

Northwest Atlantic



Fisheries Organization

Serial No. N330

NAFO SCR Doc. 81/VI/48

(Revised)

SCIENTIFIC COUNCIL MEETING - JUNE 1981

Subarea 1 Cod: Data for 1980 and Estimate of Stock and Yield for 1980-84.

by

Sy. Aa. Horsted

Grønlands Fiskeriundersøgelse

Charlottenlund, Denmark

1. NOMINAL CATCHES 1977-80

In a paper on assessment of Subarea 1 cod presented to the June 1980 Meeting of the Scientific Council (Horsted, 1980) the necessity of including some estimates of non-reported catches for the years 1977-79 in the assessment was pointed out, and some upper and lower-limit estimates were made for assessment purposes. The Standing Committee on Fisheries Science (STACFIS) also requested that some further analyses be made at that meeting, and took the upper-catch level proposed in said paper as its guideline.

Consequently, and because no new data have been brought forward for the years 1977-79, the nominal catches for 1977-79 are taken in the present paper as equal to those presented as upper-limit figures last year.

For the year 1980 the situation so far as catch reporting is concerned is likely to have improved much after the middle of February.

From vessels' reports to the Governor of Greenland there were 25 non-Greenlandic vessels fishing for groundfish off West Greenland (Subarea 1) in the first two months of 1980. They spent about 660 days on the grounds in Subarea 1. If the same approach as that mentioned for 1977-79 is taken to obtain estimates of the catch of cod for this group of vessels in the first two months of 1980 the conclusion is a catch around 9000 tonnes. This figure is, therefore, proposed for assessment purposes as the catch of cod for non-Greenlandic vessels in Subarea 1, 1980. Said catch is taken by trawlers in the first two months of the year, and when calculating numbers landed the author has considered the catch to be distributed between division 1C - 1F in the same proportion as that of the Greenland trawlers in the same period. Greenland trawlers also had a considerable catch in Division 1B, but non-Greenlandic vessels are not known to have fished there except for shrimps.

The nominal catch of cod in Subarea 1 by Greenland vessels in 1980 is estimated to be about 42000 tonnes of which that by trawlers accounted for 7232 tonnes. 7207 of these were taken in fishery directed on cod. For the remaining part no break-down by gear and effort is reported. However, it is known that a considerable part of the landings in the May-September period were from pound-net catches while for other months hand-lines, long-lines, and gill nets are the gears used. Table 1 lists the nominal catches by divisions and by gear assuming 3/4 of the small-boat catches in May-September in Division 1B - 1F to have been taken by pound nets.

## 2. TRENDS IN CATCH PER UNIT EFFORT AND TOTAL EFFORT

As for the years 1977-79, in 1980 Greenland vessels were the only ones allowed direct cod fishery. Effort figures are available only for the trawlers. As in previous years the major part (in 1980 92%) of the Greenland trawlers' landings of cod was by the trawlers in the 500-999 GRT tonnage class, and the catch and effort statistics of this group of trawlers is used for comparison between years of catch rate.

The overall c.p.u.e.-figures in Table 2 illustrate a continued decline in catch rate after the very good results in 1978. Catch rate in 1980 is just above half that for 1978. This decline applies to all divisions except Division 1B where no trawling took place in 1978-79. However, cod was found in the Holsteinsborg Deep in the beginning of 1980, and lead to a good fishing over some weeks. This is illustrated better in Table 3 where effort and catch per unit effort is given on a quarterly base.

As for the previous years the best fishing in the beginning of the year occurred in the northern part of the fishing area (Div. 1B - 1D) while in the second and third quarter catch rates were rather more uniform from division to division.

Total effort by the Greenland trawlers decreased further from 1979 to 1980, Table 2, when a considerable part of their effort was directed towards shrimp. For the 500-999 GRT tonnage class roughly 1/4 of the total hours fished was on cod, the remainder on shrimp. For this group of vessels the hours of cod fishing in 1980 are roughly half those in 1977. It seems most likely that trawlers' cod-fishing effort has been increased again in 1981 due to rather much drift ice over the most important offshore shrimp grounds. In fact, by the end of April 1981 the landings of cod by Greenland trawlers are about 80% higher than their catch by the same time in 1980, and close to their total catch of cod in 1980.

If the Greenland trawlers' catch rate is taken as an index of c.p.u.e. for the total effort in SA 1 then the figures in Table 2 compared to total catch of cod (Table 1) suggest that total effort decreased by about 60% from 1977 to 1978 but increased again in 1979 to a level of 74% of that in 1977 (Table 4). Their effort dropped again from 1979 to 1980 to a level around half that of the 1977 level. These figures are obtained from catches in terms of weight. If, instead, catches and catch rates are given by numbers then the trends in effort, as occurring from Table 4, are a decrease by about 46% from 1977 to 1978 followed by a moderate increase in 1979 to a level about 65% of that in 1977, and a very slight decrease of 3% from 1979 to 1980. However, speaking about effort in terms of fishing mortality, no corrections have been made for possible changes in catchability of cod. It is highly likely that in 1978 and in 1979, when the 1973 year class contributed significantly to the spawning shoals, cod was more easily caught by trawl than in 1977, and hence the decrease in total fishing mortality from 1977 to 1978 and 1979 may not be as big as indicated by figures in Table 4.

So far as the decrease from 1979 to 1980 is concerned there seems to be no doubt that overall effort and fishing mortality dropped, but by what magnitude is difficult to assess. According to Table 4 the decrease could be as small as 3%.

As already mentioned, for the coastal and inshore fisheries no effort figures are available. However, the trends in inshore catches over the last four years are so pronounced that they may be indicative of stock fluctuations. The figures are set out in Table 5. The coastal and inshore catches trebled from 1977 to 1979, specifically in the southern division where a heavy inflow of large fish of the 1973 year class gave a record pound-net sea-

son in 1979. By 1980 this important year class has to a great extent been fished or emigrated to East Greenland - Iceland, and although it still accounts for a considerable part (82% by numbers) of the catch in the southern divisions the availability of large fish to the inshore gears has evidently dropped from 1979 to 1980, especially in Division 1D. Partly compensating this is the increase in the fisheries of the northern divisions (Division 1A - 1C). This latter increase seems to be based on relatively young fish, specifically cod of ages 3-5 years, and their inflow in Division 1D is also considerable. The year classes 1975 and 1977 seem to be the important ones. In the Godthåb Fiord area also the 1976 year class seems important.

### 3. THE FISHERY AND THE STOCK IN THE BEGINNING OF 1981

As mentioned in section 2 the Greenland trawlers have been fishing more on cod than on shrimp in the beginning of 1981, and their catch of cod by the end of April is close to that for the whole year of 1980. Also inshore fisheries show some increase (about 26%) by the end of April.

Samples show a high degree of variation in age composition between the various parts of the grounds. Thus, on a trip by a trawler in March shoals of large spawners (to judge from the length distribution mainly of the 1975 year class) were found on the SW slope of Tovgussaq (Banana) Bank (Division 1C) while on the SE slope of the same bank and on the SW slope of Fylla's Bank (Division 1D) only small fish occurred, the 1977 year class likely to be the predominant one.

Pound-net fishing in the Godthåb Fiord started in May, and samples from this fishery suggest an overwhelming inflow of the 1977 year class (judged from length distribution, otoliths not yet received for reading).

During shrimp fishing in the Holsteinsborg Deep in late February (border Division 1B/1C) small by-catches of cod were observed, mainly of length 17-22 cm. These are likely to be of the 1979 year class.

### 4. MEAN LENGTH AND WEIGHT OF AGE GROUPS IN 1980

Age and length samples of cod in Subarea 1 and off East Greenland for 1980 were provided by Denmark (Greenland) and by the Fed. Rep. of Germany.

The Danish samples have been used to achieve mean length and weight for each individual age group. The samples are available as computer printouts at the June 1981 Meeting of the Scientific Council of NAFO. The mean lengths and weights are given in Table 6 for offshore samples and in Table 7 for coastal and inshore samples. In Table 8 the quarterly means of the figures in Table 6 and 7 are given. The weighted average for the year has been obtained by weighting with the quarterly catches of Greenlandic vessels as listed in Table 9 and assuming the estimate of 9000 tonnes by non-Greenlandic vessels to have been taken in the first quarter of the year.

The mean weights in Table 8 have not been used as such to convert catches by weight to numbers caught by age groups. In the calculations the actual mean weight of the basic sample(s) has been used, and calculation has been made on a monthly base whenever sampling intensity so allows. The mean weights by quarters are derived in order to get likely mean weights for forecasts. Plotting of the unweighted quarterly means as well as the weighted means (Figure 1) suggests that it is reasonable to expect weight by age in the forecast year to be very close to that for 1980 at least for ages 3 to 8. Provided that the distribution of catches between quarters remains as in 1980, and making the assumption of 60% of catches

being inshore the forecast values suggested by Figure 1 are given in Table 10. For fish older than 8 years the figures previously used are also given in Table 10. Plotting the average values of Table 10 (Figure 2) shows that the value for age 9 is probably somewhat too low, especially for forecast in so far as the 9 years old in 1981 are those that were 8 years old in 1980, and this group had a weight somewhat higher than normal to judge from Figure 2. Instead of the previously used figure of 6.40 for mean weight of age group 9 it is, therefore suggested to use the figure of 6.80 occurring from Figure 2.

#### 5. NUMBERS LANDED BY AGE GROUPS IN 1980

Numbers landed per age group for the years 1965-80 are listed in Table 11 while in Table 12 the figures for 1978-80 are shown for the northern and southern divisions of Subarea 1 separately.

For 1980 the offshore trawl fishery was sampled in Division 1B - 1E, and in most of the major months. 9 large samples from commercial landings supplemented by some research samples (mainly hand line) form the offshore material. In Division 1B - 1C the 1975 year class is the most frequent one while in Division 1D - 1E the number of 7-year olds (1973 year class) is more frequent. For samples in the last two months of the year (Division 1B and 1D sampled) young fish of the 1977 year class dominate, in the Division 1B sample by 47%, in Division 1D by as much as 76% (by number). Few fish older than seven years were found in the samples.

Inshore fisheries were sampled in Division 1B and 1D - 1F, the majority of the samples being from the pound-net catches and landings. In Division 1E and 1F the 1973 year class was still by far the major contributor to the fishery (above 80% by number), but in Division 1B the 1975 year class made up more than 60% in the samples of landings. In samples from Division 1D the catch of 3-year olds seems to have been considerable indicating that discard of undersized fish (i.e. below 40 cm) may have taken place to a high degree. In the Godthåb Fiord area also 4-year olds (1976 year class) have played a major role in 1980, in several samples being the predominant one. Especially in Division 1D the variation in age composition between samples is considerable, and it has been necessary to make very rough estimates of the catches that are thought to be represented by the individual samples. The Division 1D samples have been used as representing also Division 1C catches, from where no samples were taken.

The general picture thus is a much higher degree of variation in age composition between divisions, gears, and time of the year than in most recent years when the 1973 year class had an overwhelming role in the fishery. This year class is still of major importance in the southernmost part but has to a great extent been substituted by the 1975 year class in Division 1B - 1D. In the latter divisions there are also clear evidences of a forthcoming strong predominance of the 1977 year class, and in some areas like the Godthåb Fiord the 1976 year class seems to promise a major contribution to catches in 1981.

#### 6. INFORMATION ON FUTURE RECRUITMENT

The various samples from the fisheries in 1980 whether of landings or of catches do not contain fish younger than 3 years old, and apart from the 1977 year class judgement of the strength of year classes recruiting in the years for which forecast is made has to be based on observations other than the samples mentioned.

The strength of the 1980 year class can at present only be made on hydrographic and plankton observations in 1980. These are described in details in the Danish Research Report for 1980. The reference temperature at the shallow part of Fylla Bank in June was

1.9°C which is 0.3°C lower than the 1979 temperature but still just above the 1.8°C usually regarded to be the minimum temperature for a survival rate of larvae sufficiently high to produce a good year class.

The number of cod larvae in the plankton was still rather low (2.9 larvae per half-hour haul) although the highest for the 1976-80 period, and close to the mean of 3.2 for 1975.

These observations seem to justify a moderate optimism for the 1980 year class, and it is tentatively regarded to be of the same magnitude as the 1975 year class. Reference temperature in 1975 was also 1.9°C.

On the basis of hydrographic and plankton observations the 1979 year class was tentatively (last year) cautiously regarded to be somewhat below the relatively good year classes 1973, 1975, and 1977, but with the remark that future adjustment in upward direction might be necessary.

Very few fishing experiments have been reported in 1980 which would be likely to supply further information on the 1979 year class. However, in February 1981 observers on board one of the Greenland trawlers fishing for shrimp in the Holsteinsborg Deep reported and sampled by-catches of small cod. The sample ranged from 15 to 37 cm total length with 87% of the fish in the range 17-22 cm, and no doubt belonging to age group 2.

Throughout the last four years when frequent observations of the offshore shrimp fishery in Division 1B has been made very few cod have been observed in the shrimp catches with the exception of some hauls in the Holsteinsborg Deep in the beginning of 1980 containing fish of the 1977 year class.

The observation of the 1979 year class in the Holsteinsborg Deep could thus lend support to the assumption of a year class of a strength between the 1975 and 1977 year classes, and with a northward distribution into Division 1B. The 1981 pound-net fisheries in this division may give further information for future adjustment of the estimate of this year class, but until then some upward adjustment from last year's input value of 75 mio. (3-year olds) is made in this assessment to an estimate of 90 mio. recruits.

The 1978 year class would likely have shown up by at least some individuals in the pound-net fisheries or in research hauls or commercial shrimp hauls had it been of any noteworthy strength. The virtual absence of 2-year olds in the 1980 observations leads to a continued estimate of this year class as a very poor one.

Much new information has, however, become available on the strength and distribution of the 1977 year class. It seems to have its major concentration in Division 1B - 1D. As mentioned in last year's report it accounted for the major part of the high discard rate in the 1979 pound-net fishery. In 1980 its length distribution has been just around the local minimum landing size of 40 cm. Thus discard of this year class is likely to have been considerable also in the 1980 pound-net fisheries, and the year class made up more than half the numbers in several of the pound-net landings sampled in Division 1D. It recruited gradually to the trawl fishery during 1980, and made up 47% by numbers in landings from the Holsteinsborg Deep in November and as much as 76% in a sample from Fylla Bank in December. Reports from the trawl fishery at the beginning of 1981 indicate that age composition of the shoals varies considerably between the fishing grounds, even from shoal to shoal on the individual grounds. The major part of the "small-fish shoals" seems to be of the 1977 year class.

Reports from the beginning of the 1981 pound-net season in Division 1D also indicate that by far the major part of the landings will be of this year class with a modal length around 45 cm but still with some fish to be discarded (below 40 cm). Its strength now seems to be well above that of 1975, and to approach that of the 1973 year class but mainly with a more northern distribution (1B - 1D) where the 1973 had a distinct southern distribution (1D - 1F).

The above mentioned estimates are all relative between the year classes. As the basis for an absolute figure for the strength of the year class the absolute strength of the 1973 year class as resulting from the virtual population analysis has been used (see section 9). The 1973 year class now seems to be of a strength equal to 225 mio. recruits (3-year olds). Therefore the following estimates are made for year classes 1976-80:

<u>Year class</u>	<u>Mio. fish at age 3</u>	
1976	30	For year-classes 1981, necessary as input for catch prognosis 1984, the year class is set very low, 20 mio. fish, since the spring of 1981 has shown very low water temperatures.
1977	200	
1978	20	
1979	90	
1980	75	

#### 7. VALUES OF INSTANTANEOUS FISHING MORTALITY (F) AND PARTIAL RECRUITMENT

At last year's meeting of the Scientific Council, when Subarea 1 cod was reassessed at the meeting, various catch curves were used to estimate fishing mortality rate in 1979. The value ( $F = 0.82$ ) indicated by the catch curve for 1978-79 for age groups 7-10 was considered the best estimate (Schumacher *et al.*, 1980). The catch curve just mentioned had the advantage of avoiding disturbance of high year class fluctuations by omitting year class 1973.

For 1980 it does not seem possible to use catch curves without including the 1973 year class since very few cod of older year classes occur in the samples, and hence in the estimates of numbers landed by age groups.

Figure 3 gives the catch curve for ages 4-14 averaged over the period 1978-80. The basic material is found in Table 12 while the average figures are found in Table 13. Ignoring age groups 3 and 4 which could be supposed not to be fully recruited the plots seem to fall in three groups, viz.

a group formed by age groups 5-7
- - - - - 8-11, and
- - - - - 12 and older.

The latter group contains rather few individuals, and ageing of these old fish might be less accurate. For these reasons this group is ignored. The first group differs from the second mainly by containing individuals of the 1973 year class in all age groups represented whereas the second group consists mainly of the poor year classes from 1969 to and including 1972, but with the relatively good 1968 year class having an upward tendency of bias for the 10 and 11 age-group-plots.

The total mortality coefficient obtained by the first and second group are  $Z = 0.83$  and  $0.76$ , respectively. Recalling the possible bias in the second group a value for total mortality in 1980 is suggested to be about  $0.83$ . With  $M = 0.25$  (including emigration)  $F$  would then be  $0.58$ . This value is lower than the 1979 value of  $0.82$  adopted last year, but recalling that total effort decreased by up to 30% from 1979 to 1980 the value is probably

not too far from the actual level and is, therefore, taken as the input value for fully recruited age groups in the analyses.

If the plots for age groups 3 and 4 were to be raised to fall on the regression line for ages 5-7 the number in these groups would have to be multiplied by a factor 81 and 5.8, respectively. In other words, partial recruitment could then be considered to be about 1.2 and 17% for age-groups 3 and 4, respectively. However, since the 1973 year class has increased the level of the regression line for ages 5-7 to a level higher than that which would be proper for comparison with the plots of ages 3 and 4 it is suggested to use values closer to those adopted last year (2% and 47%). The proposal is

partial recruitment for age group 3 =	2%
- - - - -	4 = 33%

The partial F-values corresponding to this partial recruitment would be 1.5% and 27%, respectively, when  $M = 0.20$  and  $Z = 0.83$ .

Terminal-F values for years prior to 1977 are taken as in the initial assessment made last year (Horsted, 1980) whereas for 1977-79 the value of 0.82 adopted for reassessment at last year's meeting (Schumacher et al., 1980) is used. For 1980 the value of 0.63 found as mentioned is used.

#### 8. NATURAL MORTALITY RATE AND EMIGRATION

As previously the natural mortality is set at  $M = 0.20$  except for age group 3 for which it is raised to 0.30 to take into account non-surviving discarded fish.

Emigration rate most likely varies between year classes, and the usual value of 0.05 for Subarea 1 as a whole was probably too low when the 1973 year class dominated. However, most of the newer year classes have a more northern distribution, and it is, therefore, proposed to maintain the overall value of 0.05 for emigration of fish six years old or older.

#### 9. RESULTS AND DISCUSSION

##### i) The virtual population analyses (VPA).

The initial VPA run with parameters as mentioned gave an estimate of the 1977 year class by 1980 as three years old of 311 mio. fish (Tables 14a and b). However, since the 1973 year class, (which is at present thought to be bigger than the 1977 year class) showed up in the run with a value of 225 mio. recruits a new VPA run was made in which partial F was adjusted so as to result in the 1977 year class supplying 200 mio. recruits in 1980 (Tables 15a and b). For the 1976 year class the initial run resulted in about 29 mio. recruits in 1979, a figure about 50% higher than the initial estimate of 20 mio. for this year class. However, with the significant occurrence of this year class in Division 1D an increase of the initial estimate seems proper, and a round figure of 30 mio. fish is set.

For the 1975 year class the initial run leads to a figure of only 32 mio. recruits in 1978. This figure seems too low considering all previous evidence from research and from practical fisheries. Recalling, however, that in 1978 fishermen concentrated their efforts mainly on the numerous 1973 year class of which some individuals formed spawning concentrations it is highly likely that the partial F for 3-year olds was lower than usual in that year. In last year's reassessment (Schumacher et al.) the analyses were, therefore, carried

out so as to achieve an estimate of the 1975 year class by 1978 closer to the estimates based upon other evidence. In 1979 the estimate was 75 mio. fish (3 years old), by 1980 a figure of 115 mio. was adopted, and the reassessment simply adjusted  $F$  for age groups 3 in 1978 to result in an initial stock of 115 mio. recruits. The author did try the same approach but then found so many residuals of this year class by 1980 that a much lower  $F$  had to be assumed for age group 5 in 1980 than for other fully recruited age groups ( $F_5 = 0.10$  when  $F = 0.63$  was set for fully recruited age groups). The author is, therefore, more and more inclined to believe that the strength of the 1975 year class has been overestimated previously. However, it would still be hard to believe that the year class was not above the 1974 and 1976 year classes which have values of about 41 mio. and 29 mio. (in 1977 and 1979, respectively) according to the VPA run. Therefore, a value of 50 mio. fish at age 3 is proposed for the 1975 year class, and partial  $F$  in 1978 is adjusted accordingly (Tables 15a and b).

It could not be ruled out, however, that the initial high estimates of the strength of the 1975 year class were, in fact, more correct, and that the explanation for the relatively few residuals by 1980 could be a relatively higher discard rate in 1977-79 of small fish when catches contained lots of larger fish of the 1973 year class.

#### ii) Forecasts

The EEC has requested advice on catches and spawning stock size up to and including 1984 (i.e. spawning stock size by January 1985) for a number of fishing strategies. The EEC has also advised that the  $F$  values for 1981 be chosen so as to correspond to a catch of about 50000 tonnes. From the present state of the 1981 fishery this catch figure seems reasonable.

Forecast so far ahead as mentioned will, of course, be subject to revisions in later years. With the very high year class fluctuations the catches are much dependent upon estimates of recruitment, and catches in 1981-83 are likely to be heavily dominated by the 1977 year class which so far has been observed only one year in the commercial fishery. Year classes younger than the 1977 year class will also contribute substantially to catches in 1982-84, and it should be remembered that these year classes have not yet been evaluated from their occurrence in the landings.

Also forecasts of spawning stock size becomes dependent upon estimates of future recruitment. By 1985 about 90% of the estimated spawning stock consists of year classes 1977-79. The value of the forecasts is, therefore, extremely highly dependent upon the validity of the estimates of future recruitment.

The results of the forecasts are set out in Table 16 and illustrated in Figure 4. From Schumacher *et. al.*, 1980, the  $F_{0.1}$  level has been considered to be equal to 0.25, and  $F_{max}$  equal to 0.48 for fully recruited age groups.

The results, as compared to results for most of the years in the 1970'ies, generally show some progress in the stock as a consequence of the recruitment of the relatively good (relative to extremely poor year classes 1969-72) year class 1977, and the expected 1979 year class. Of course, a good deal of uncertainties exists in the judgement of the strength of these year classes, but generally stock seems to be slowly improving. In this connection it is again pointed out that the possibility of the spawning stock being a limiting factor for the reproduction of the stock cannot and should not be ignored. So far it has not been possible to identify a critical level for the spawning stock. As an approach, however, Figure 5 shows the estimated strength of year classes 1947-79 in relation to estimates of



spawning biomass (defined as ages 6+) and to the mean temperature in June over the shallow part of Fylla Bank. Table 17 lists the material. Spawning stock size for the years 1965-80 is taken from the VPA runs, Table 14b, applying offshore mean weights of Table 10 (for 1980 offshore-inshore mean). For years prior to 1965 time has not allowed analyses of spawning stock size. However, it could be assumed that the spawning stock for the years 1947-64 was above 500000 tonnes. All plots at spawning stock at or above 500000 tonnes have then been made at the 500000-tonnes line. Year-classes strength is taken from Table 15b, this paper, for 1962-80. For years prior to 1962 Hermann *et. al.* (1965) gave estimates relative to the 1924 year class for the years 1924-51. This series of figures was continued by Smidt (unpublished, pers. comm.) on the basis of figures in Horsted, 1973. A third series for 1957-66 was supplied by the ICES/ICNAF Working Group on Cod Stocks in the North Atlantic (Anon., 1973, Table 8). To get figures for Subarea 1 separately the author has regarded half the combined 1E-1F-ICES XIV stock as belonging to Division 1E-1F. This series overlap the present VPA series for the years 1962-66 but is somewhat lower in all these years. The mean ratio for the 1962-66 period between these two series is 1.28/1.00. The ICES/ICNAF figures have then been raised by 1.28, and compared to Smidt's index-figures for an overlapping period 1957-61. This leads to a new conversion factor of 3.95 for Smidt's relative figures to be raised to correspond to the absolute VPA figures. In this way estimates of year-class strength for the period 1947-61 was obtained. They do not pretend to be accurate figures, just very rough estimates.

Figure 5 illustrates the dependency of year-class strength (survival of larvae) upon water temperature. With the exception of year classes 1956, 1963, and 1973 no real strong year class has occurred when the June temperature over Fylla Bank was at or below 1.8°C, and the three year classes all seem to have been of East Greenland parentage.

The dependency of year class strength upon spawning stock size is less clear, and the material seems to be missing plots for spawning stocks between 200000 and 500000 tonnes. Such plots may well occur in the next few years. However, again apart from year class 1973, no real strong year class occurs on the lower side of the 500000-tonnes-spawning-biomass line. A spawning biomass at or above 500000 tonnes by temperatures above 1.8°C has, however, not always resulted in strong year classes, so other factors than just temperature and spawning stock size seem to have co-influence. This, however, seems no motive not to take stock/recruitment relationship seriously into account in management of the stock.

#### ACKNOWLEDGEMENT

The author acknowledges with many thanks the help by colleagues in the institute in preparing this document and for carrying out the necessary sampling and analyses of the samples. Programming and computer work was undertaken by Mr. Per Kannevorff, otolithe readings by Mrs. Inge Meldal.

#### REFERENCES

- Anon., 1973. Report of the ICES/ICNAF Working Group on Cod Stocks in the North Atlantic. Cons. int. Explor. Mer. Coop. Res. Rep. 33, 52 pages.
- Hermann, F., P. M. Hansen and Sv. Aa. Horsted, 1973. The Effect of Temperature and Currents on the Distribution and Survival of Cod Larvae at West Greenland. Int. Comm. Northw. Atl. Fish., Spec. Publ. 6: 389-395.

Horsted, Sv. Aa., 1973. Torsken ved Grønland. Danm. Fisk. og Havunders. Fisk og Hav 73: 25-31.

Horsted, Sv. Aa., 1980. Subarea 1 Cod: Data for 1979 and early 1980, and Estimates of Stock and Yield for 1980-82. NAFO SCR Doc. 80/VI/72. 36 pages (mimeo).

Schumacher, A., J. Messtorff, Sv. Aa. Horsted and P. Kanneworff, 1980. Some further analyses of Subarea 1 Cod. NAFO SCR Doc. 80/VI/113. 12 pages (mimeo).

Table 1. Nominal catch (tonnes x  $10^{-3}$ ) of cod in Subarea 1, 1980. The figures include provisional figures for Greenland vessels and an estimate of 9000 tonnes for non-Greenlandic trawlers. Pound-net catches are estimated as being 3/4 of total mixed-gear catches in June-September for Division 1B - 1F.

Division	Otter trawl (offshore)	Pound net (inshore)	Mixed gear (mainly inshore)	Total
1A	-	-	718	718
1B	1800	1506	833	4139
1C	7862	1442	763	10067
1D	4430	3067	3645	11142
1E	2100	4484	3381	9965
1F	40	7784	7168	14992
Total Subarea 1.	16232	18283	16508	51023

Table 2. Effort (hours fished), catch of cod, and catch per unit effort for the Greenland trawlers (500-999 GRT class) in 1978-80. Only figures for directed cod fishing are included. Total nominal catch of cod (all nations, all gears) shown at the bottom of the table.

Division	1978			1979			1980		
	tonnes	hours	kg/hour	tonnes	hours	kg/hour	tonnes	hours	kg/hour
1B	0	0	-	0	0	-	1789	727	2461
1C	11803	3562	3314	6428	2983	2155	1646	1513	1088
1D	2414	815	2962	3586	1163	3083	1768	1983	892
1E	3268	873	3743	711	365	1948	1395	1092	1277
1F	212	70	3029	24	9	2667	19	31	613
Total SA 1.	17697	5320	3327	10749	4520	2378	6617	3735	1772
East									
Greenland	731	389	1889	1525	760	2007	226	246	919

**Table 3.** Effort (hours fished) and catch per unit effort (kg/hour) by quarter of the year for the Greenland trawlers (500-999 GRT tonnage class) in 1978-80. Only figures for direct cod fishing are included.

<u>1978</u>								
Division	I		II		III		IV	
	hours	c.p.u.e.	hours	c.p.u.e.	hours	c.p.u.e.	hours	c.p.u.e.
1C	3030	3225	487	3398	-	-	45	8333
1D	261	2877	224	2821	79	570	251	3928
1E	260	988	492	5701	5	2400	116	1672
1F	-	-	-	-	64	3250	6	667
Total SA 1.	3551	3036	1203	4233	148	1791	418	3729
East								
Greenland	-	-	-	-	360	1981	27	667
<u>1979</u>								
Division	I		II		III		IV	
	hours	c.p.u.e.	hours	c.p.u.e.	hours	c.p.u.e.	hours	c.p.u.e.
1C	2727	2059	256	3180	-	-	-	-
1D	711	2942	452	3305	-	-	-	-
1E	123	675	242	2595	-	-	-	-
1F	-	-	-	-	-	-	9	2667
Total SA 1.	3561	2187	950	3091	-	-	9	2667
East								
Greenland	-	-	-	-	-	-	760	2007
<u>1980</u>								
Division	I		II		III		IV	
	hours	c.p.u.e.	hours	c.p.u.e.	hours	c.p.u.e.	hours	c.p.u.e.
1B	382	4398	-	-	-	-	345	316
1C	886	1109	2	1500	24	833	600	1067
1D	402	1226	45	1956	83	410	1453	794
1E	209	785	753	1580	11	182	119	328
1F	6	500	7	1143	16	375	2	1000
Total SA 1.	1885	1763	807	1597	134	463	2519	773
East								
Greenland	60	1350	-	-	26	615	160	806

Table 4. Effort (hours fished), catch of cod by weight as well as by numbers, and catch per unit effort for the Greenland trawlers (500 - 999 GRT class), and total effort for Subarea 1, 1977-80.

Year	Grl. trawlers' effort (hours)	Grl. trawlers' catch of cod (tonnes and nos. x 10 <sup>-3</sup> )	Grl. trawlers' c.p.u.e. (kg/hour and nos./hour)	Total SA 1 catch (including estimates)	Total effort	Catch by weight
1977	7530	9740	1293	73387	56757	
1978	5320	17697	3327	73474	22084	
1979	4520	10749	2378	99172	41704	
1980	3735	6617	1772	51023	28794	
1977	7530	8886	1180	56697	48048	Catch by number
1978	5320	7693	1446	37491	25927	
1979	4520	5136	1136	43817	31219	
1980	3735	2419	648	19671	30373	

Table 5. Coastal and inshore nominal catches of cod (tonnes) by Greenland fishermen 1977-80. (Figures for 1980 are provisional).

Division	1977	1978	1979	1980
1A	216	348	420	718
1B	580	1587	1848	2339
1C	2505	3244	2147	2205
1D	2946	2614	10504	6712
1E	3521	4642	11117	7865
1F	4231	7244	16319	14952
Total SA 1	13999	19679	42355	34794
East Greenland	2372	1419	1496	1551

Table 6. Mean length (total length, cm below), and mean weight (kg, round fresh) of age groups in Danish offshore cod samples from Subarea 1, 1980. Figures are given only for age groups represented by more than five fish in the sample, and only for samples where both length and weight was recorded. OTB = bottom otter trawl, FPN = pound-net, LHP = hand line, res. = research vessel.

Age group	Div. Month Gear	1B February		1C February		1D January		1D July		1D August	
		OTB		OTB		OTB	LHP(res.)	LHP		LHP	LHP(res.)
III	l	-	45.7	-	-	-	42.0	-	-	-	-
	w	-	1.19	-	-	-	1.25	-	-	-	-
IV	l	47.9	54.8	48.3	48.2	49.0	49.2	-	-	-	-
	w	1.13	1.93	1.21	1.20	1.10	1.05	-	-	-	-
V	l	57.5	64.6	55.2	55.8	58.3	58.3	60.5	-	-	-
	w	2.12	3.29	1.85	1.91	1.85	1.84	2.35	-	-	-
VI	l	67.0	75.7	61.6	63.8	66.0	66.7	69.5	-	-	-
	w	3.42	5.30	2.62	2.89	2.65	2.72	3.25	-	-	-
VII	l	75.2	84.8	70.4	73.0	75.5	76.6	78.8	-	-	-
	w	4.51	6.99	3.75	4.08	4.05	4.06	4.70	-	-	-
VIII	l	-	-	88.2	84.0	-	83.5	-	-	-	-
	w	-	-	7.43	6.23	-	5.41	-	-	-	-
IX	l	76.3	89.8	-	-	-	82.6	-	-	-	-
	w	3.98	9.21	-	-	-	4.83	-	-	-	-
Overall l		58.3	56.6	58.9	64.1	71.0	71.0	74.5			
Overall w		2.24	2.50	2.34	2.97	3.50	3.38	4.12			

Table 6. continued

Age group	Div Month Gear	1D		1D		1E		1E		1D/E		1E July LHP(res.)
		October	OTB	December	OTB	April	OTB	May	OTB	June	OTB	
III	1	45.7		44.4		-		-		-		-
	w	1.10		1.02		-		-		-		-
IV	1	54.8		51.9		47.6		47.9		47.7		-
	w	1.85		1.64		1.14		1.14		1.12		-
V	1	63.4		60.0		55.7		57.0		56.8		61.2
	w	2.83		2.49		1.81		1.85		1.79		2.17
VI	1	71.6		69.0		61.8		66.8		67.3		70.2
	w	3.98		3.62		2.33		2.67		2.70		2.93
VII	1	82.5		80.6		70.3		72.7		75.5		73.6
	w	5.73		5.40		3.38		3.60		3.85		3.51
VIII	1	79.7		-		72.9		-		85.1		-
	w	5.07		-		4.32		-		5.58		-
IX	1	92.1		-		-		-		87.7		-
	w	8.20		-		-		-		5.74		-
Overall	I	73.9		48.2		64.5		66.1		63.5		70.8
Overall w		4.49		1.42		2.75		2.84		2.56		3.13

**Table 7.** Mean length (total length, cm below), and mean weight (kg, round fresh) of age groups in Danish coastal and inshore cod samples from Subarea 1, 1980. Figures are given only for age groups represented by more than five fish in the sample, and only for samples where both length and weight was recorded. OTB = bottom otter trawl, FPN = pound-net, LHP = hand line, LLS = bottom long lines, res. = research vessel.

Age group	Div. Month	ID	Jan.-March LHP/res.)	1D	February OTB(res.)	1D	May FPN	1D	June FPN	1D	July FPN	1D	August LHP(res.)	1D	October LHP(res.)	1D	November LHP(res.)	1D	November LLS	1E	June FPN	1E	July FPN
III	1	37.3		31.3		41.2	41.4	39.8	38.8	41.6	41.6	48.0	37.2	-									
	w	0.53		0.34		0.85	0.89	0.69	0.60	0.75	0.75	1.28	0.71	-									
IV	1	41.2		-		43.2	44.3	47.4	46.9	52.3	50.3	56.3	45.1	46.9									
	w	0.73		-		0.95	1.16	1.09	1.01	1.45	1.31	1.98	1.02	1.11									
V	1	49.2		-		55.5	57.0	56.9	-	61.3	55.5	64.7	58.3	57.7									
	w	1.33		-		2.07	2.35	1.85	-	2.30	1.89	2.99	1.99	1.93									
VI	1	59.4		-		60.0	66.0	61.5	-	65.6	61.0	72.9	63.1	61.6									
	w	2.31		-		2.56	3.15	2.33	-	3.21	2.32	4.14	2.60	2.51									
VII	1	61.9		-		76.0	-	72.6	-	76.5	71.4	81.0	72.2	73.1									
	w	2.91		-		5.01	-	3.61	-	4.35	3.70	5.45	3.72	3.84									
VIII	1	-		-		-	-	-	-	84.0	-	79.6	-	-									
	w	-		-		-	-	-	-	5.0	-	5.13	-	-									
IX	1	-		-		-	-	-	-	-	-	93.0	-	-									
	w	-		-		-	-	-	-	-	-	7.86	-	-									
Overall	I	40.8		31.3		45.1	42.5	51.4	41.0	53.3	44.7	76.5	70.4	71.2									
Overall	w	0.78		0.34		1.17	1.00	1.57	0.71	1.86	0.99	4.76	3.52	3.63									

Table 8. Subarea 1 cod, 1980. Mean weight (kg, round fresh) by age as obtained from samples listed in Tables 6 and 7. Weighting factors to obtained weighted annual mean are the catches listed in Table 9 plus an estimate of offshore, non-Greenlandic catches of 9000 tonnes in the first quarter of the year. For comparison figures obtained in 1977, 1978, and 1979 are listed.

Age group	Unweighted mean by quarter				Weighted mean by quarter			
	1	2	3	4	1980	1979	1978	1977
Offshore samples	III	-	-	1.25	1.10	1.10	0.59	0.66
	IV	1.18	1.13	1.08	1.81	1.27	1.29	1.03
	V	1.96	1.82	2.05	2.87	2.08	2.54	1.43
	VI	2.98	2.57	2.89	4.30	3.13	2.98	1.87
	VII	4.11	3.61	4.08	6.04	4.35	4.40	3.39
	VIII	6.83	4.95	5.41	5.07	6.41	6.29	-
	IX	3.98	5.74	4.83	8.71	4.82	-	-
	X	-	-	-	-	6.77	-	-
	XI	-	-	-	-	7.58	-	-
						9.16	-	-
Inshore samples	III	0.44	0.82	0.65	0.93	0.74	0.73	0.86
	IV	0.73	1.04	1.07	1.58	1.18	1.06	1.55
	V	1.33	2.14	1.89	2.36	2.03	1.99	2.14
	VI	2.31	2.74	2.42	3.22	2.67	2.69	2.49
	VII	2.91	4.37	3.73	4.50	4.01	2.63	4.44
	VIII	-	-	-	5.07	5.07	-	-
	IX	-	-	-	7.86	7.86	-	-



Table 9. Nominal catch of cod by Greenlandic vessels in Subarea 1, 1980 by quarter of the year. Weighting factor offshore is the percentage distribution of these catches including an estimate of 9000 tonnes in the first quarter by non-Greenlandic vessels.

Quarter	1	2	3	4
Offshore tonnes	3474	1298	76	2384
%	48.0	17.9	1.1	33.0
Weighting factor	76.8	8.0	0.5	14.7
Inshore tonnes	806	5842	19673	8470
%	2.3	16.8	56.5	24.3

Table 10. Weight (kg, round fresh) by age of Subarea 1 cod suggested by Figure 1 as estimates for forecasts in the present paper. Average calculated by assuming 60% of catches as being inshore catches.

Age group	Mean weight		Weighted average
	offshore	inshore	
III	1.05	0.75	0.87
IV	1.45	1.25	1.33
V	2.15	2.00	2.06
VI	3.15	2.90	3.00
VII	4.40	4.20	4.28
VIII	6.35	5.50	5.84
IX	Values taken as in previous years' assessment. In brackets figures as revised according to Figure 2.		6.40 (6.80)
X			7.80
XI			9.00
XII			9.70
XIII			10.20
XIV			10.40
XV			10.50

Table 11. Number of cod (in thousands) per age group in Subarea 1, nominal catches, 1965-80. For the years 1977-80 the catches on which the calculations are based are those given in Table 4 as total catch.

CATCH AT AGE	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
age 3	16163	15320	1727	3764	668	49	272	15	131	343	275	10760	634	287
4	36231	78220	1591	7970	12390	2768	2517	10936	23028	10844	3595	40260	46639	5494
5	58431	92030	30438	56220	27433	10342	10338	12080	16365	2884	3677	2243	6081	5494
6	98900	59415	50462	39824	12464	13463	5257	2081	16065	6935	1803	1302	1501	1009
7	15399	49126	29900	10005	12784	4383	2077	2550	2605	1006	5883	1594	4468	851
8	12568	12833	5990	11725	5115	2810	1841	624	1406	800	1389	139	168	41
9	568	1330	3523	8348	204	149	953	709	1552	177	284	153	179	131
10	1915	981	503	2182	741	201	51	130	293	152	38	27	82	11
11	770	137	160	322	37	41	134	122	97	11	10	14	21	1
12	270	247	85	305	68	41	56		44			26		
sum	164084	132324	144767	128305	82627	42567	41831	43747	28218	15438	16656	20565	56699	37493

age	1979	1980
3	286	2538
4	356	3038
5	10650	4234
6	18970	2020
7	700	7
8	400	134
9	733	158
10	550	1
11	800	10
12	500	1
13	500	1
14	500	1
15	10	1
sum	43817	19672

The last age group is a plus-group.

Table 12. Number of cod (in thousands) per age group in nominal catches (including estimates of non-reported catches) 1978-80.

Age group	Div.	1978		1979		1980	
		1A-1D	1E-1F	SA 1	1A-1D	1E-1F	SA 1
III	275		12	287	276	10	286
IV	3757		1737	5494	10420	236	10656
V	18878		11161	30039	11902	603	12505
VI	852		152	1004	9324	9646	18970
VII	428		81	509	239	470	709
VIII	79		4	83	379	21	400
IX	37		4	41	73	5	78
X	11		2	13	52	-	52
XI	7		-	7	50	5	55
XII	7		-	7	80	-	80
XIII	7		-	7	5	-	5
XIV	-		-	-	5	-	5
XV+	-		-	-	11	5	16
Total	24338	13153	37491	32816	11001	43817	12465
Estimated nom.							
catch (tonnes)	50794	22680	73474	67799	31373	99172	26066
Calculated							
mean weight (kg)	2.09	1.72	1.96	2.07	2.85	2.26	2.09
							2.59

Table 13. Average numbers caught per year for age groups 4-14 for the years 1978-80 based upon figures in Table 12. See also Figure 3.

Age group	average numbers caught 1978-80	$l_n$ numbers
3	1033	6.94
4	6396	8.76
5	15593	9.65
6	7331	8.90
7	2947	7.99
8	206	5.33
9	59	4.08
10	28	3.33
11	21	3.04
12	34	3.53
13	5	1.61
14	2	0.69

FISHING MORTALITIES

age	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
3	0.075	0.057	0.026	0.052	0.011	0.001	0.004	0.001	0.013	0.024	0.014	0.057	0.018	0.010
4	0.033	0.029	0.023	0.021	0.014	0.002	0.003	0.006	0.004	0.014	0.037	0.041	0.092	0.027
5	0.035	0.045	0.022	0.039	0.028	0.034	0.039	0.088	0.041	0.048	0.063	0.061	0.106	0.049
6	0.055	0.066	0.008	0.053	0.024	0.029	0.012	0.071	0.052	0.057	0.066	0.053	0.077	0.054
7	0.055	0.043	0.003	0.021	0.006	0.040	0.059	0.047	0.052	0.048	0.091	0.039	0.037	0.043
8	0.055	0.043	0.003	0.021	0.006	0.040	0.059	0.047	0.052	0.048	0.091	0.039	0.037	0.043
10	0.055	0.043	0.003	0.021	0.006	0.040	0.059	0.047	0.052	0.048	0.091	0.039	0.037	0.043
11	0.055	0.043	0.003	0.021	0.006	0.040	0.059	0.047	0.052	0.048	0.091	0.039	0.037	0.043
12	0.055	0.043	0.003	0.021	0.006	0.040	0.059	0.047	0.052	0.048	0.091	0.039	0.037	0.043
13	0.055	0.043	0.003	0.021	0.006	0.040	0.059	0.047	0.052	0.048	0.091	0.039	0.037	0.043
14	0.055	0.043	0.003	0.021	0.006	0.040	0.059	0.047	0.052	0.048	0.091	0.039	0.037	0.043
15	0.055	0.043	0.003	0.021	0.006	0.040	0.059	0.047	0.052	0.048	0.091	0.039	0.037	0.043
Mean	0.471	0.470	0.575	0.686	0.629	0.494	0.731	0.848	0.572	0.558	1.003	0.744	0.905	0.507

age	1979	1980
3	0.011	0.009
4	0.014	0.010
5	0.033	0.030
6	0.033	0.030
7	0.033	0.030
8	0.033	0.030
10	0.033	0.030
11	0.033	0.030
12	0.033	0.030
13	0.033	0.030
14	0.033	0.030
15	0.033	0.030
Mean	0.672	0.630

Table 14a. VPA Suber 1 cod.

STOCK IN NUMBERS													
age	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
3	385254	244181	773388	86362	689399	39272	85927	14709	11881	1680	22447	225333	40907
4	307420	154751	119595	55740	60751	50503	29051	61423	10887	8763	12063	16393	157717
5	231543	264737	160987	137419	38451	32589	38372	21157	42887	6841	16403	2650	98044
6	276023	116657	69759	25533	29087	35536	13513	29505	7267	20450	34364	1139	34364
7	27171	11660	4771	25738	11471	9175	13513	5391	3204	3390	2380	2651	1025
8	61735	12805	12105	3680	25315	4812	4624	1212	1	1615	1000	904	925
9	1133	2	1	1880	1823	4	2	412	1	515	2	307	949
10	1163	489	1421	4822	1766	655	380	1254	450	206	271	218	111
11	5216	2308	262	522	243	434	269	2018	772	2075	322	122	111
12	480	308	1015	261	160	763	496	161	335	382	71	17	160
13	508	361	119	398	12	170		209	75	19	17	48	31
14	428	361											
15													
sum1	939386	844959	625465	458202	315011	213538	216839	148351	90267	63629	58473	256172	214859
sum2	121006	181553	249029	179681	148866	85174	63010	46104	24515	31345	17761	7796	8431
age	1979	1980											
3	29175	310789											
4	23708	21368											
5	19422	9891											
6	14520	6821											
7	1193	18195											
8	613	130											
9	159	142											
10	110	142											
11	92	385											
12	21	35											
13													
14													
15													
sum1	119078	365615											
sum2	46772	23566											
sum1 : sum of stock age 3 to 15													
sum2 : sum of stock age 6 to 15													

Table 14 b. VPA Subarea 1 cod.

Run identification: SA1-001

end 25

FISHING MORTALITIES

age	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
3	0.075	0.057	0.097	0.052	0.011	0.001	0.004	0.001	0.013	0.024	0.014	0.057	0.018	0.007
4	0.077	0.058	0.098	0.053	0.012	0.002	0.005	0.002	0.014	0.025	0.015	0.058	0.019	0.008
5	0.079	0.060	0.100	0.055	0.014	0.003	0.006	0.003	0.016	0.027	0.016	0.060	0.020	0.009
6	0.081	0.062	0.102	0.057	0.016	0.004	0.008	0.004	0.018	0.029	0.018	0.062	0.021	0.010
7	0.083	0.064	0.104	0.059	0.018	0.005	0.010	0.005	0.020	0.031	0.020	0.064	0.022	0.011
8	0.085	0.066	0.106	0.061	0.020	0.006	0.012	0.006	0.022	0.033	0.022	0.066	0.023	0.012
9	0.087	0.068	0.108	0.063	0.022	0.007	0.014	0.007	0.024	0.035	0.024	0.068	0.024	0.013
10	0.089	0.070	0.110	0.065	0.024	0.008	0.016	0.008	0.026	0.037	0.026	0.070	0.025	0.014
11	0.091	0.072	0.112	0.067	0.026	0.009	0.018	0.009	0.028	0.039	0.028	0.072	0.026	0.015
12	0.093	0.074	0.114	0.069	0.028	0.010	0.020	0.010	0.030	0.041	0.030	0.074	0.027	0.016
13	0.095	0.076	0.116	0.071	0.030	0.011	0.022	0.011	0.032	0.043	0.032	0.076	0.028	0.017
14	0.097	0.078	0.118	0.073	0.032	0.012	0.024	0.012	0.034	0.045	0.034	0.078	0.029	0.018
15	0.099	0.080	0.120	0.075	0.034	0.013	0.026	0.013	0.036	0.047	0.036	0.080	0.030	0.019
Mean	0.0471	0.0470	0.0494	0.0575	0.0629	0.0494	0.0731	0.0848	0.0572	0.0558	1.003	0.744	0.905	0.507

age	1979	1980
3	0.011	0.015
4	0.013	0.017
5	0.015	0.019
6	0.017	0.021
7	0.019	0.023
8	0.021	0.025
9	0.023	0.027
10	0.025	0.029
11	0.027	0.031
12	0.029	0.033
13	0.031	0.035
14	0.033	0.037
15	0.035	0.039
Mean	0.0172	0.0200

Table 15a. VPA Subarea 1 cod.

STOCK IN NUMBERS

age	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
3	2852	244181	72388	86340	9339	39272	85927	14709	11981	1680	22447	225333	40907	49711
4	2852	154475	119585	55345	9339	39272	85927	13423	10884	18763	12063	163350	157717	29761
5	2852	222737	160287	72388	9339	39272	85927	61514	42887	6841	6204	6650	9804	27261
6	2852	166002	100287	25363	9339	39272	85927	22605	72304	20450	3469	2685	3434	2659
7	2852	110002	72388	25363	9339	39272	85927	5305	3504	3390	2310	2601	1023	1325
8	2852	132002	4777	1980	9339	39272	85927	4191	1979	1961	1080	907	983	1221
9	2852	482	12105	4	1415	4	4699	1272	472	286	2	208	111	156
10	2852	2308	11421	1980	1763	4	280	2054	722	207	900	108	349	119
11	2852	2308	11421	1980	1763	4	280	1228	365	395	271	22	122	208
12	2852	2308	11421	1980	1763	4	280	1228	365	395	271	22	122	208
13	2852	2308	11421	1980	1763	4	280	1228	365	395	271	22	122	208
14	2852	2308	11421	1980	1763	4	280	1228	365	395	271	22	122	208
15	2852	2308	11421	1980	1763	4	280	1228	365	395	271	22	122	208
sum1	93986	844959	625445	455202	315011	213538	216839	146351	90267	63629	58473	256172	214859	171495
sum2	121006	181553	249029	179681	146866	83174	63010	46704	24515	31345	17761	7766	6431	4762

age	1979	1980
3	2852	200291
4	2852	200291
5	2852	200291
6	2852	200291
7	2852	200291
8	2852	200291
9	2852	200291
10	2852	200291
11	2852	200291
12	2852	200291
13	2852	200291
14	2852	200291
15	2852	200291
sum1	131950	265611
sum2	46772	23566

sum1 : sum of stock age 3 to 15  
sum2 : sum of stock age 6 to 15

Run identification: SA1-002

end 25

Table 15b. VPA Subarea 1 cod.



Table 16. Subarea 1 cod. Forecasts of stock size (age 3+), spawning stock size and catch (all in thousand tonnes) (Revised) by various fishing strategies in 1982-84, assuming that the nominal catch in 1981 will be about 50,000 tonnes.

Year	Option no.	1 (F=0.10)	2 (F=0.20)	3 (F <sub>0.1</sub> =0.25)	4 (F <sub>max</sub> =0.48)	5 (F=0.60)	6 (catch=50,000 tonnes)
1980	stock size	332	all other options equal to option 1				
	spawning stock	92					
	F	0.63					
1981	catch	53	all other options equal to option 1				
	stock size	325					
	spawning stock	81					
1982	F	0.357	all other options equal to option 1				
	catch	50					
	stock size	461					
1983	spawning stock	50	all other options equal to option 1				
	F	0.10					
	catch	27					
1984	stock size	471	0.20	0.25	0.48	0.60	0.197
	spawning stock	313	461	446	389	364	50
	F	0.10	283	270	214	190	461
1985	catch	31	0.20	0.25	0.48	0.60	284
	stock size	531	54	63	91	98	0.185
	spawning stock	331	470	443	347	311	50
1986	F	0.10	272	247	157	126	475
	catch	39	0.20	0.25	0.48	0.60	277
	stock size	429	65	74	96	100	0.149
1987	spawning stock	429	334	296	174	134	50
	F	0.10	0.20	0.25	0.48	0.60	356
	catch	27	57	62	107	128	

Table 17. Mean temperature in June over the shallow part of Fylla Bank (Div. 1D), estimated year-class strength of the corresponding cod year class (mio. fish at age 3) and spawning biomass producing the year class. Spawning biomass defined as biomass of 6-year-old and older fish. For estimates of year-class strength see text, page 10.

Year	Fylla Bank temperature ( $^{\circ}\text{C}$ )	Spawning biomass (thousand tonnes)	Year class strength (nos. $\times 10^{-6}$ at age 3)
1947	3.5		585
48	-		-
49	0.6		99
50	2.1		351
51	-		-
52	-		146
53	2.1		438
54	2.3		87
55	-		99
56	0.9		233
57	2.3		523
58	-		157
59	1.6		93
60	2.7		403
61	3.2		501
62	-		225
63	1.6		244
64	2.3		77
65	2.1	649	86
66	1.6	758	69
67	-	978	39
68	2.1	798	86
69	0.3 (mean May-Aug.)	649	15
70	0.3	414	12
71	0.8	324	17
72	0.7	222	22
73	1.7	144	225
74	1.0	131	41
75	1.9	85	50
76	1.4	41	29
77	2.1	30	200
78	0.9	20	20
79	2.2	153	90
80	1.9	96	75

above 500

forecast estimates

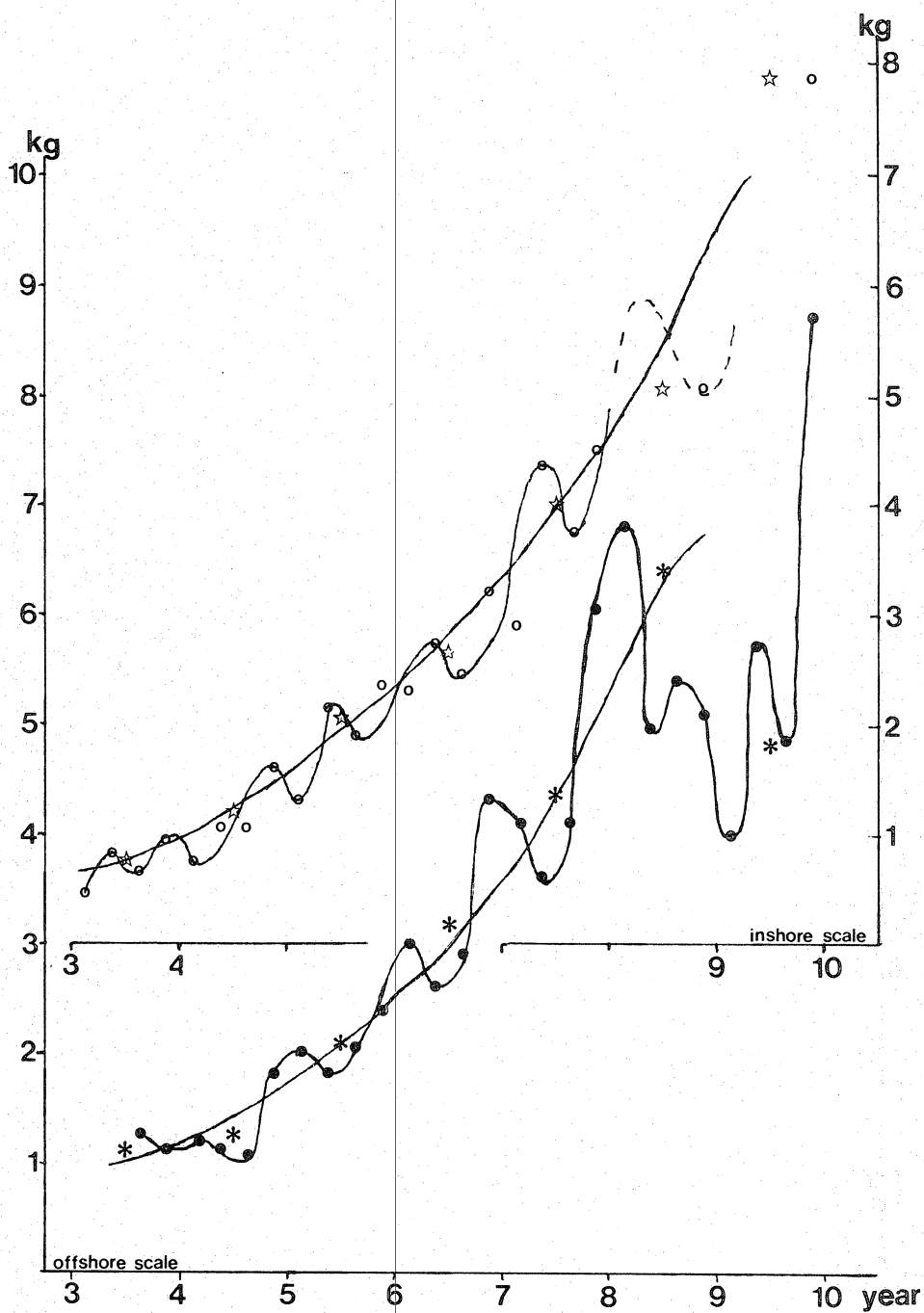


Figure 1. Subarea 1 cod. Quarterly mean weight (kg, round fresh), and weighted mean for the year 1980 of inshore samples (upper part of the figure), and offshore samples (lower part). Weighting factors are given in Table 9.

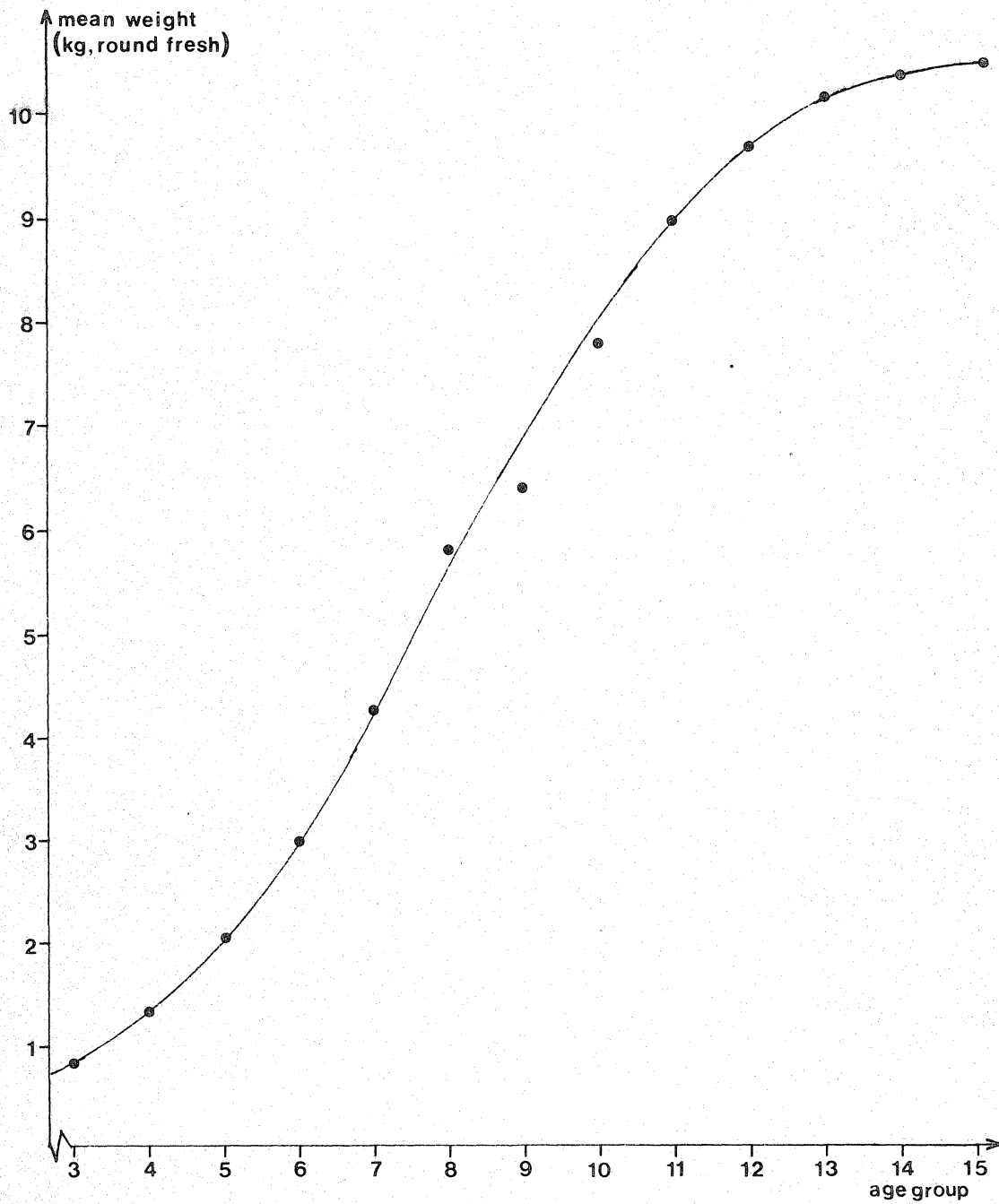


Figure 2. Weighted mean weight by age of Subarea 1 cod, 1980, for ages 3-8, and as used in previous years' assessment for ages 9 and older (see Table 10)

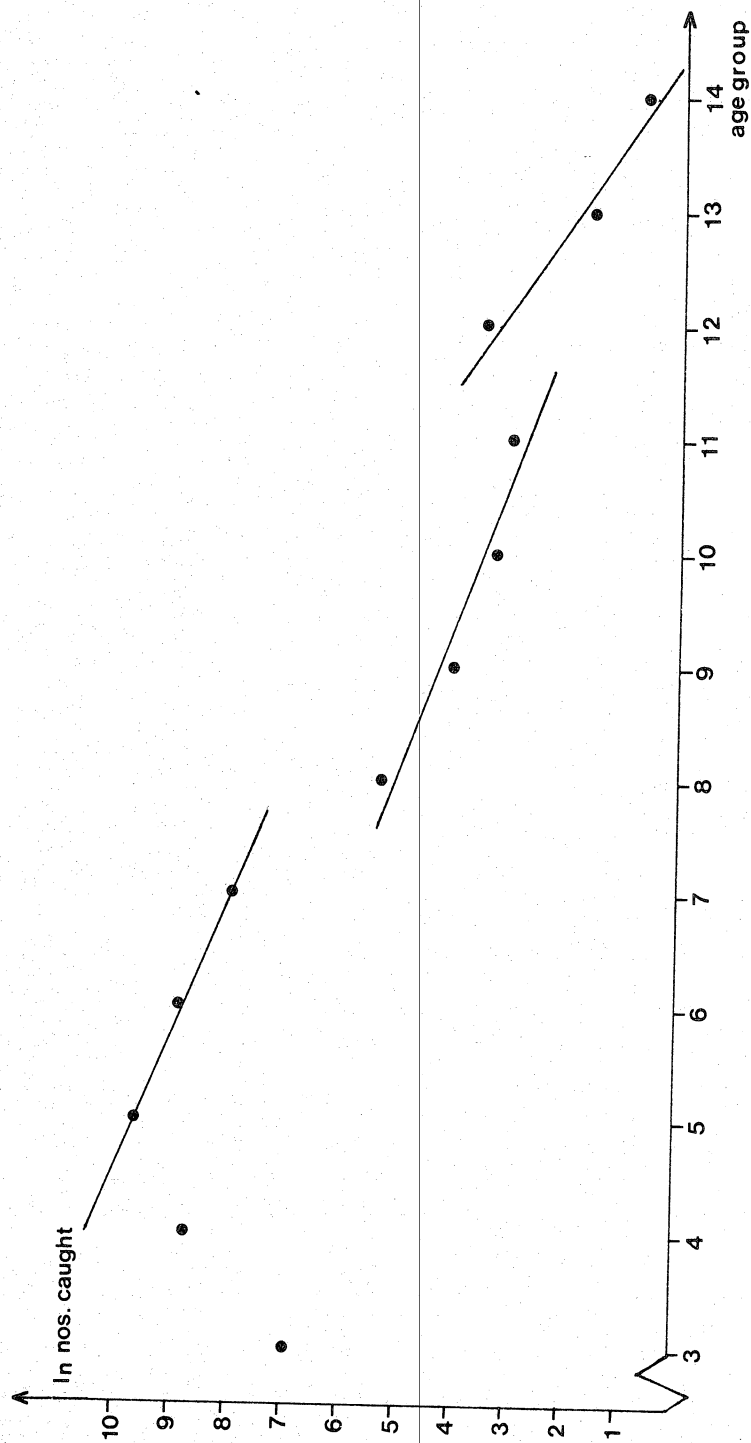
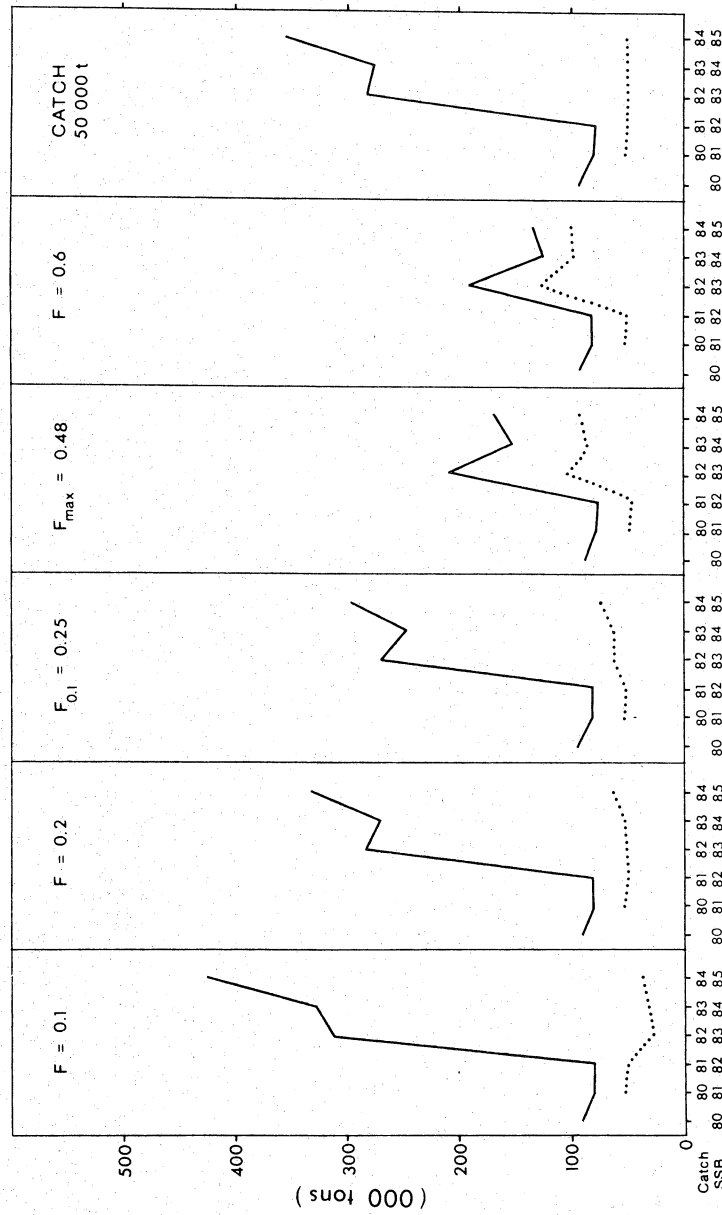


Figure 3. Subarea 1 cod. Natural logarithm of numbers caught by age averaged over the period 1978-80, and regression lines for age groups 5-7, 8-11, and 12-14. Equation for these lines are

$$\begin{aligned}
 y &= 13.83 - 0.83x & \text{for age groups } 5-7 \\
 y &= 11.18 - 0.76x & \text{for age groups } 8-11 \\
 y &= 20.4 - 1.42x & \text{for age groups } 12-14
 \end{aligned}$$

For ages 5-14 the regression line is expressed by the equation  
 $y = 16.01 - 1.25x$



Year

Figure 4. Subarea 1 cod. Projected catches (lower curve) and spawning biomass (upper curve) by various fishing strategies assuming nominal catch in 1981 to be 50,000 tonnes. The figure corresponds to Table 16. Catches are for the first year indicated by the coupled years at the bottom of the figure, spawning biomass at the beginning of the following year.

Figure 5. Subarea 1 cod. Estimates of year class strength for year classes 1947-80 shown in relation to parent stock size and Fylla Bank temperature in June when the year class was born. Figures are also found in Table 17.

