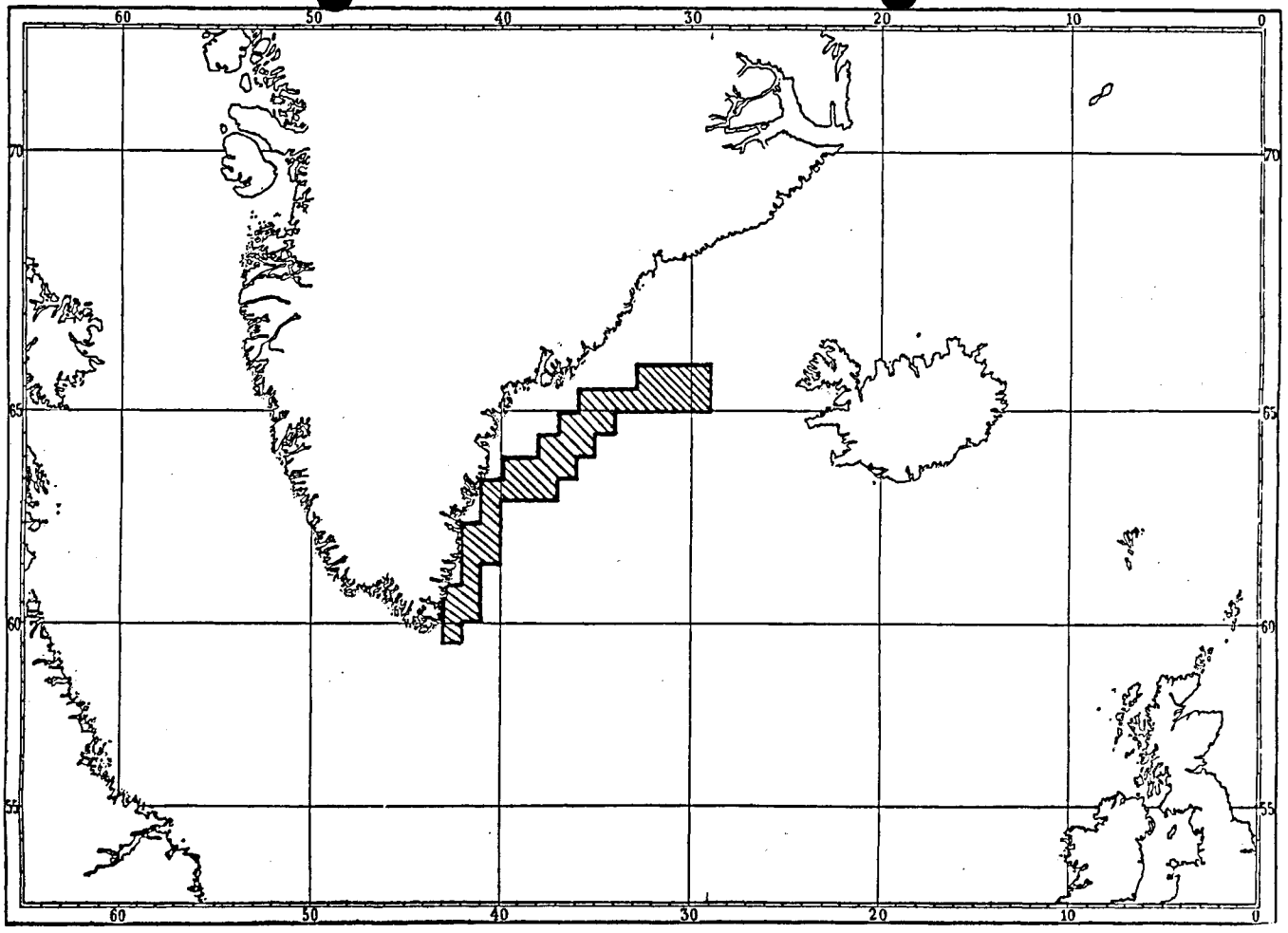
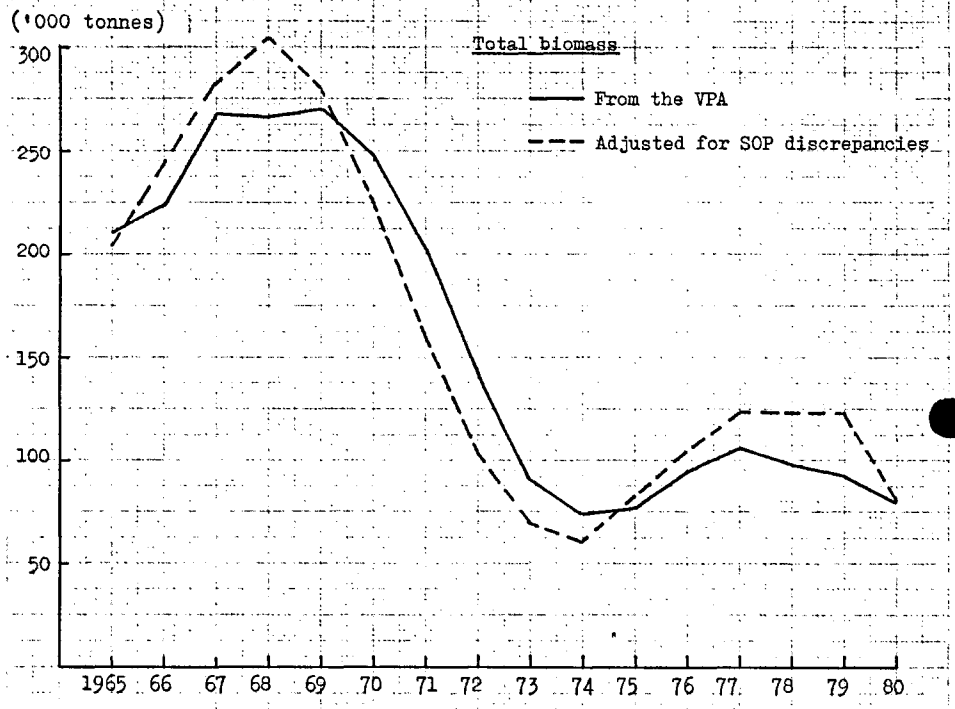


Figure 5.1.1 Area (hatched) for which trawlable biomass of cod off East Greenland was calculated from 1980 survey data.





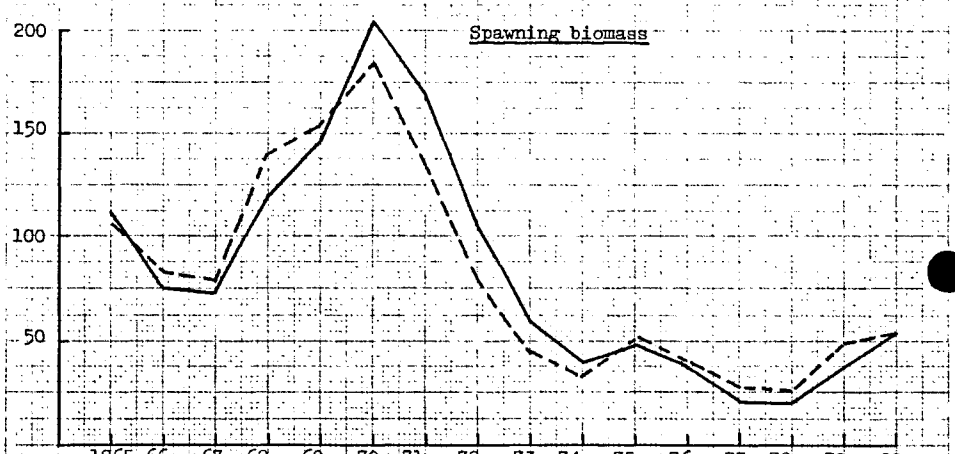


Figure 5.4.1. East Greenland cod.
Trends in stock biomass.

Figure 6.1. Cod off East Greenland.
Yield 1982, total biomass and spawning stock biomass at beginning of 1983 for different levels of fishing mortality in 1982.

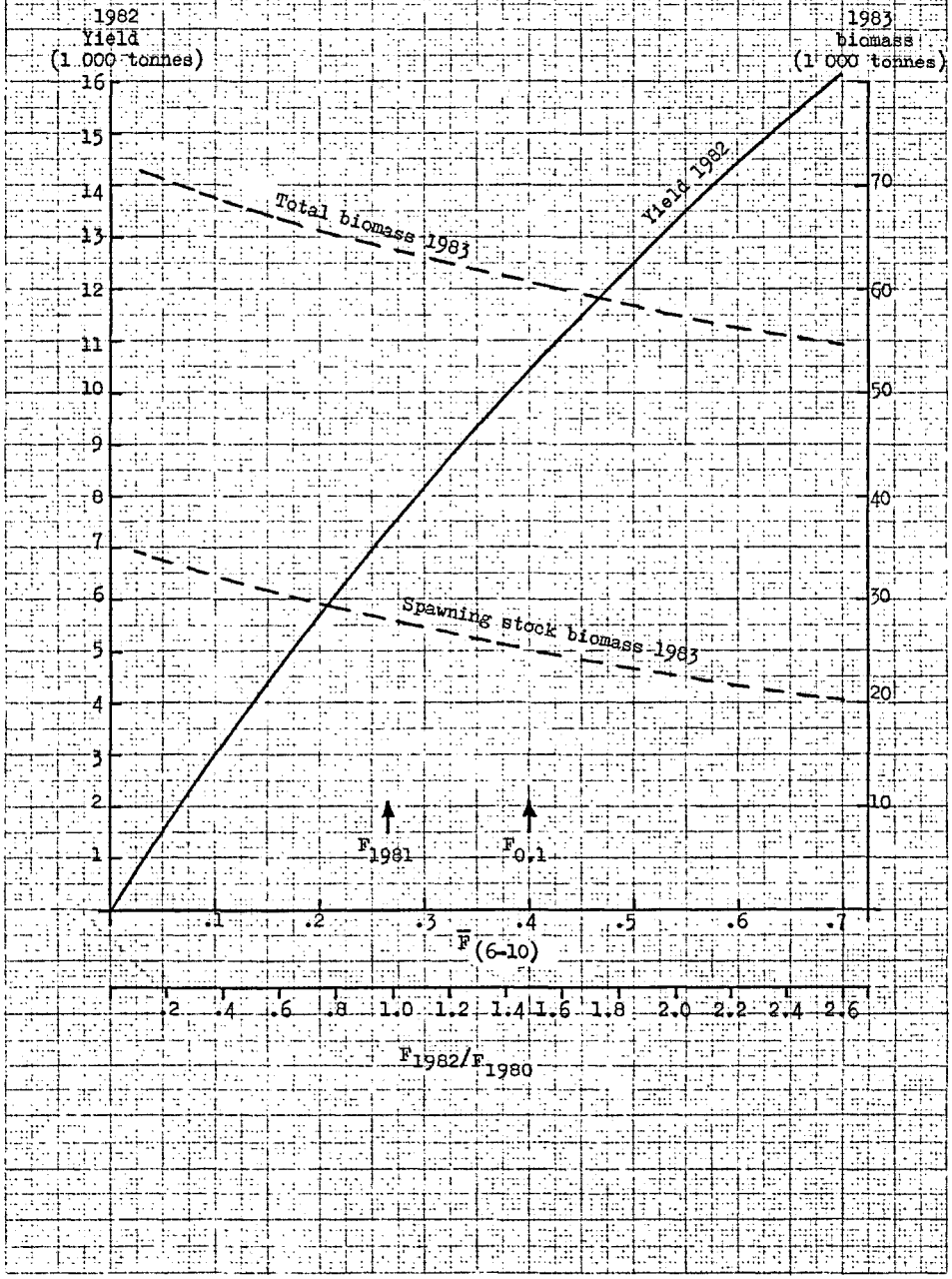


Figure 6.2. Cod off East Greenland.
Yield 1982, total biomass and spawning stock biomass at beginning of 1983 for different levels of fishing mortality in 1982.

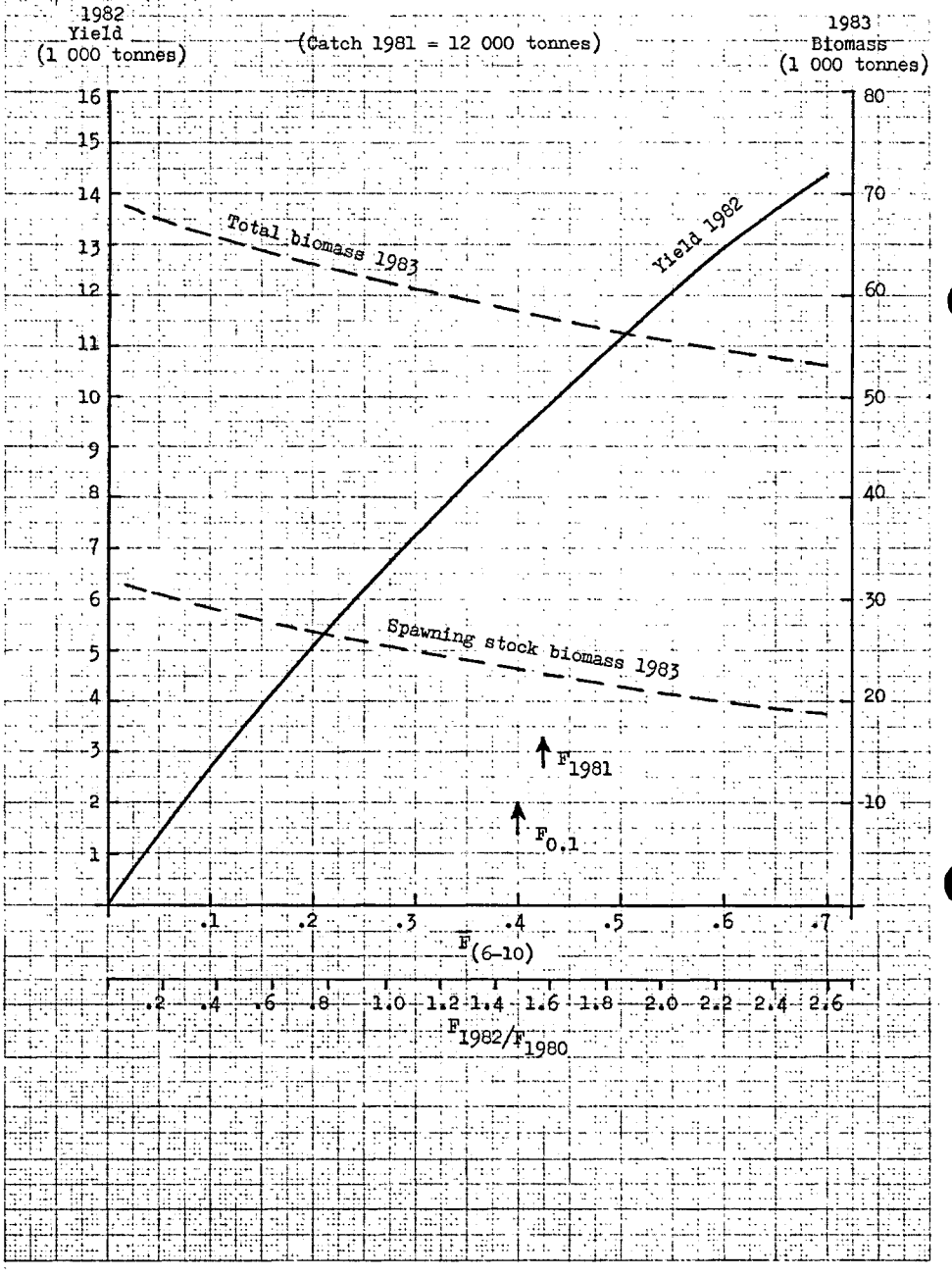


Figure 7.1. Cod off East Greenland.
Yield per recruit and spawning stock biomass per recruit for different mesh sizes (M=0.2, E=0.29 for age 7 and older).