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Subarea 1 Cod: Data for 1979 and early 1980, and Estimates of Stock and Yield for 1980-82

by

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1. Nominal catches 1977-79

Since May-June 1977 direct cod fishing in Greenland waters has been allowed for Greenlandic vessels only. Non-Greenlandic vessels with access to fisheries for species other than cod have had some allowance for by-catches of cod. When fishing for redfish the allowable by-catch of cod is up to 10% while up to 3% in fisheries for other species under quota regulation.

It has been rather difficult to control directly whether these by-catch regulations were actually followed. A number of cases were, however, reported already in 1977 but especially in 1978/79 by the Greenland cod-fishing trawlers that non-Greenlandic vessels were trawling on the same grounds and depths as they were. However, when inspection vessels approached, the vessels normally spread. Boardings were made occasionally, but since most of the vessels are factory freezer trawlers inspection of the hold is very difficult.

A training program for inspection officers now includes identification of frozen products by species. In the beginning of 1980, in four cases have non-Greenlandic trawlers been proven to have severely misreported their catch, which was in fact mainly cod. Three of the vessels were taken to port and court in Greenland, and captains were heavily fined.

This leaves scientists with a very delicate problem, squeezing them between fairness to people of which only a minority has been proven to manipulate with figures, and conscience to science. The easiest way out of the dilemma would be to refuse making assessment - and that is probably what one should have done. However, the author has chosen to illustrate the possible state of the stock by setting what could be considered to be surely upper and lower limits of the actual catches. This has been done in the hope that the outcome of analyses for the extremes will have so much in common that the results can form a basis for advice on future management of the stock.

The approach to achieve an upper limit of estimated catches is influenced by the observation that so to say the whole fleet (25-30 vessels) of non-Greenlandic groundfish trawlers left Greenland waters shortly after the first two vessels were arrested on 13 and 17 February 1980. Most of the vessels had been fishing since the beginning of January. Their total catch by the time they left Greenland waters in the last part of February was reported by the vessels to the Governor of Greenland as 2828 tonnes of which 141 tonnes of cod and 1630 tonnes of redfish.

The evidence of the arrested vessels were as follows (taken from the sentence)

Vessel "A"

Fishing in Greenland waters since 21 December 1979. Arrested 13 February 1980

Catch reported by vessel (round, fresh fish in tonnes)		Catch observed
Cod	5	549 (fillets: 186)
Redfish	66	126 (" : 42)
Wolffish	64	34 (" : 10.5)
Other groundfish	197	10
Total	332	719

Other groundfish include roundnose grenadier, Greenland halibut, American plaice, halibut and fish not specified.

Catch was observed as products. The author has converted to round, fresh fish by conversion factors taken from FAO Bull.Fish.Stat., Vol.25. The observed figures for products are given in brackets.

Vessel "B"

Fishing in Greenland waters, mainly East Greenland, since 29 December 1979. Arrested 17 February 1980.

Catch reported by vessel (round, fresh fish in tonnes)		Catch observed
Cod	13	579 (fillets: 179)
Redfish	84	124 (fillets: 30. Gutted: 18)
Wolffish	10	17 (fillets: 5.3)
Other groundfish	105	89
Total	212	809

Other groundfish include the same species as for vessel "A".

Vessel "C"

The sentence is not yet available. The vessel reported arrival in East Greenland waters 26 February 1980 and was arrested in late April. By 21 April the vessel reported a total catch of 279 tonnes of which 14 cod, while the preliminary estimate by inspection is 70 tonnes of cod out of a total 170 tonnes in the hold (figures quoted from press).

The evidence from the above mentioned vessels indicate that not only the species composition, but also the total catch may be wrongly reported, in some cases with less than half the actual amount. Maybe captains fail to convert

figures to round, fresh weight when reporting directly from the fishing grounds. Comparison between total annual catch reported by vessels to the Greenland Governor's office and the figure supplied later to ICNAF by national offices was possible only for 1978 at the time when the paper was produced. The non-Greenlandic groundfish trawlers' reports were summarized by the Governor's office as 20 027 tonnes (all species) for Subarea 1 and 15 680 tonnes for East Greenland while subsequent preliminary figures presented to ICNAF by national offices and laboratories amounted to 39 483 tonnes for Subarea 1 and 34 771 tonnes for East Greenland, roughly doubling the figures summarized by the Governor of Greenland./

Whether the total catch for 1979 as reported by vessels to the Greenland authorities is also underreported is not yet clear.The total catch is summarized to 50 600 tonnes in Subarea 1 and 35 300 tonnes at East Greenland. Comparing these figures to the 1978 catches reported by national offices, and comparing reports of fishing activity between the two years there seems, however, to be no evidence that the total catch of 1979 is wrongly reported, only that the species composition so is. However, the accuracy of the total catch figures reported by vessels can only be judged when nationally collected figures become available.

In order to arrive at an upper limit of estimated catches of cod in 1977-79 the following considerations are made:

i) Total catch figures (all species together) for 1977-78 are accepted as reported by national offices to ICNAF and to ICES.

ii) By the time the paper was produced national figures for 1979 were not available to the author. Instead those all-species figures summarized in the office of the Governor of Greenland were used.

iii) Off West Greenland the non-Greenlandic groundfish trawlers have to some extent been operating on the same banks as the Greenland trawlers. The percentage of cod in the Greenland groundfish trawlers' catch was 80% in 1977. Applying this figure to total catch by non-Greenlandic vessels leads to round figures for catch of cod in SA 1 of 38 000 tonnes for 1977. In 1978 and 1979 the percentage of cod in the Greenland trawlers' fishery was 93% and 95%, respectively. However, as the large non-Greenlandic factory trawlers may make better use of odd species than the Greenland trawlers the author hesitates in proposing figures higher than 90% of cod for the non-Greenlandic vessels. Applying 90% to the catches in 1978 (as reported by national offices) and 1979 (summary of vessels' direct reports) leads to round figures of 36 000 and 46 000 tonnes of cod as the upper limit for the non-Greenlandic vessels in Subarea 1 in the two years, respectively.

For the East Greenland area material from Greenland trawlers' fishery is probably too limited to form a basis for upper limits of non-Greenlandic vessels' catch. Instead it has been assumed that cod made up 50% of the total catch in 1977 but 75% in 1978-79 when the 1973 year-class is likely to have raised the figure. These figures are not just arbitrary, but rather like those in 1970-73 when the total catch level was close to that in 1977-1979, and when the 1968 year-class played a role much like that now played by the 1973 year-class. These assumptions would lead to upper limits at East Greenland by non-Greenlandic vessels of 11000, 17000 and 26000 tonnes for the years 1977, 1978 and 1979, respectively.

Quite evidently much lower figures could be argued, but the above given figures are suggested and used as an upper limit in the analyses carried out in this paper. A lower limit could be the figures so far supplied through national sta-

tistical offices or research laboratories.

Anyway, analyses of these extremes will hopefully have so much in common that they will give some ideas about the actual stock situation.

Tables 1-3 give the nominal catch of cod for the years 1977-79 as reported in the statistics supplied to ICNAF/NAFO and to ICES, while Tables 1a - 3a give upper limits of catches according to the considerations mentioned above. In allocating the catches to divisions it has been assumed that their distribution follows the same pattern as those catches reported by divisions.

2. Trends in catch per unit effort and total effort

Since Greenland vessels were the only ones allowed direct cod fishery in most of 1977 and in 1978-1980 their catch and effort data are used to evaluate trends in catch per unit effort. Unfortunately effort figures are available only for the trawlers, while effort in the inshore fisheries by mixed gears, mainly pound nets, is not recorded.

The trawlers' annual effort, catch and catch per unit effort by division for the years 1977-79 are given in Table 4 while a breakdown by quarter of the year is given in Table 5.

The overall cpue-figures in Table 4 illustrate a very significant increase in cpue by 157% from 1977 to 1978 while cpue for the trawlers decreased again (by about 30%) from 1978 to 1979. These fluctuations seem closely connected with the occurrence of the relatively good 1973 year-class. The year-class made up about 80% by number of the catches in 1977 as well as in 1978 (see Tables 14 and 14a) but had a smaller mean weight in 1977 than in 1978. In 1979 the 1973 year-class accounted for about half the number of cod caught, supplemented by younger age-groups, so that mean weight of fish in 1979 was only 15-22% higher than in 1978, not enough to counterbalance the decrease in numbers of the 1973 year-class. At the same time there are evidences of a probably significant migration of the individuals of the 1973 year-class from West to East Greenland - Iceland, and annual catch rate at East Greenland seems to have been rather constant in the three years considered (the material for this conclusion is very limited).

A more detailed study of the fluctuations between the three years (Table 5) shows similar seasonal trends for all three years. In the first quarter of the year fishing has concentrated and achieved its best catch rates in Div. 1C and northern part of Div. 1D. In the second quarter there is a more uniform distribution of the effort between Div. 1C-1E evidently due to increasing catch rates in Div. 1E and southern part of Div. 1D. The limited material available from the third and fourth quarter of the year indicates a continuation of the southward shift of cod concentrations during fall but a re-establishment during winter of Div. 1C-1D as the more important area.

It should be noted that the overall decrease in Greenland trawlers' effort from 1977 to 1979 is due to political and economical considerations. It has been attempted to keep total catch of cod at a low level as adviced by ICNAF

Assessment Subcommittee, and the trawlers were transferred to shrimp fishing in the last part of all three years.

As already mentioned, for the inshore catches no effort figures are available. However, the trends in inshore catches in the 1977-79 period are so pronounced that some conclusions may be drawn. The catches are illustrated in Tables 1-3 (mixed gears). First of all the inshore fishery has shown a considerable increase, around a trebling from 1977 through 1978 to 1979. Secondly the figures show that by far the major part of the increase is occurring in Div.1E and especially in Div. 1F where catches nearly quadribled in the period. Unfortunately sampling in the latter two divisions has been rather limited, but fishermen's information and the few samples taken point to the southward migration of the 1973 year-class as the major reason for the observed changes. Especially remarkable was the occurrence of the year-class in the inshore part of Div. 1F in 1979. In the sample taken it accounted for 89% by number. Whether special hydrographic conditions directed migrating cod to the fiords or whether they grew up there is not known. However, it is likely that those which survived the 1979 fishery have had a considerable migration to East Greenland.

The increase in the inshore fisheries from 1977 to 1979 is thus heavily influenced by the 1973 year-class. This year-class has now been extensively fished and has also emigrated to some extent, and inshore catches are not likely to maintain the high 1979 level unless the 1973 year-class is now substituted by other year classes of a strength similar to that of the 1973 year-class. In fact, to be judged from the catches by 30 April 1980 the inshore catch in 1980 will be well below that in 1979.

If the Greenland trawlers' catch rate is taken as an index of cpue for the total effort in SA 1 then the figures in Tables 1-5 suggest that total effort decreased by about 60% from 1977 to 1978 but increased again by 89-97% from 1978 to 1979. The 1979 effort calculated in this way is about 75% of the 1977 effort. The increase from 1978 to 1979 would to some extent fall on the inshore fisheries, and it is highly likely that small-boat activity did in fact increase considerably as catch rates improved. However, in terms of fishing mortality the situation is not that simple. The major part of the basic trawler-effort was recorded at a time when cod formed pre-spawning shoals, and it has not been possible to take into account the seasonal variation in catchability. It should, however, be noted that in terms of number of fish landed the catch dropped by 20-34% from 1977 to 1978 but increased slightly (14-17%) from 1978 to 1979 (Tables 14-14a). Table 6 illustrates the changes in catch and effort between 1977 and 1979 when catch is expressed by numbers rather than by weight. From this table it occurs that overall effort dropped by 35-46% from 1977 to 1978 when considering numbers caught. However, considering that the 1973 year-class was exposed to a total mortality in 1977 which is not likely to have been counterbalanced by a continued recruitment between the two years, then in terms of fishing mortality the effort would not seem to have decreased between the two years, rather the catchability of cod increased as part of the 1973 year-class contributed to the spawning shoals. A comparable change in catchability may not have occurred between 1978 and 1979. The 1974 and 1975 year-classes are

not likely to be as strong as the 1973 year-class. The decrease in numbers caught per unit effort from 1978 to 1979 may, therefore, be explained by year-class fluctuation rather than by change in catchability. As total numbers caught increased somewhat from 1978 to 1979 the overall effort seems to have increased by about 20% according to figures in Table 6.

It should be noted that the above comparison of effort between years is made for the upper and the lower limits of catches separately. If true figures were available the variation in overall effort between years could change considerably.

3. The fishery and the stock in the beginning of 1980

As in 1977-79 the Greenland trawlers did again experience good catch rates in the beginning of 1980 (see Table 5). However, total effort decreased as most of the trawlers continued to fish for shrimp to which fishery they were converted in May 1979.

A remarkable observation was that in February concentrations of cod were found in the Holsteinsborg Deep (southernmost part of Div. 1B). Cod has not been found in offshore concentrations so far north for many years. The occurrence was, however, not too surprising as 2-years old cod (1975 year-class) was observed as causing a high discard rate of undersized fish in the inshore pound net fishery in Div. 1B in 1977. Samples of the trawlers' fishery in the Holsteinsborg Deep in February-March 1980 confirm that the 1975 year-class was the predominating one in the landings (81% by number) but there was also a rather high discard rate (1/3 - 1/2 by numbers) of small cod amongst which the 1977 year-class made up about 73% (see Table 7).

The concentration of cod in the Holsteinsborg Deep was observed only during some weeks in February and beginning of March, and the major part of the trawl fishery in the first quarter of 1980 has taken place in Div. 1C, 1D and 1E. Samples from this fishery (Table 8) point to the 1973 year-class as the important one in Div.1E while in Div.1C-1D an inflow of year-class 1975 occurs.

Echograms from an acoustic survey by the R/V ADOLF JENSEN on 17-18 April, 1980 over fishing banks in Div. 1D-1E (Figs 1a-1b) did not show any sign of noteworthy formations of cod.

Inshore catches in SA 1 by 31 March are about 46% below catches at the same time in 1979. The decrease is entirely in Div. 1E-1F (by 54%) whereas for Div. 1A-1D there is an increase. However, the important pound net season has not yet started (for 1979 only 4% of the total catch was taken by 31 March). The very good inshore fishery in 1979 was to a great extent based upon the 1973 year-class, but it seems likely that the major part of the inshore catches in 1980 will consist of the 1975 year-class in Div. 1B-1D and a mixture of year-classes 1973-76 in Div. 1D-1F and that there will be considerable discard of 3-years old cod in the pound net fishery especially in the northern divisions.

4. Mean length and weight of age groups in 1979

Age and length samples of cod in Subarea 1 and off East Greenland for 1979 were provided by Denmark(G) and by the Fed.Rep.of Germany.

The FRG samples give figures for mean length and weight of each total sample

while some of 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 Meeting of the Scientific Council of NAFO. The mean lengths and weights for age groups in the Danish samples are given in Table 9. In Table 10 is given the quarterly mean of the figures in Table 9. The weighted average has been obtained by weighting with the quarterly catches of Greenlandic vessels as listed in Table 11.

In 1978 (Horsted, 1979) it was observed that the important 1973 year-class (age-group 5) had an extraordinarily high mean weight, especially in the first quarter of the year. This phenomenon for the same year-class (age-group 6) seems to occur again in 1979 although with less pronounced difference than in 1978 between first quarter and the remainder of the year. Possibly the explanation again is that only part of the year-class, viz. the faster growing individuals, were spawners as 6-years old.

The mean weights in Table 10 have not been used as such to convert catches by weight to numbers caught. In the calculation the actual mean weight of the samples by which the conversion is made is used and this has as far as possible been done on a monthly base. The mean weights by quarters are given to achieve likely mean weights for forecasts, but evidently the great variation between years of mean weights makes it difficult to estimate mean weights for each year class in the forecast years. The fisheries trend in 1977-79 will, however, suggest that offshore catches will continue to be taken mainly in the first half of the year, *i.e.* with relatively high mean weights for age-groups 5 and 6. Inshore catches are likely to be taken mainly in the second and third quarters as in the preceding years.

For forecasts it is, therefore, suggested to take the average of the weighted means for the last three years, and to assume that offshore catches will be greater than inshore catches, say 60% of total catch (depending heavily on quotas set). Following this suggestion one arrives at figures set out in Table 12. These figures differ only slightly from those used in last years forecasts except for age-groups 8-11 where recent figures are higher than figures previously used. However, very few fish of these ages are found in the forecast stock. For fish older than 11 years no material exists in 1979. Previously used figures for mean weight of age-groups 12 to 15+ are also listed in the table. Since, however, it occurs unreasonable to adopt figures with a decrease in mean weight from age 11 to age 12 a smoothed set of figures obtained by plotting weight for ages 3-11 and the formerly used value for age-group 15+ (see Fig. 2), is adopted for the forecasts. These values are listed at the right hand side of Table 12.

5. Numbers landed by age groups in 1977, 1978 and 1979

Numbers landed per age groups for the years 1965-76 and used in earlier years' assessment of Subarea 1 cod as a whole are listed in Table 13. Details are found in Res.Doc. 75/31, 76/VI/17, 77/VI/8 and 78/VI/44. For 1977 and 1978 figures were given in Res.Doc. 79/VI/59. These figures have been revised

to correspond with the estimated upper and lower limits for catches as presented in Tables 1-2 and 1a-2a and are listed together with preliminary figures for 1979 in Tables 14 and 14a.

For 1979 the offshore catch by Greenlandic otter trawlers is fairly well sampled, allowing to a great extent monthly analyses by divisions. Inshore catches are less well sampled. For instance, for the large catch of 27-28000 tonnes in Div. 1E-1F only one sample exists.

In 1979 the 1973 year-class has still been the major contributor to the fishery. Year-class 1974 has surprised by contributing more fish than the 1975 year-class although the former is considered a much smaller year-class than the latter. However, when the 1975 year-class gets fully recruited it is expected to confirm its strength relative to the 1974 year-class. Very few fish older than 8 years were caught. Samples by the Fed. Rep. of Germany (Div. 1E-1F and off East Greenland), received after Tables 14-14a were worked out, confirm that the 1973 year-class was the predominating one in these areas, and also that fish older than 8 years were relatively few.

6. Information on future recruitment

With a prescribed minimum mesh size of 130 mm (manila) in the trawls and with a local minimum size of 40 cm for cod landed in Greenland the commercial fishery does not supply much information on age-groups 1-3, the important ones for recruitment estimates, unless information on amount and composition of discards is available.

Discarding of small cod (with a high possibility of surviving by proper handling) occurs especially in the pound-net fishery, and some information on discards in 1979 has been collected. Information on discards in the trawl fishery is not always given, but discarding occurs to have been rather limited in 1979.

On the basis of the available information on discards in the commercial fishery and observations by research vessels the prospects of the forthcoming recruitment is as follows:

The strength of the 1979 year-class can at present be made only on hydrographic and plankton observations in 1979. These are described in the Danish Research Report for 1979. In brief, water temperatures in the spring and summer of 1979 were relatively high. The reference temperature at the shallow part of Fylla Bank in June was 2.2°C. Temperatures above 1.8°C at this place and time are normally favourable for survival of cod larvae. Temperatures remained relatively high in July.

The number of cod larvae in the plankton was , however, relatively low (1.2 larvae per half-hour haul), the same level as in the cold period 1969-74 when poor year classes occurred. However, for the 1973, 1975 and 1977 year-classes the number of larvae was 1.0, 3.2 and 0.7, respectively. The reference temperature in these years was very close to 2°C, and the year-classes seem to be relatively good (relative to current low stock level). It should be remembered, however, that the 1973 year-class got a considerable inflow of recuits from the East Greenland area. With this in mind it seems proper to regard

tentatively the 1979 year-class cautiously, with possible (upward) adjustment later, as somewhat below the 1973, 1975 and 1977 year-classes.

Individuals of the 1978 year-class have not yet reached a size, where they would occur in the pound-net fishery. Very few research hauls have been made in the divisions and on the depths where young cod would occur. Thus no new information is available to justify a change from last year's prediction of this year class, based upon hydrographical conditions and results of larval surveys,in 1978, that the year class will be a very poor one.

The 1977 year-class has been observed at several occasions, probably most noteworthy as discards in the trawl fishery in February-March 1980 in the Holsteinsborg Deep, Div. 1B (see Page 7, Section 3). Discard rate when sampling was about 1/3 - 1/2 by numbers, and the 1977 year-class accounted for the major part of the discarded fish (73% in a sample of these, see Table 7).

Inshore fishermen in Div. 1B reported some discards of fish just below minimum size (40 cm) in the pound-net fishery in 1979. Samples of commercial sized fish indicate that the major part of the undersized fish would belong to the 1976 year-class, but there would probably also be some of the 1977 year-class amongst them.

In Div. 1C observations of pound-net catches were made at only two occasions in July. Few fish were discarded in the one case, whereas the other observation was a discard rate of about 1/4. About 2/3 of the discarded fish were 2 years old, the remainder 3-4 years.

Furthermore, reports and samples from the pound-net fishery in Div. 1D shows the 1977 year-class as occurring as discards in most of the pound-net catches. The extreme case from a fiord near Godthåb in late June showed a discard rate of 82% by numbers, 60% of which belonged to the 1977 year-class. However, discard rate was generally much lower and with less inflow of 2-years old fish so that 3-years old fish (year-class 1976) accounted for the major part of the discards in this division.

The only observation in Div. 1F did not give good basis for judgement of recruits, but observations in 1978 (by the Fed. Rep. of Germany) showed the 1977 year-class to be present also in Div. 1E, offshore.

The 1977 year-class thus seems to be distributed at least from Div. 1B to 1E, possibly also in Div. 1F. It seems likely to contribute to a gradual northward extension of the present rather limited area for cod fishing, and to become an important part of the fishery by 1981-83. It may also be proper to judge its actual size somewhat higher than on the basis of last year's information, possibly close to the size of the 1975 year-class.

The 1976 year-class showed up in the commercial catches in 1979, and as already mentioned it accounted also for a considerable part of fish discarded from pound-nets in Div. 1B-1E. Its occurrence in the 1980- samples so far available (Tables 7 and 8) would still indicate its strength to be well below the neighbouring 1975 and 1977 year-classes.

The above mentioned judgements are all relative between the year-classes. As the basis for an absolute figure for the strength of the year-classes it has been considered, that the year-class 1975 will be below, suggested as 1/3 below the 1973 year-class (the latter as measured by VPA, including immi-

grants from East Greenland in the input for numbers caught). As discussed later in the paper the 1973 year-class seems to have contributed to the fishery by a strength equivalent to about 175 mio. recruits at age 3. This would suggest year-class 1975 to be in the order of 115 mio. recruits. Consequently, the tentative suggestions for recruitment to be used in forecasts for Subarea 1 are

Year class	Mio. fish at age 3 (beginning of the year)
1975	115
1976	20
1977	90
1978	20
1979	75

7. Values of instantaneous fishing mortality rate (F) for virtual population analyses

In last years analyses great difficulties were encountered in arriving at levels of F and especially relative F between age groups which gave reasonable results of VPA. However, it was found likely that F for fully recruited age groups was at least 0.20, probably about 0.30.

The trends in effort and catch per unit effort suggest that there has been some increase in overall fishing mortality from 1978 to 1979, probably a 20% increase. As a basis for the VPA runs this year an F value of 0.35 is, therefore, set for the suggested lower limit or catches. For the upper limit of catches, F will have to be increased to 0.85 if the upper-limit-catch is to be based on the same initial stock size by January 1979 as the lower catch.

F-values for fully recruited age-groups in 1977 is set equal to that in 1978 at the lower-limit-catch (F = 0.28). For the upper-limit-catch F values will then have to be set at 0.82 for 1977 and 0.63 for 1978, respectively to allow for the assumption here made, that the initial stock in the two years was the same whatsoever the catch. This assumption will be discussed later in the paper.

Terminal-F values for years prior to 1977 are taken as in last year's assessment except that for 1976 the value has been raised from 0.25 to 0.30 because some decrease from 1976 to 1977 was argued earlier on the basis of fishing effort in the two years and F 1977 is now set at 0.28 (lower limit). The F-values are then:

Year	1965	1966	1967	1968	1969	1970-75	1976
F	0.46	0.54	0.62	0.80	0.55	0.35	0.30

Year	1977	1978	1979
F upper	0.82	0.63	0.85
F lower	0.28	0.28	0.35

Furthermore, since the range between upper and lower limits of catches in 1977-78 is considerable, a half-way-between-situation has been analyzed. Numbers caught in the three years have then been set as the average for the upper and lower limits in Tables 14 and 14a. The corresponding F for fully

recruited age-groups assuming same initial stock at the beginning of each year and an M of 0.20 is F = 0.52, 0.44 and 0.57 for 1977, 1978 and 1979, respectively.

Mean annual catch by numbers per age group for the years 1974-78 has been plotted against age in Fig.3 using a mean value of the upper and lower limits for catch estimates 1977-78. Excluding age-group 3 the estimate of Z found by regression is 0.61. Substracting a natural mortality rate of 0.20 and an emigration rate of 0.05 (for age-groups 6 and older) the fishing mortality rate would be 0.36 for that period. However, the period was characterized by having only two relatively strong year classes the 1968 and the 1973 year-classes and since the latter seems more abundant than was the former the Z value may be slightly upward biassed. The level of terminal F of 0.30-0.35 for the recent years seems, therefore, not too unrealistic by the lower limit of catch estimates. Furthermore, plotting the age-groups 6 to 11 for the year 1978 indicates a Z value of 0.81 for these age groups. If the difference between this value and the 0.65 value is a measure of the decreasing availability of these older fish to the fishery, then their partial F would be about half the $F_{\text{ages } 4-6}$ for age-group 8 and one quart for age-group 11.

8. Partial recruitment

In last year's analyses it was concluded, that the virtual disappearance of gears such as long line and gill net in the offshore fishery, and the tendency of trawlers to concentrate on concentrations of newly recruited fish has resulted in a change in the partial recruitment pattern. Also the overwhelming use of pound nets in the inshore fishery contributes to this change as pound nets have a much higher tendency to catch small fish than have long lines and gill nets. Part of the explanation for very few fish older than 8 years in the catches could be due to selectivity of gears, but by the very poor recruitment during most of the years since 1968 the major reason is unfortunately rather real scarcity of old fish in the stock. However, with the present fishing pattern it does seem reasonable to assume a partial recruitment pattern to the fishery which assume a maximum F for age-groups 4 to 6. Thereafter there could well be a gradual decrease of F by age, depending to some extent on the actual stock composition. If a very good year class is followed by several poor year classes then fishing may continue to look for shoals of that year class until a new good year class forms shoals of young fish. This situation could to some extent apply to the 1973 year-class in 1980. If shoals with a major content of this year class can be found trawlers could have a very good output of their fishery. It may be possible that they find such shoals, at any rate for a limited period, but it seems more likely that they will benefit from shoals of younger fish (the 1975 year-class). However, to let F decrease by 50% from age 6 to age 7 as in last year's extra analyses may be too drastic for the current situation. It is, therefore, proposed to let the F value decrease gradually from maximum at age 6 to 10% of maximum at age 10 and 11+. The choice of rate of decrease

will not be very important in the present analyses as very few old fish are present in the stock.

The partial recruitment/relative F by age groups is, therefore, taken to be as follows in the present analyses

Age	3	4	5	6	7	8	9	10	11+
F (% of highest F)	20	100	100	100	80	55	25	10	10

9. Natural mortality rate and emigration

As previously the natural mortality is set at M = 0.20. It is, however, suggested to follow last year's approach and let M for age-group 3 increase to 0.30 in the light of the high discard rate of this age group in both trawls and pound nets. Survival from trawls is considered very low, and although it is possible to ensure very high survival of discards from pound nets the proper handling to ensure this possibility does not always take place.

Emigration rate is most likely varying between year classes. The generally used value of E = 0.05 for Subarea 1 as a whole is probably too low for year-class 1973. However, the forecast years seem likely to be dominated mainly by year classes with a main distribution north of Div. 1E, and they would not have as strong as tendency to emigrate to East Greenland as have individuals of the 1973 year-class. It is, of course, not impossible (and indeed to be hoped) that one of the recruiting year classes will get a contribution by immigrants from East Greenland as seems to have been the case for the 1973 year-class. However, this possibility has not been included in the analyses and would have to be taken in as a later adjustment should it occur. For the forecast years it is, therefore, proposed to maintain emigration rate at a coefficient of 0.05.

10. Results and discussion

i) The virtual population analyses (VPA)

The results of the VPA runs are presented in Tables 15 a-c so far as resultant F-values are concerned and in Tables 16 a-c so far as stock in numbers by age groups is concerned. The mean F is weighted mean for age-groups 6-15, weighting factor being the initial number of fish in each age group. This mean may not be very illustrative in most recent years with the said change in partial F-values. Instead for the years 1977-78 it may be more proper to regard the mean F-values associated with age-groups 4-6. It is then found that the range for the weighted mean F in 1977 is 0.25-0.49, the actual value depending on actual catch level, whereas in 1978 it is found to be in the range of 0.24-0.49. The F value for these age groups and these years is, of course, influenced by the input value of terminal F for 1979, but the results seem to be in accordance with conclusions drawn from trends in fishing effort (see Section 7). However, the high input values proposed in Section 7 are not occurring in the analyses. This is due to the assumptions made.

The input-F values in Section 7 were argued basically on trends in effort as observed at the lower limit of catch level. For each of the years 1977-79

the upper F-input was then based on the assumption that for each of the years regarded the stock size at the beginning of each year was the same whatsoever the F-value in that year. Considering just one year this assumption is, of course, valid. However, actual stock size in any year was, of course, influenced by the actual level of fishing in previous years. Working back from the 1979 input, as does the VPA, the input F values will, therefore, not lead to exactly the same stock size, nor to the same F-values for 1977-78 as those initially constructed by the said assumption. The VPA runs as carried out here can, therefore, not illustrate the difference between the influence of various levels of fishing in 1977-78 on the 1979 stock. The situation could to some extent be constructed but this may not serve any purpose as long as a good deal of speculation would be created. The differences in resultant stocks by various levels of fishing may better be demonstrated for the years to come.

As far as stock size in previous years and thereby estimates of year-class strength is concerned, the present analyses are in reasonably good agreement with those last year (Res.Doc. 79/VI/59, Appendix 2). The important 1973 year-class has values of 167-210 mio. individuals by age 3, higher than last year's estimates of 100-145 mio. fish. The 1974 year-class shows values between 31 and 48 mio. fish (last year 25-46, and an initial estimate 40 mio.). Last year the 1975 year-class was estimated to be about 75 mio. recruits. Analyses this year does not support this value, but the estimate in the present analyses is heavily dependant upon the 1979 input value of F and partial F, and the achieved values for the 1975 year-class as being of only 26-28 mio. recruits seem unreasonable low (see Section 6). Probably the partial recruitment in the VPA is set too high, or the year class may have been underrepresented in samples as compared to the actual catch.

ii) Forecasts

The EEC has requested advice for catches and spawning stock size up to and including 1983 (spawning stock size by January 1984) for a range of values of F (see Annex 2 to NAFO Circular Letter 80/27). Forecasts so far ahead will, of course, be subject to revision in later years. For instance, if fishing pattern remains as at present, the predicted catches for 1983 will be heavily dependent both on events in the fishery over the 1980-82 period and upon the estimates of the 1977-79 year-classes of which none so far have been observed in the commercial fishery (except for the first observation of the 1977 year-class in the beginning of 1980). Even the spawning stock size by 1984 will be dependent upon estimates of the 1977 year-class.

It is, therefore, with some reluctance, that forecasts for 1983 are given at all. Anyway, looking at catch projection for 1983 it should be remembered that the tentative estimate of the 1979 year-class is based upon some water temperatures and 22 cod larvae. The 1979 year-class accounts for the following percentage of the projected 1983 catch in the calculations:

By number: 44% by the F = 0.1 fishing level, increasing to 59% by the F = 0.6 level

By weight: 25% by the F = o.1 level, increasing to 47% by the F = o.6 level

These ranges cover all assumptions made of the catch in 1979 and in 1980.

It has further been requested that the F applied for 1980 be corresponding to the TAC. This is a little difficult since a TAC has been set only for the offshore fishery (not to exceed 20 thousand tonnes). Any calculation will, however, have to take into account also the inshore catches. The author has severe doubt that inshore catches will reach the high 1979 level. It has, therefore, been chosen to give forecasts for two assumptions of the 1980 catch, one level being a catch of 35 000 tonnes, the other a catch of 55 000 tonnes. This range corresponds roughly to the range that Greenland vessels have had in 1978-79.

Furthermore, the change in partial recruitment in the later years has made it a little uncertain as to what is the present $F_{0.1}$ level. For a number of years it has been taken to be in the range of 0.35-0.40, based on a yield curve from 1969 (Horsted and Garrod, 1969), but by the new fishing pattern (change in partial F by age) it seems to have changed somewhat to a value of 0.34. This value has, therefore, been used as the $F_{0.1}$ reference point in the present analyses (see Fig.4).

Prognoses for catch and spawning stock size has been made on three different levels of assumed catches in 1979, covering the aforementioned upper and lower limits and a medium value, corresponding to catches in 1979 of 97 000, 75 000 and 52 000 tonnes, respectively. Furthermore, as already stated, for each of these levels the 1980 catch is supposed to be either 35 000 tonnes (options 1-5) or 55 000 tonnes (options 6-10). The results are set out in Tables 17 and 18 for the upper and lower limits of catches in 1979, and in Table 19 for a mean situation.

Options 1 and 6 operate with an F value of 0.10 for the years after 1980 (all F values refer to age groups with maximum F). Options 2 and 7 operates with F = 0.20 after 1980, options 3 and 8 with F = 0.60 and options 4 and 9 with the $F_{0.1}$ value (F = 0.34 as mentioned above). Options 5 and 10 shows the results of keeping a steady catch level of 35 000 and 55 000 tonnes respectively in the 1980-82 period.

The way the programs and the input values are made the three levels of catches in 1979 do not have the same starting values of stock size in 1979. The lower catch limit has a somewhat higher initial stock by 1979 than the upper limit. This will, for the same strategies, lead to different results. If the basic year had been 1977 one would have found higher difference between the levels for each of the options. However, for future management, it is important to notice inside each table the big difference between the various strategies. Taking the estimated spawning stock size by 1980 as a reference point it will be seen that options 1 and 2 (fishing at levels corresponding to F = 0.1 - 0.2) should mean a gradual rebuilding of the spawning stock to reach a level which for the F = 0.1 level (options 1 and 6) will be about double the 1980 level (somewhat dependent on the 1980 catch level). For the F = 0.2 level (options 2 and 7) the increase will be less, about 1/2 to 3/4 of the 1980 level by 1984. Fishing at the assumed $F_{0.1}$ level will no more than just maintain the present spawning stock by 1984, although with some

interim increase in 1981-83, while fishing at a level corresponding to F = 0.6 (options 3 and 8) will mean a further reduction in spawning stock size after a small increase by 1981, when the assumed good 1975 year-class recruits to the spawning stock.

The spawning biomass by 1980 was in last year's analyses estimated to be 96-121 000 tonnes. Present estimates range from 97 000 to 153 000 tonnes, the latter high figure under the assumption that 1979 catches were at the low limit of Table 3.

The forecasts are illustrated by Figs 5-7.

Cod at East Greenland (ICES XIVb)

Samples of landings by the Greenland trawlers were used as the basis for a break down into age groups of the estimated upper and lower limits for catches in 1979 (Tables 14 and 14a). The figures for 1979 differ from those in 1977 and 1978 by a nearly complete absence of cod older than 6 years. The basis for the calculation is, however, very weak based on only one large sample and this was from the area at Kap Farvel. It is most likely that more samples, especially from other parts of the area, would have shown representatives of older fish. However, there seems no doubt that the 1973 year-class was of overwhelming importance in 1973, and it is highly likely to continue to be so in 1980 as there is no evidence at present of younger, significant year-classes. A number of recent recaptures at Iceland of cod tagged at Greenland support the conclusion drawn from the age composition and distribution of cod in Subarea 1 that the 1973 year-class has had (and still may have) a high rate of migration from West Greenland to East Greenland and Iceland. This is not unexpected, as the year-class at West Greenland evidently was supported by inflow of cod from East Greenland in its younger years. When the same phenomenon has been observed earlier (*e.g.* for year-classes 1963 and 1968) there has been observed a considerable spawning migration back to East Greenland.

Thus a major part of the residuals of the 1973 year-class is now found at the southernmost part of Subarea 1 and in ICES XIVb. Whether its spawning in 1979 and 1980 will result in a new inflow of young cod to West Greenland still has to be seen. However, the importance of the East Greenland area as a potential spawning area for the West Greenland stock should still be called to mind when discussing management of the stock.

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References

Horsted, Sv.Aa. and D.J.Garrod, 1969. A yield per recruit function for Subarea 1 cod. Int.Comm.Northw.Atl.Fish., Redbook III: 17-21.

Horsted, Sv.Aa., 1979. Subarea 1 cod. Data for 1977-78 and early 1979, and estimates of biomass and yield, 1979-81. Int.Comm.Northw. Atl.Fish., Res.Doc. 79/VI/59, Ser.No. 5399.

Table 1. Nominal catch (tonnes x 10^{-3}) of cod in Subarea 1 and off South-East Greenland 1977 based on figures in ICNAF Stat. Bull. Vol. 27 and ICES Bull. Stat. Vol. 62.

Division	Otter trawl	Set gill net	Long line	Mixed gear	Total
1A	-	127	-	216	343
1B	3	298	-	580	881
1C	3547	935	-	2505	6987
1D	3066	5013	19	2946	11044
1E	6208	2025	573	3521	12327
1F	1092	-	1091	4231	6414
Total SA 1	13916	8398	1683	13999	37996
South-East Greenland x)	4473		537	2372	7382
Grand total	18389	8398	2220	16371	45378

x) Catches by Fed. Rep. of Germany and by USSR not specified on North-East Greenland and South-East Greenland are taken as being in the South-Eastern area.

Table 1a. Upper limit for nominal catch (tonnes x 10^{-3}) of cod in Subarea 1 and off South-East Greenland, 1977, when possible misreporting of species composition is taken into account (see text, Section 1).

Division	Otter trawl	Set gill net	Long line	Mixed gear (mainly inshore)	Total
1A	-	127	-	216	343
1B	-	298	-	580	878
1C	12479	935	-	2505	15919
1D	8199	5013	19	2946	16177
1E	27208	2025	573	3521	33327
1F	1421	-	1091	4231	6743
Total SA 1	49307	8398	1683	13999	73387
South-East Greenland	11909	-	537	2372	14818
Grand total	62216	8398	2220	16371	88205

Table 2. Nominal catches (tonnes x 10^{-3}) of cod in Subarea 1 and off South-East Greenland, 1978, based upon figures supplied to ICNAF/NAFO (STATLANT 21B forms for Greenland, Sum.Doc. 79/VI/30 for other countries) or reported in National Research Reports (Sum.Doc. 79/VI/33) or - if no other data are available - as reported by vessels to the Greenland administration.

Division	Otter trawl	Long line	Mixed gear (mainly inshore)	Total
1A	-	-	348	348
1B	2	-	1587	1589
1C	11855	-	3244	15099
1D	2635	2	2614	5251
1E	3794	1	4642	8437
1F	559	-	7244	7803
Total Subarea 1	18845	3	19679	38527
South-East Greenland	4669	30	1419	6118
GRAND TOTAL	23514	33	21098	44645

Table 2a. Upper limit for nominal catch (tonnes x 10^{-3}) of cod in Subarea 1 and off South-East Greenland, 1978, when possible misreporting of species composition is taken into account (see text, Section 1).

Division	Otter trawl	Long line	Mixed gear (mainly inshore)	Total
1A	-	-	348	348
1B	6	-	1587	1593
1C	35689	-	3244	38933
1D	7304	2	2614	9920
1E	10138	1	4642	14781
1F	655	-	7244	7899
Total Subarea 1	53792	3	19679	73474
South-East Greenland	26731	30	1419	28180
GRAND TOTAL	80523	33	21098	101654

Table 3. Nominal catch (tonnes x 10^{-3}) of cod in Subarea 1 and off South-East Greenland, 1979, based upon preliminary statistics reported for assessment purpose or as reported by vessels to the Greenland authorities.

Division	Otter trawl	Mixed gear (mainly inshore)	Total
1A	-	420	420
1B	12	1848	1860
1C	7045	2147	9192
1D	3956	10504	14460
1E	790	11117	11907
1F	28	16319	16347
Total SA 1	11831	42355	54186
South-East Greenland	2401	1496	3897
Grand total	14232	43851	58083

Table 3a. Upper limit for nominal catch (tonnes x 10^{-3}) of cod in Subarea 1 and off South-East Greenland, 1979, when possible misreporting of species composition is taken into account (see text, Section 1).

Division	Otter trawl	Mixed gear (mainly inshore)	Total
1A	-	420	420
1B	12	1848	1860
1C	33841	2147	35988
1D	19027	10504	29531
1E	3799	11117	14916
1F	138	16319	16457
Total SA 1	56817	42355	99172
South-East Greenland	27525	1496	29021
Grand total	84342	43851	128193

Table 4. Effort (hours fished), catch of cod and catch per unit effort for the Greenland trawlers (500-999 GRT class) in 1977-79. Only figures for directed cod fishing are included.

Division	1977			1978			1979		
	hours	tonnes	kg/hour	hours	tonnes	kg/hour	hours	tonnes	kg/hour
1A-1B	0	0	-	0	0	-	0	0	-
1C	2432	2478	1019	3562	11803	3314	2983	6428	2155
1D	1531	1510	986	815	2414	2962	1163	3586	3083
1E	3446	5459	1584	873	3268	3743	365	711	1948
1F	121	293	2421	70	212	3029	9	24	2667
Table SA 1	7530	9740	1293	5320	17697	3327	4520	10749	2378
East Greenland	428	868	2028	387	731	1889	760	1525	2007

Table 5. Effort (hours fished) and catch per unit effort by quarter of the year for the Greenland trawlers in 1977-79 and first part of 1980. Only figures for direct cod fishing are included.

Division	Year / Quarter	1977 I hours	1977 I kg/hour	1977 II hours	1977 II kg/hour	1977 III hours	1977 III kg/hour	1977 IV hours	1977 IV kg/hour
1C		2258	1066	129	341	-	-	45	600
1D		919	693	566	1498	14	571	32	531
1E		1383	1277	1876	1846	141	1113	46	1565
1F		-	-	33	3364	88	2068	-	-
Total SA 1		4560	1055	2604	1715	243	1428	123	943
East Greenland		-	-	-	-	268	2213	160	1719

	1978 I		1978 II		1978 III		1978 IV	
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

	1979 I		1979 II		1979 III		1979 IV	
1C	2727	2059	256	3180	-	-	-	-
1D	711	2942	452	3305	-	-	-	-
1E	123	675	242	2595	-	-	-	-
1F	-	-	-	-	-	-	9	2667
Total	3561	2187	950	3091	-	-	9	2667
East Greenland	-	-	-	-	-	-	760	2007

	1980 I	
1B	387	4344
1C	1015	1047
1D	427	1173
1E	200	840
1F	11	909
	2040	1678
	60	1350

Table 6. Effort (hours fished), catch of cod by weight as well as by numbers, and catch per unit effort for the Greenland trawlers, and total effort (trawlers' effort raised to correspond to total catch) for Subarea 1, 1977-79 (see Table 4 for trawlers' effort and Tables 14 and 14a for numbers landed). The range of figures refers to lower and upper limits of estimated catches, respectively (Tables 1-3 and 1a-3a, respectively).

	Year	Trawlers' effort (hours)	Trawlers' catch of cod	Trawlers' cpue (tonnes/hour)	Total catch	Total effort
Catch by weight (tonnes)	1977	7530	9740	1.293	37996-73387	29386-56757
	1978	5320	17697	3.327	38527-73474	11580-22084
	1979	4520	10749	2.378	54186-99172	22786-41704
Catch by numbers (thousands)	1977	7530	8886	1.180	24457-56697	20726-48048
	1978	5320	7693	1.446	19660-37491	13596-25927
	1979	4520	5136	1.136	22324-43817	19651-31219

Table 7. Samples of cod from a Greenland trawler's catch in the Holsteinsborg Deep (Div. 1B) in February-March, 1980. The two samples of commercial sized fish and of discards were not from the same haul. Observations on discard rate indicates this to have been about 1/3 to 1/2 of the catch by numbers.

Length group	No. in age groups 3	4	5	Total No.	0/00	Average weight
27	8	0	0	8	19	-
30	27	0	0	27	64	-
33	115	0	0	115	274	-
36	120	9	0	129	307	-
39	33	59	7	99	236	-
42	5	33	0	38	90	-
45	0	1	3	4	10	-
Total	308	102	10	420		
0/00	733	243	24			
Av.len.	34.54	39.76	40.80	35.96		
st.dev.	2.84	1.87	2.90	3.54		
Av.wgt.	-	-	-			

Length group	No. in age groups 4	5	6	7	8	9	10	11	12	Total No.	0/00	Average weight
42	1	0	0	0	0	0	0	0	0	1	1	0.710
45	9	3	0	0	0	0	0	0	0	12	14	0.894
48	11	22	0	0	0	0	0	0	0	33	38	1.041
51	5	66	7	0	0	0	0	0	0	78	90	1.372
54	0	143	0	0	0	0	0	0	0	143	165	1.747
57	5	136	5	0	0	0	0	0	0	146	168	2.004
60	0	154	5	0	0	0	0	0	0	159	183	2.339
63	0	105	4	0	0	0	0	0	0	109	126	2.718
66	0	42	14	2	0	2	0	0	0	60	69	3.240
69	0	22	19	3	0	0	0	0	0	44	51	3.729
72	0	6	15	3	1	1	0	0	0	26	30	4.086
75	0	2	14	3	0	1	0	0	0	20	23	4.451
78	0	0	7	9	0	1	0	0	1	18	21	4.777
81	0	0	2	3	0	4	0	0	1	10	12	5.247
84	0	0	2	2	0	0	1	0	0	5	6	6.280
87	0	0	0	0	0	1	0	0	0	1	1	5.200
90	0	0	0	0	0	0	1	0	1	2	2	6.250
93	0	0	0	0	0	0	0	0	1	1	1	5.600
Total	31	701	94	25	1	10	2	0	4	868		
0/00	36	808	108	29	1	12	2	0	5			
Av.len.	48.87	58.14	68.46	75.72	72.00	76.80	87.00	-	85.50	59.86		
st.dev.	4.26	5.17	7.75	5.14	-	6.96	4.24	-	7.14	7.76		
Av.wgt.	1.23	2.20	3.62	4.65	3.20	4.06	4.95	-	5.28			2.431
st.dev.	1.31	1.16	3.61	4.84	-	4.45	7.02	-	6.24			1.00

Table 8. A sample of a Greenland trawler's landings from a trip in April, 1980 to Div. 1D and 1E.

Length group	No. in age groups 3	4	5	6	7	8	Total No.	0/00	Average weight
39	0	1	0	0	0	0	1	1	0.854
42	1	7	1	0	0	0	9	6	0.881
45	0	31	3	0	0	0	34	22	0.996
48	0	47	4	4	0	0	55	36	1.158
51	0	26	49	3	9	0	87	57	1.473
54	0	4	117	9	0	0	130	85	1.662
57	0	0	105	18	14	0	137	89	1.846
60	0	0	33	51	56	0	140	91	2.160
63	0	0	20	41	92	0	153	100	2.448
66	0	0	9	22	102	0	133	87	2.859
69	0	0	0	6	164	6	176	115	3.209
72	0	0	0	13	179	0	192	125	3.416
75	0	0	0	0	142	0	142	93	3.900
78	0	0	0	0	74	3	77	50	4.367
81	0	0	0	0	43	1	44	29	4.976
84	0	0	0	0	13	0	13	8	5.546
87	0	0	0	1	7	0	8	5	5.780
90	0	0	0	0	1	0	1	1	7.259
Total	1	116	341	168	896	10	1532		
0/00	1	76	223	110	585	7			
Av.len.	42.00	47.64	55.73	61.84	70.36	72.90	64.45		
st.dev.	-	2.91	3.83	5.46	6.39	5.11	9.57		
Av.wgt.	0.85	1.14	1.81	2.33	3.38	4.32			2.752
st.dev.	-	0.15	0.31	0.50	0.81	0.42			1.05

Table 9. Mean length (cm below) and mean weight (kg, round fish) of age groups in Danish cod samples from Subarea 1, 1979 and first part of 1980. Figures are given only for age groups represented by more than 5 fish in the sample and only for samples where both length and weight was recorded. OTB = bottom otter trawl, FPN = pound net, SGN = set gillnet, LHP = handline.

Age group	Div Month Gear	1C February OTB	1C March OTB	1C April OTB	1D January OTB	1C-1D March OTB	1D April OTB	1D-1E May OTB	1D May SGN
III	l	-	-	-	-	-	-	-	39.0
	w	-	-	-	-	-	-	-	0.70
IV	l	47.2	46.9	48.0	47.7	46.6	47.0	48.6	51.0
	w	1.11	1.06	1.09	1.14	1.04	1.08	1.24	1.55
V	l	56.6	56.9	57.3	58.0	56.8	60.1	57.3	55.7
	w	1.86	1.88	1.82	2.06	1.87	2.20	2.02	2.13
VI	l	67.2	69.7	69.5	67.4	69.8	70.4	66.8	59.1
	w	3.08	3.35	3.08	2.91	3.35	3.45	3.03	2.48
VII	l	75.4	70.0	-	73.8	71.4	78.0	73.5	-
	w	4.22	3.57	-	4.27	3.70	4.45	4.14	-
VIII	l	85.3	-	-	86.5	-	85.6	83.5	-
	w	6.52	-	-	7.13	-	5.93	5.07	-
IX	l	89.0	-	-	-	-	89.2	-	-
	w	6.72	-	-	-	-	6.92	-	-
X	l	-	92.0	-	-	91.2	94.0	-	-
	w	-	7.71	-	-	7.38	7.67	-	-
XI	l	-	-	-	-	-	99.0	-	-
	w	-	-	-	-	-	9.16	-	-
Overall mean length		55.6	54.0	53.9	63.0	53.5	69.5	65.3	55.3
Overall mean weight		1.88	1.71	1.59	2.57	1.66	3.58	2.91	2.07

Table 9. continued

Age group	Div Month Gear	1D June FPN	1D June SGN	1D July SGN	1D September LHP	1D October-November SGN	1F November OTB	1B February-March 1980 OTB	1D April 1980 OTB
III	l	40.1	39.9	40.0	47.7	-	-	-	-
	w	0.76	0.75	0.75	1.49	-	-	-	-
IV	l	46.5	46.5	47.1	52.1	55.9	47.6	48.9	47.6
	w	1.22	1.22	1.29	1.60	1.97	1.09	1.23	1.14
V	l	52.8	53.0	54.5	59.4	62.2	51.9	58.1	55.7
	w	1.84	1.84	1.97	2.32	2.63	1.40	2.20	1.81
VI	l	66.2	60.0	61.2	69.4	71.9	62.9	68.5	61.8
	w	3.16	2.53	2.61	3.55	3.97	2.51	3.62	2.33
VII	l	70.1	-	60.5	76.8	-	-	75.7	70.4
	w	3.73	-	2.31	4.71	-	-	4.65	3.38
VIII	l	74.1	-	-	85.7	-	-	-	-
	w	4.88	-	-	7.08	-	-	-	-
IX	l	-	-	-	-	-	-	76.8	-
	w	-	-	-	-	-	-	4.06	-
X	l	-	-	-	-	-	-	-	-
	w	-	-	-	-	-	-	-	-
XI	l	-	-	-	-	-	-	-	-
	w	-	-	-	-	-	-	-	-
Overall mean length		51.8	49.1	51.5	66.4	69.1	62.6	59.9	64.5
Overall mean weight		1.76	1.48	1.71	3.24	3.72	2.50	2.43	2.75

Table 10. Subarea 1 cod, 1979. Mean weight (kg round, fresh) by age as obtained from samples listed in Table 9. Weighting factors to obtain weighted mean are the catches listed in Table 11. For comparison figures obtained for 1977 and 1978 are also listed.

	Age group	Unweighted mean by quarter 1	2	3	4	Weighted mean 1979	Weighted mean 1978	Weighted mean 1977
Offshore samples	III	-	-	-	-	-	0.59	0.66
	IV	1.09	1.14	-	1.09	1.10	1.29	1.03
	V	1.92	2.01	-	1.40	1.94	2.54	1.43
	VI	3.17	3.19	-	2.51	3.17	2.98	1.87
	VII	3.94	4.30	-	-	4.04	4.40	3.39
	VIII	6.83	5.50	-	-	6.47	6.29	-
	IX	6.72	6.92	-	-	6.77	-	-
	X	7.55	7.67	-	-	7.58	-	-
	XI	-	9.16	-	-	9.16	-	-
Inshore samples	III	-	0.74	1.12	-	1.01	0.73	0.86
	IV	-	1.33	1.45	1.97	1.51	1.06	1.55
	V	-	1.94	2.15	2.63	2.19	1.99	2.14
	VI	-	2.72	3.08	3.97	3.15	2.69	2.49
	VII	-	3.73	3.51	-	3.57	2.63	4.44
	VIII	-	4.88	7.08	-	6.45	-	-

Table 11. Nominal catch of cod by Greenlandic vessels in Subarea 1, 1979 by quarter of the year.

Quarter	1	2	3	4
Offshore, tonnes	7789	2936	-	69
%	72.2	27.2	-	0.6
Inshore, tonnes	1667	9589	23866	7233
%	3.9	22.6	56.3	17.1

Table 12. Weight (kg round, fresh) used in the forecast for catches in 1980-82.

Age group	Weighted mean weight offshore			Weighted mean weight inshore			Average 1977-79 assuming 60% of total catch is offshore	
	1977	1978	1979	1977	1978	1979	Calculated	Smoothed (Fig. 2)
III	0.66	0.59	-	0.86	0.73	1.01	0.72	0.72
IV	1.03	1.29	1.10	1.55	1.06	1.51	1.23	1.23
V	1.43	2.54	1.94	2.14	1.99	2.19	2.02	2.02
VI	1.87	2.98	3.17	2.49	2.69	3.15	2.71	2.71
VII	3.39	4.40	4.04	4.44	2.63	3.57	3.78	3.78
VIII	-	6.29	6.47	-	-	6.45	6.41	4.90
IX	-	-	6.77	-	-	-	6.77	6.40
X	-	-	7.58	-	-	-	7.58	7.80
XI	-	-	9.16	-	-	-	9.16	9.00
XII							6.60	9.70
XIII			as in previous years' assessment				7.70	10.20
XIV							9.00	10.40
XV+							10.50	10.50

Table 13. Number of cod (in thousands) per age group in Subarea 1 nominal catches, 1965-76.

age	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
3	14163	1530	1727	3764	662	49	272	15	131	343	275	10760
4	56928	7872	15091	7976	12399	2768	2519	10039	2302	1079	3595	4026
5	52451	62130	30457	36670	8709	10342	10172	9786	16378	2384	2677	2243
6	9055	39941	61848	29824	27433	6465	9283	12020	3065	6938	1803	1216
7	9890	5915	24562	34591	14664	13985	5237	4081	2605	1135	5855	302
8	15395	4955	2700	10005	12411	4365	9158	2550	1406	1806	1388	1594
9	2849	6912	1996	1725	4784	2810	2077	2660	1203	800	619	139
10	566	1289	5237	833	513	1280	1841	624	552	194	291	148
11	488	283	352	2348	237	149	953	954	165	177	84	53
12	1911	130	93	187	704	85	78	709	237	152	38	27
13	75	981	166	37	41	201	51	130	93	272	9	17
14	37	139	453	42	62	27	134	57	37	147	12	14
15	276	247	85	303	8	41	56	122	44	11	10	26
sum	164084	132324	144767	128305	82627	42567	41831	43747	28218	15438	16656	20565

Table 14. Number of cod (in thousands) per age group in nominal catches 1977-79. Catch figures are those reported by national offices or, for 1979, directly by vessels to Greenland authorities.

Age group	1977				1978				1979			
	1A-1D	1E-1F	Total SA 1	East Greenland	1A-1D	1E-1F	Total SA 1	East Greenland	1A-1D	1E-1F	Total SA 1	East Greenland
III	225	39	264	-	271	1	272	-	272	10	282	-
IV	8851	9875	18726	2180	2133	771	2904	46	4032	186	4218	6
V	1265	1433	2698	916	7108	8591	15699	2148	3767	470	4237	31
VI	678	546	1224	502	385	78	463	413	4002	8808	12810	1517
VII	287	210	497	356	217	31	248	46	93	457	550	-
VIII	247	151	398	85	47	1	48	51	141	4	145	1
IX	229	148	377	141	12	1	13	29	19	1	20	2
X	75	44	119	43	11	2	13	65	15	-	15	-
XI	40	23	63	26	-	-	-	25	21	1	22	-
XII	45	24	69	13	-	-	-	18	21	-	21	-
XIII	13	9	22	2	-	-	-	12	1	-	1	-
XIV	-	-	-	-	-	-	-	4	1	-	1	-
XV+	-	-	-	-	-	-	-	2	2	-	2	-
Total	11955	12502	24457	4264	10184	9476	19660	2859	12387	9937	22324	1557
Nominal catch (tonnes)	19255	18741	37996	7382	22287	16240	38527	6118	25932	28254	54186	3627
Calculated mean weight (kg)	1.61	1.50	1.55	1.73	2.19	1.71	1.96	2.14	2.09	2.84	2.43	2.33

Table 14a. Upper limit for number of cod (in thousands) per age group in nominal catches 1977-79 (see Tables 1a-3a) and text, Section 1).

Age group	1977				1978				1979			
	1A-1D	1E-1F	Total SA 1	East Greenland	1A-1D	1E-1F	Total SA 1	East Greenland	1A-1D	1E-1F	Total SA 1	East Greenland
III	544	90	634	-	275	12	287	-	276	10	286	-
IV	20261	26388	46649	5051	3757	1737	5494	298	10420	236	10656	39
V	2425	3628	6053	1706	18878	11161	30039	8102	11902	603	12505	229
VI	744	771	1515	772	852	152	1004	2599	9324	9646	18970	11303
VII	312	306	618	598	428	81	509	281	239	470	709	-
VIII	247	178	425	159	79	4	83	327	379	21	400	11
IX	229	217	446	282	37	4	41	191	73	5	78	21
X	100	68	168	98	11	2	13	421	52	-	52	-
XI	47	32	79	52	7	-	7	165	50	5	55	-
XII	52	36	88	25	7	-	7	118	80	-	80	-
XIII	13	9	22	6	7	-	7	78	5	-	5	-
XIV	-	-	-	-	-	-	-	28	5	-	5	-
XV+	-	-	-	-	-	-	-	14	11	5	16	-
Total	24974	31723	56697	8689	24338	13153	37491	12622	32816	11001	43817	11603
Nominal catch (tonnes)	33317	40070	73387	14818	50794	22680	73474	28180	67799	31373	99172	29021
Calculated mean weight (kg)	1.33	1.26	1.29	1.71	2.09	1.72	1.96	2.22	2.07	2.85	2.26	2.50

FISHING MORTALITIES

age	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	0.075	0.007	0.026	0.051	0.011	0.001	0.003	0.001	0.011
4	0.177	0.058	0.097	0.169	0.251	0.062	0.080	0.180	0.205
5	0.325	0.298	0.328	0.359	0.282	0.342	0.334	0.501	0.496
6	0.388	0.453	0.562	0.638	0.514	0.358	0.607	0.865	0.295
7	0.553	0.506	0.600	0.775	0.824	0.579	0.591	0.636	0.487
8	0.455	0.642	0.488	0.563	0.776	0.674	1.059	0.699	0.502
9	0.633	0.404	0.628	0.721	0.623	0.420	0.880	1.204	0.941
10	0.455	0.718	0.659	0.631	0.520	0.354	0.576	0.789	0.980
11	0.631	0.461	0.463	0.766	0.390	0.295	0.520	0.728	0.527
12	0.527	0.361	0.285	0.512	0.589	0.249	0.262	1.034	0.421
13	0.193	0.610	1.204	0.185	0.210	0.350	0.245	1.001	0.370
14	0.086	0.699	0.687	1.408	0.569	0.220	0.444	0.506	0.991
15	0.460	0.540	0.620	0.800	0.550	0.350	0.350	0.350	0.350
Mean	0.471	0.470	0.575	0.686	0.629	0.492	0.719	0.822	0.450

age	1974	1975	1976	1977	1978	1979
3	0.022	0.014	0.061	0.015	0.012	0.170
4	0.129	0.345	0.297	0.430	0.189	0.850
5	0.340	0.536	0.377	0.990	0.549	0.850
6	0.416	0.480	0.514	0.487	0.436	0.850
7	0.178	0.810	0.143	0.577	0.317	0.680
8	0.811	0.364	0.577	0.324	0.146	0.470
9	0.644	0.798	0.059	0.331	0.049	0.210
10	0.397	0.550	0.474	0.098	0.015	0.085
11	1.148	0.316	0.190	0.537	0.006	0.085
12	1.627	0.905	0.167	0.583	0.085	0.085
13	1.415	0.383	1.785	0.211	0.085	0.085
14	2.110	0.199	2.307	0.485	0.014	0.085
15	0.350	0.350	0.300	0.820	0.630	0.085
Mean	0.446	0.629	0.362	0.387	0.233	0.776

Table 15a

Results of virtual population analyses by upper limits of catches in 1977-79 (Tables 1a-3a, 14a, text Section 1)

STOCK IN NUMBERS

age	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	225254	244183	78090	87316	69699	48622	90732	18412	13391
4	385656	154751	179584	56371	61462	51067	35979	66983	13627
5	207470	264475	119595	133421	38968	39167	39312	27185	45799
6	31540	122737	160687	70553	76307	24074	22778	23048	13490
7	26023	16657	60759	71332	29038	35537	13100	9670	7556
8	47141	11660	7820	25965	25587	9923	15512	5649	3986
9	6776	23290	4777	3738	11517	9175	3939	4192	2187
10	1735	2802	12105	1986	1415	4812	4694	1272	979
11	1163	857	1064	4880	823	655	2629	2054	450
12	5216	482	421	522	1766	434	380	1218	772
13	480	2399	262	246	243	763	264	228	337
14	506	308	1015	61	160	154	419	161	65
15	426	361	119	398	12	70	96	209	75
sum1	939386	844961	626299	456789	316996	224454	229834	160279	102715
sum2	121006	181553	249029	179681	146867	85597	63811	47700	29898

age	1974	1975	1976	1977	1978	1979
3	18630	23525	209672	48069	27666	2109
4	9808	13508	17192	146116	35067	20249
5	9084	7057	7830	10457	77790	23763
6	22824	5296	3381	4397	3181	36799
7	7824	11721	2553	1574	2105	1602
8	3614	5098	4059	1724	689	1194
9	1879	1251	2758	1775	971	463
10	664	769	439	2026	992	720
11	286	348	345	213	1430	761
12	207	71	198	223	97	1108
13	395	32	22	130	97	69
14	182	75	17	3	82	69
15	19	17	48	1	1	63
sum1	75417	68768	248514	216707	150167	88969
sum2	37895	24678	13820	12065	9644	42848

Table 16a

Results of virtual population analyses by upper limits of catches in 1977-79 (Tables 1a-3a, 14a, text Section 1)

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

Run identification: SA1-upper-3

FISHING MORTALITIES

age	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	0.075	0.007	0.026	0.052	0.011	0.001	0.003	0.001	0.013
4	0.177	0.058	0.097	0.172	0.254	0.062	0.088	0.182	0.226
5	0.325	0.298	0.328	0.359	0.286	0.347	0.338	0.569	0.502
6	0.388	0.453	0.562	0.638	0.514	0.367	0.622	0.884	0.358
7	0.553	0.506	0.600	0.775	0.823	0.579	0.614	0.667	0.509
8	0.455	0.642	0.488	0.563	0.776	0.674	1.058	0.752	0.546
9	0.633	0.404	0.628	0.721	0.623	0.420	0.879	1.203	1.123
10	0.455	0.718	0.659	0.631	0.520	0.354	0.576	0.786	0.976
11	0.631	0.461	0.463	0.766	0.390	0.295	0.520	0.728	0.524
12	0.527	0.361	0.285	0.512	0.589	0.249	0.262	1.034	0.421
13	0.193	0.610	1.204	0.185	0.210	0.350	0.245	1.001	0.370
14	0.086	0.699	0.687	1.408	0.569	0.220	0.444	0.506	0.991
15	0.460	0.540	0.620	0.800	0.550	0.350	0.350	0.350	0.350
Mean	0.471	0.470	0.575	0.686	0.629	0.495	0.731	0.846	0.509

age	1974	1975	1976	1977	1978	1979
3	0.025	0.017	0.078	0.010	0.015	0.070
4	0.145	0.405	0.391	0.199	0.154	0.350
5	0.385	0.631	0.478	0.495	0.255	0.350
6	0.423	0.583	0.689	0.539	0.149	0.350
7	0.230	0.836	0.188	0.734	0.207	0.280
8	0.881	0.516	0.614	0.430	0.146	0.190
9	0.752	0.970	0.092	0.300	0.023	0.088
10	0.570	0.742	0.704	0.111	0.016	0.035
11	1.137	0.557	0.301	0.815	0.001	0.035
12	1.601	0.883	0.369	0.866	0.026	0.035
13	1.415	0.368	1.625	0.625	0.026	0.035
14	2.110	0.199	1.983	0.379	0.053	0.035
15	0.350	0.350	0.300	0.280	0.280	0.035
Mean	0.484	0.726	0.469	0.450	0.117	0.331

Table 15 b

Results of virtual population analyses by lower limits of catches in 1977-79 (Tables 1-3, 14, text Section 1)

STOCK IN NUMBERS

age	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	225269	244195	77144	86464	69050	44450	90110	16914	12055
4	385656	154761	179593	55670	60830	50586	32888	66522	12518
5	207470	264475	119604	133428	38394	38650	38919	24654	45422
6	31540	122737	160687	70560	76313	23605	22356	22726	11428
7	26023	16657	60759	71332	29043	35541	12736	9344	7309
8	47141	11660	7820	25965	25587	9927	15516	5367	3734
9	6776	23290	4777	3738	11517	9175	3942	4194	1970
10	1735	2802	12105	1986	1415	4812	4694	1275	981
11	1163	857	1064	4880	823	655	2629	2054	452
12	5216	482	421	522	1766	434	380	1218	772
13	480	2399	262	246	243	763	264	228	337
14	506	308	1015	61	160	154	419	161	65
15	426	361	119	398	12	70	96	209	75
sum1	939400	844983	625370	455249	315153	218823	224947	154866	97119
sum2	121006	181553	249029	179688	146878	85137	63031	46776	27124

age	1974	1975	1976	1977	1978	1979
3	16372	18737	166677	30568	21464	4820
4	8818	11835	13645	114269	22419	15668
5	8177	6247	6464	7558	76695	15738
6	22516	4555	2722	3282	3771	48671
7	6222	11482	1979	1064	1490	2531
8	3423	3851	3876	1277	398	943
9	1684	1105	1791	1633	647	268
10	499	618	326	1273	942	493
11	288	220	229	126	887	722
12	209	72	98	132	43	690
13	395	33	23	53	43	33
14	182	75	18	4	22	33
15	19	17	48	2	2	16
sum1	68803	58847	197896	161240	128824	90626
sum2	35436	22028	11110	8845	8246	54400

Table 16 b

Results of virtual population analyses by lower limits of catches in 1977-79 (Tables 1-3, 14, text Section 1)

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

Run identification: SA1-lower-3

FISHING MORTALITIES

age	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	0.075	0.007	0.026	0.051	0.011	0.001	0.003	0.001	0.012
4	0.177	0.058	0.097	0.170	0.251	0.062	0.082	0.180	0.209
5	0.325	0.298	0.328	0.359	0.283	0.344	0.335	0.512	0.497
6	0.388	0.453	0.562	0.638	0.514	0.361	0.611	0.871	0.305
7	0.553	0.506	0.600	0.775	0.824	0.579	0.598	0.645	0.494
8	0.455	0.642	0.488	0.563	0.776	0.674	1.058	0.715	0.515
9	0.633	0.404	0.628	0.721	0.623	0.420	0.880	1.204	0.991
10	0.455	0.718	0.659	0.631	0.520	0.354	0.576	0.788	0.978
11	0.631	0.461	0.463	0.766	0.390	0.295	0.520	0.728	0.526
12	0.527	0.361	0.285	0.512	0.589	0.249	0.262	1.034	0.421
13	0.193	0.610	1.204	0.185	0.210	0.350	0.245	1.001	0.370
14	0.086	0.699	0.687	1.408	0.569	0.220	0.444	0.506	0.991
15	0.460	0.540	0.620	0.800	0.550	0.350	0.350	0.350	0.350
Mean	0.471	0.470	0.575	0.686	0.629	0.493	0.723	0.829	0.462

age	1974	1975	1976	1977	1978	1979
3	0.023	0.015	0.070	0.013	0.013	0.110
4	0.134	0.366	0.345	0.331	0.165	0.570
5	0.347	0.562	0.410	0.784	0.407	0.570
6	0.417	0.495	0.559	0.487	0.289	0.570
7	0.186	0.813	0.149	0.581	0.254	0.460
8	0.831	0.386	0.581	0.330	0.127	0.310
9	0.674	0.844	0.063	0.305	0.034	0.140
10	0.438	0.597	0.527	0.090	0.015	0.057
11	1.144	0.365	0.214	0.556	0.003	0.057
12	1.619	0.897	0.201	0.603	0.056	0.057
13	1.415	0.379	1.726	0.265	0.056	0.057
14	2.110	0.199	2.195	0.442	0.018	0.057
15	0.350	0.350	0.300	0.520	0.440	0.057
Mean	0.454	0.646	0.383	0.381	0.169	0.526

Table 15c

Results of virtual population analyses by mean values of upper and lower limits of catches used for Tables 15a-16a and 15b-16b.

STOCK IN NUMBERS

age	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	225259	244187	77798	87055	69501	47824	90657	18144	12972
4	385656	154754	179587	56154	61269	50920	35388	66928	13429
5	207470	264475	119598	133423	38790	39009	39192	26701	45754
6	31540	122737	160687	70555	76309	23929	22649	22950	13095
7	26023	16657	60759	71332	29039	35538	12988	9570	7480
8	47141	11660	7820	25965	25587	9925	15514	5562	3909
9	6776	23290	4777	3738	11517	9175	3940	4192	2120
10	1735	2802	12105	1986	1415	4812	4694	1273	980
11	1163	857	1064	4880	823	655	2629	2054	451
12	5216	482	421	522	1766	434	380	1218	772
13	480	2399	262	246	243	763	264	228	337
14	506	308	1015	61	160	154	419	161	65
15	426	361	119	398	12	70	96	209	75
sum1	939390	844968	626012	456315	316431	223208	228808	159189	101440
sum2	121006	181553	249029	179683	146871	85455	63571	47417	29285

age	1974	1975	1976	1977	1978	1979
3	17778	20743	184436	41476	25578	3147
4	9498	12877	15131	127423	30341	18709
5	8923	6803	7315	8772	74959	21059
6	22787	5164	3174	3976	3280	40852
7	7518	11692	2451	1414	1903	1913
8	3556	4860	4037	1644	616	1150
9	1819	1207	2573	1758	920	423
10	613	723	404	1881	1009	693
11	287	308	310	186	1339	774
12	207	71	167	195	83	1039
13	395	32	23	106	83	61
14	182	75	17	3	63	61
15	19	17	48	1	2	48
sum1	73581	64571	220085	188836	140175	89929
sum2	37383	24148	13203	11165	9297	47014

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

Table 16c

Results of virtual population analyses by mean values of upper and lower limits of catches used for Tables 15a-16a and 15b-16b.

Run identification: SA1-mid-3

Catch projections based on catch statistics for 1979

Option no.		1	2	3	4	5	6	7	8	9	10
1979											
	Sp. biomass	142	142	142	142	142	142	142	142	142	142
	Fishing mort.	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850
	Catch	97	97	97	97	97	97	97	97	97	97
1980											
	Sp. biomass	97	97	97	97	97	97	97	97	97	97
	Fishing mort.	0.303	0.303	0.304	0.304	0.303	0.517	0.517	0.518	0.517	0.517
	Catch	35	35	35	35	35	55	55	55	55	55
1981											
	Sp. biomass	120	120	120	120	120	102	102	102	102	102
	Fishing mort.	0.100	0.200	0.600	0.340	0.247	0.100	0.200	0.600	0.340	0.484
	Catch	15	29	74	46	35	13	26	65	41	55
1982											
	Sp. biomass	128	119	90	108	115	107	100	76	91	82
	Fishing mort.	0.100	0.200	0.600	0.340	0.255	0.100	0.200	0.600	0.340	0.598
	Catch	16	29	55	42	35	15	27	50	38	55
1983											
	Sp. biomass	208	177	96	142	163	184	157	85	126	93
	Fishing mort.	0.100	0.200	0.600	0.340	0.224	0.100	0.200	0.600	0.340	0.580
	Catch	20	34	56	46	35	19	32	54	44	55
1984											
	Sp. biomass	216	172	74	126	156	194	154	65	113	72

List of identifications used in the table:

Option no. 1: SA1-upper-B-1
Option no. 2: SA1-upper-B-2
Option no. 3: SA1-upper-B-3
Option no. 4: SA1-upper-B-4
Option no. 5: SA1-upper-B-5
Option no. 6: SA1-upper-B-6
Option no. 7: SA1-upper-B-7
Option no. 8: SA1-upper-B-8
Option no. 9: SA1-upper-B-9
Option no. 10: SA1-upper-B-10

Table 17. Subarea 1 cod: projected catch and spawning biomass (tonnes x 10^{-3}) by various fishing strategies and by two assumptions for the catch in 1980. Results in this table are obtained by applying an upper limit for the catch in 1979 (see Table 3a and text, Section 1).

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Catch projections based on catch statistics for 1979

Option no.		1	2	3	4	5	6	7	8	9	10
1979											
	Sp. biomass	166	166	166	166	166	166	166	166	166	166
	Fishing mort.	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350
	Catch	52	52	52	52	52	52	52	52	52	52
1980											
	Sp. biomass	153	153	153	153	153	153	153	153	153	153
	Fishing mort.	0.178	0.179	0.179	0.179	0.178	0.294	0.294	0.295	0.294	0.294
	Catch	35	35	35	35	35	55	55	55	55	55
1981											
	Sp. biomass	220	220	220	220	220	200	199	199	199	200
	Fishing mort.	0.100	0.200	0.600	0.340	0.163	0.100	0.200	0.600	0.340	0.292
	Catch	22	42	108	68	35	20	39	100	63	55
1982											
	Sp. biomass	229	213	159	192	218	207	193	145	174	180
	Fishing mort.	0.100	0.200	0.600	0.340	0.179	0.100	0.200	0.600	0.340	0.356
	Catch	21	37	71	54	35	20	35	67	51	55
1983											
	Sp. biomass	306	263	149	214	275	283	243	138	198	204
	Fishing mort.	0.100	0.200	0.600	0.340	0.175	0.100	0.200	0.600	0.340	0.371
	Catch	23	38	63	52	35	22	37	61	50	55
1984											
	Sp. biomass	307	249	116	188	264	286	231	108	174	176

List of identifications used in the table:

Option no. 1: SA1-lower-B-1
Option no. 2: SA1-lower-B-2
Option no. 3: SA1-lower-B-3
Option no. 4: SA1-lower-B-4
Option no. 5: SA1-lower-B-5
Option no. 6: SA1-lower-B-6
Option no. 7: SA1-lower-B-7
Option no. 8: SA1-lower-B-8
Option no. 9: SA1-lower-B-9
Option no. 10: SA1-lower-B-10

Table 18. Subarea 1 cod: projected catch and spawning biomass (tonnes x 10^{-3}) by various fishing strategies and by two assumptions for catch in 1980. Results in this table are obtained by applying a lower limit for catch in 1979 (see Table 3 and text, Section 1).

Catch projections based on catch statistics for 1979

Option no.		1	2	3	4	5	6	7	8	9	10
1979											
	Sp. biomass	152	152	152	152	152	152	152	152	152	152
	Fishing mort.	0.570	0.570	0.570	0.570	0.570	0.570	0.570	0.570	0.570	0.570
	Catch	75	75	75	75	75	75	75	75	75	75
1980											
	Sp. biomass	124	124	124	124	124	124	124	124	124	124
	Fishing mort.	0.228	0.228	0.228	0.228	0.228	0.380	0.380	0.381	0.380	0.380
	Catch	35	35	35	35	35	55	55	55	55	55
1981											
	Sp. biomass	168	168	168	168	168	149	149	149	149	149
	Fishing mort.	0.100	0.200	0.600	0.340	0.198	0.100	0.200	0.600	0.340	0.367
	Catch	18	35	90	57	35	17	32	82	51	55
1982											
	Sp. biomass	176	164	123	148	164	155	144	109	131	128
	Fishing mort.	0.100	0.200	0.600	0.340	0.210	0.100	0.200	0.600	0.340	0.446
	Catch	19	33	63	48	35	17	31	58	45	55
1983											
	Sp. biomass	254	218	121	176	216	232	198	110	160	146
	Fishing mort.	0.100	0.200	0.600	0.340	0.195	0.100	0.200	0.600	0.340	0.449
	Catch	21	36	59	49	35	20	34	57	47	55
1984											
	Sp. biomass	259	208	93	155	208	238	191	85	142	121

List of identifications used in the table:

Option no. 1: SA1-mid-B-1
Option no. 2: SA1-mid-B-2
Option no. 3: SA1-mid-B-3
Option no. 4: SA1-mid-B-4
Option no. 5: SA1-mid-B-5
Option no. 6: SA1-mid-B-6
Option no. 7: SA1-mid-B-7
Option no. 8: SA1-mid-B-8
Option no. 9: SA1-mid-B-9
Option no. 10: SA1-mid-B-10

Table 19. Subarea 1 cod: projected catch and spawning stock biomass (tonnes x 10^{-3}) by various fishing strategies and and by two assumptions for catch in 1980. Results in this table are obtained by applying a mean of upper and lower limits of catch in 1979 (see Tables 3 and 3a, and text, Section 1).

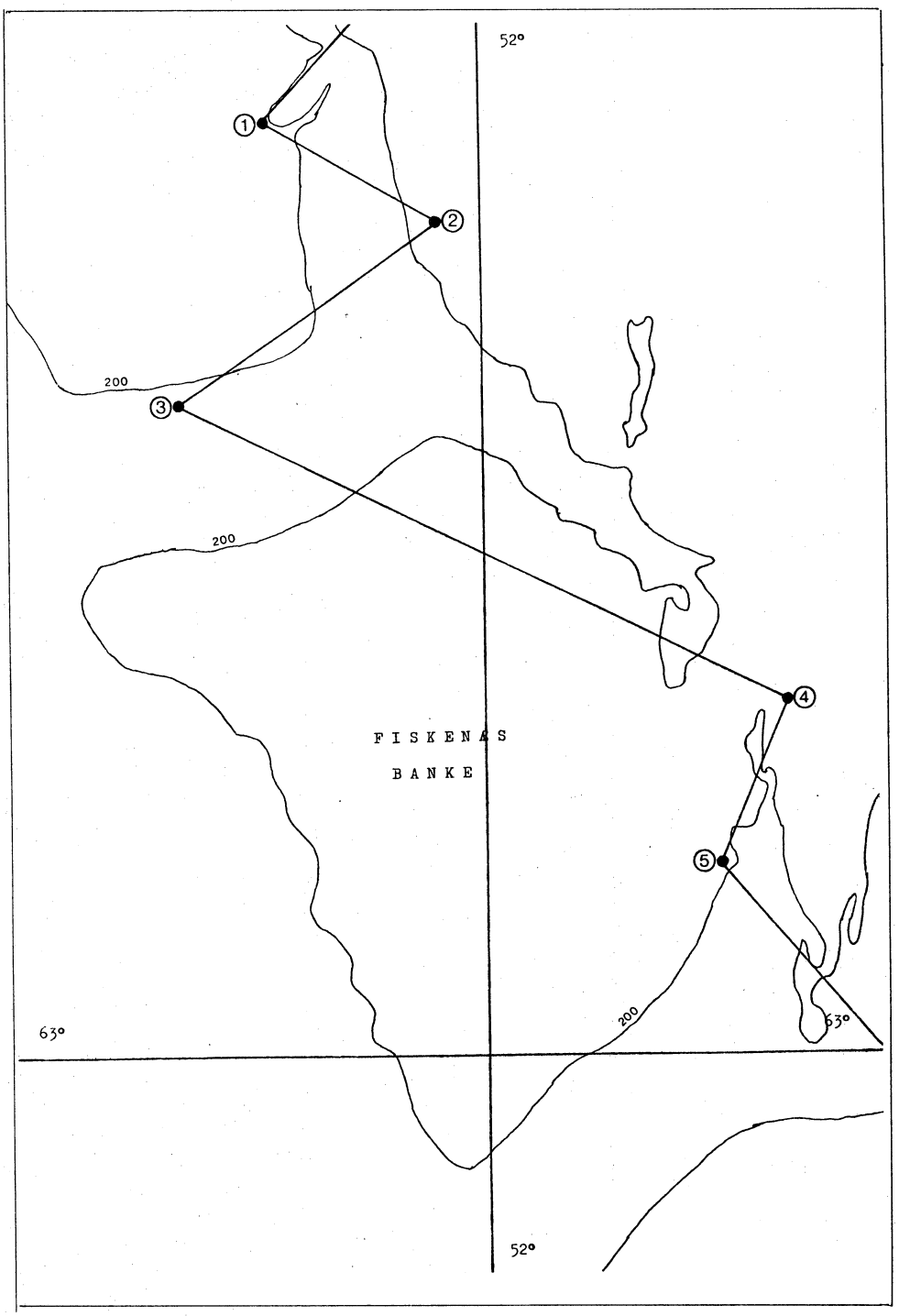

Fig. 1a. Acoustic survey by R/V Adolf Jensen, 17-18 April, 1980. Black dots are reference positions. No signs of fishable concentrations of cod are observed. Numbers in circles are reference positions for echograms. Survey map continued on Fig. 1b.

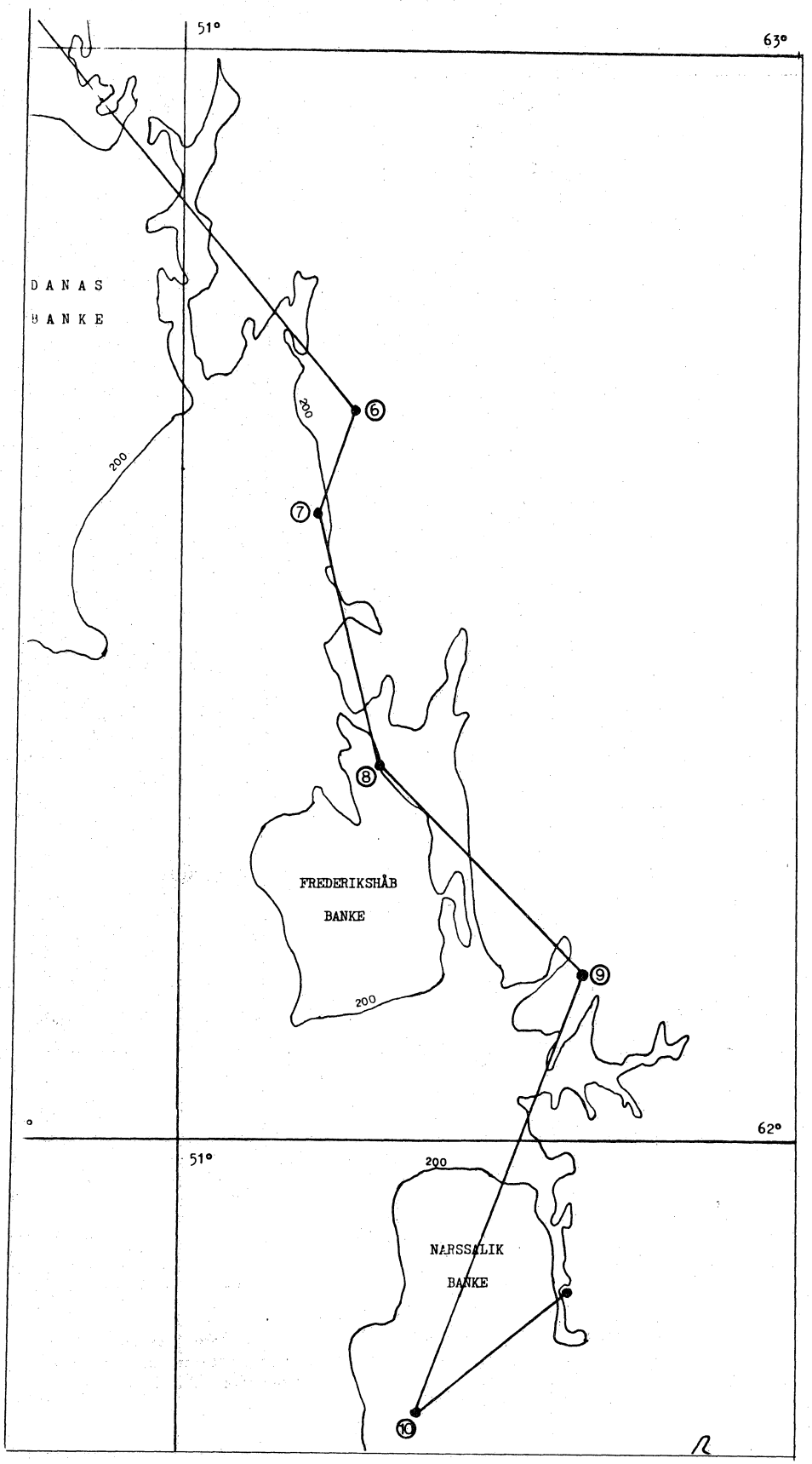

Fig. 1b. See text to Fig. 1a.

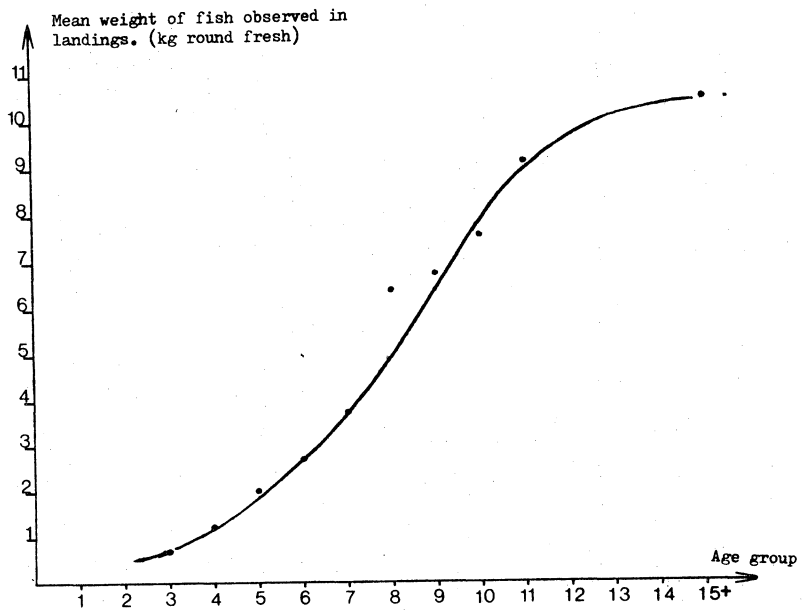

Fig.2
Relation between mean weight of age groups and ages. Mean weights are those obtained as weighted mean in Table 12 for age-groups 3-11 and 15+. Line fitted by eye.

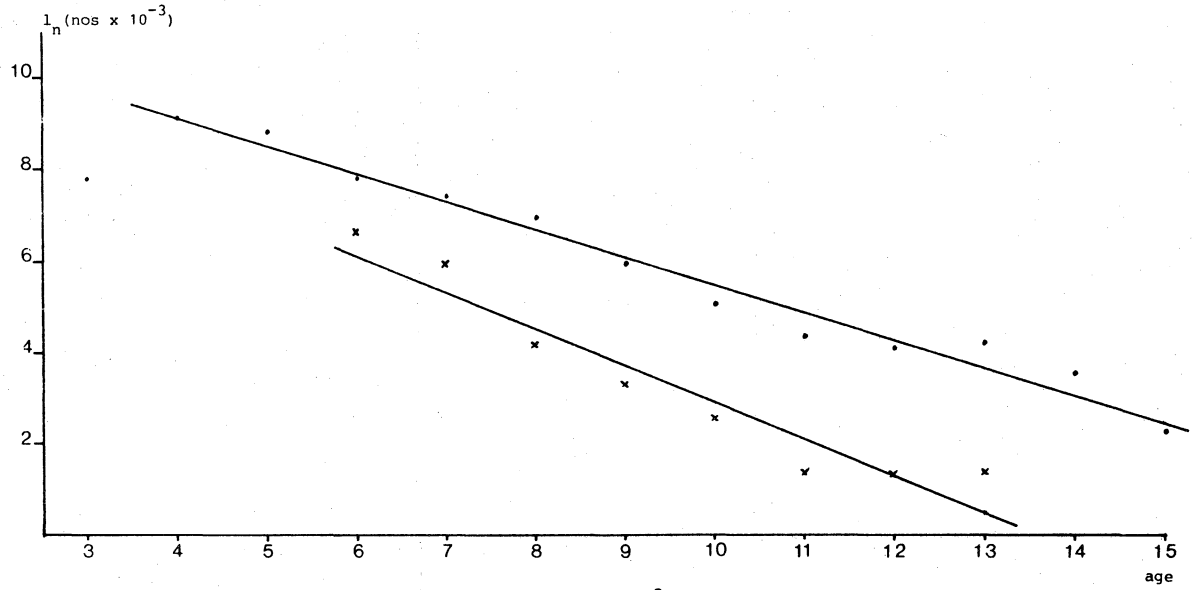

Figure 3. Upper line: mean annual catch (nos. x 10^{-3}) per age group for the years 1974-78 plotted on log-scale to give estimate of total mortality (Z).

Lower line: mean annual catch (nos. x 10^{-3}) of age-groups 6-13 for the years 1978-79.

Upper line: $y = 11.56 - 0.61\ x$ Lower line: $y = 11.07 - 0.81\ x$

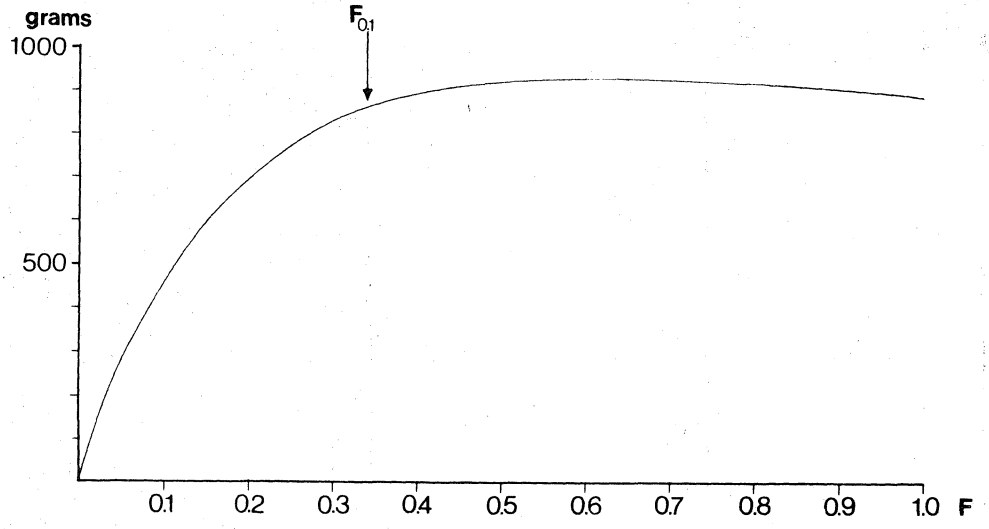

Fig. 4. Yield-per-recruit curve by values of weight by age, partial recruitment (partial F), natural mortality and emigration rate as used in the analyses in this paper.

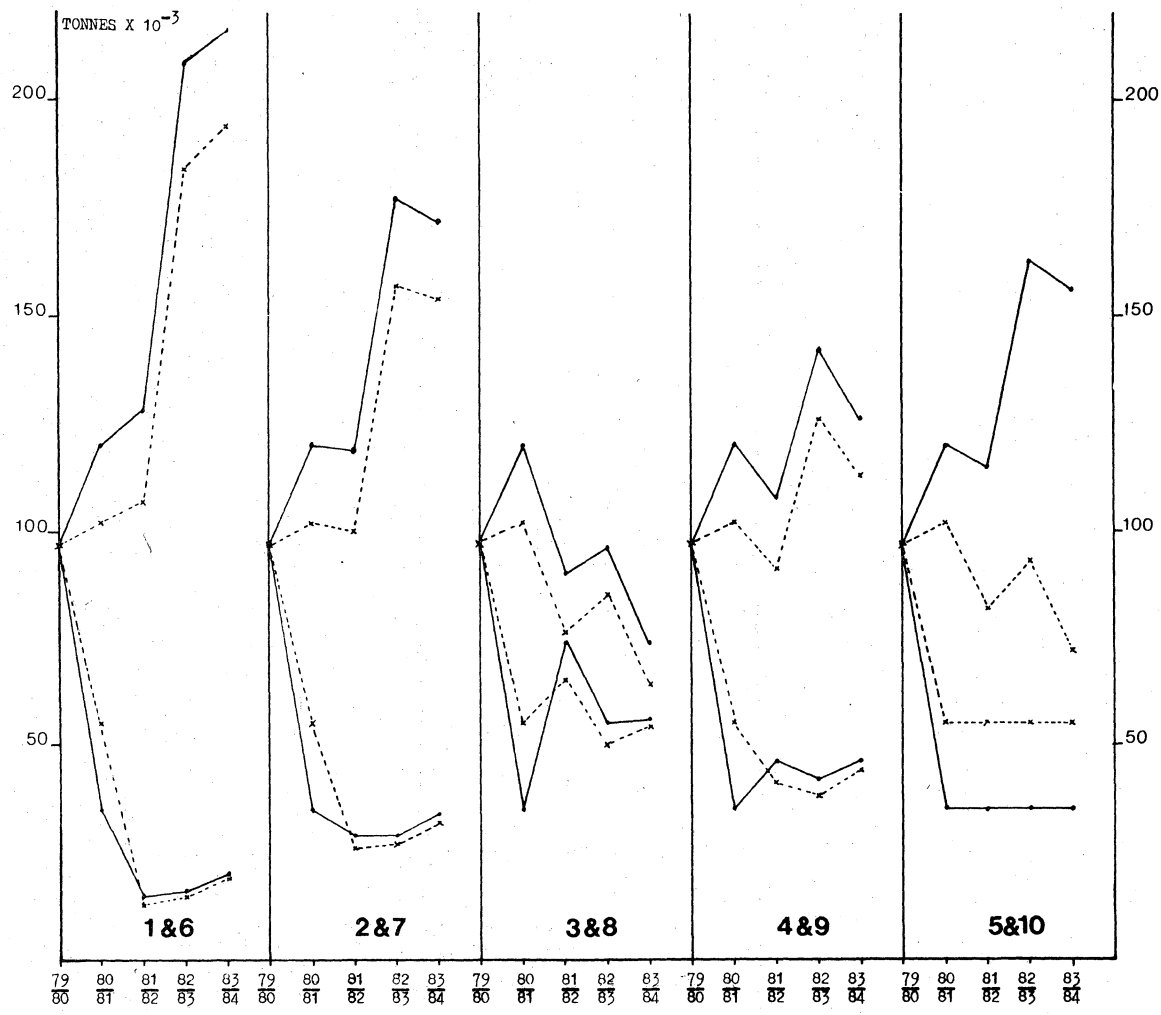

Fig. 5. Projected catches and spawning biomass by various fishing strategies and assumptions of catch in 1980 (see text Section 10 ii). Results illustrated in this figure are based upon upper limits of catch in 1979. The figure corresponds to Table 17. Figures at the bottom of each section refer to strategy numbers in the Table.
Upper year refers to catch, lower year to sapwning biomass at the beginning of that year. Full line by assumed catch in 1980 = 35,000 tons, broken line 55,000 tons.

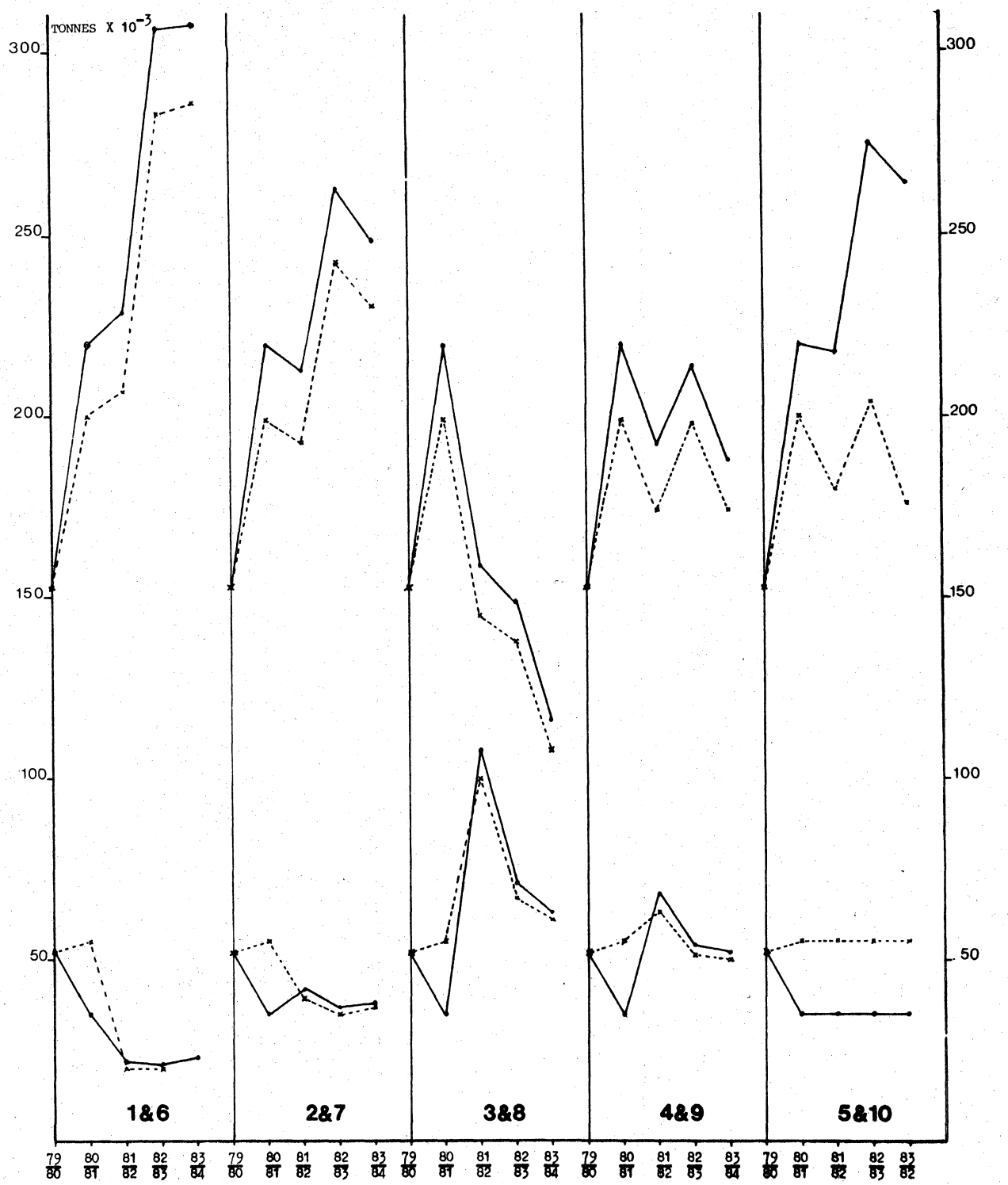

Fig. 6. Projected catches and spawning biomass by various fishing strategies and assumptions of catch in 1980 (see text Section 10 ii). Results illustrated in this figure are based upon lower limits of catch in 1979. The figure corresponds to Table 18. Figures at the bottom of each section refer to strategy numbers in the Table.
Upper year refers to catch, lower year to spawning biomass at the beginning of that year. Full line by assumed catch in 1980 = 35,000 tons, broken line 55,000 tons.

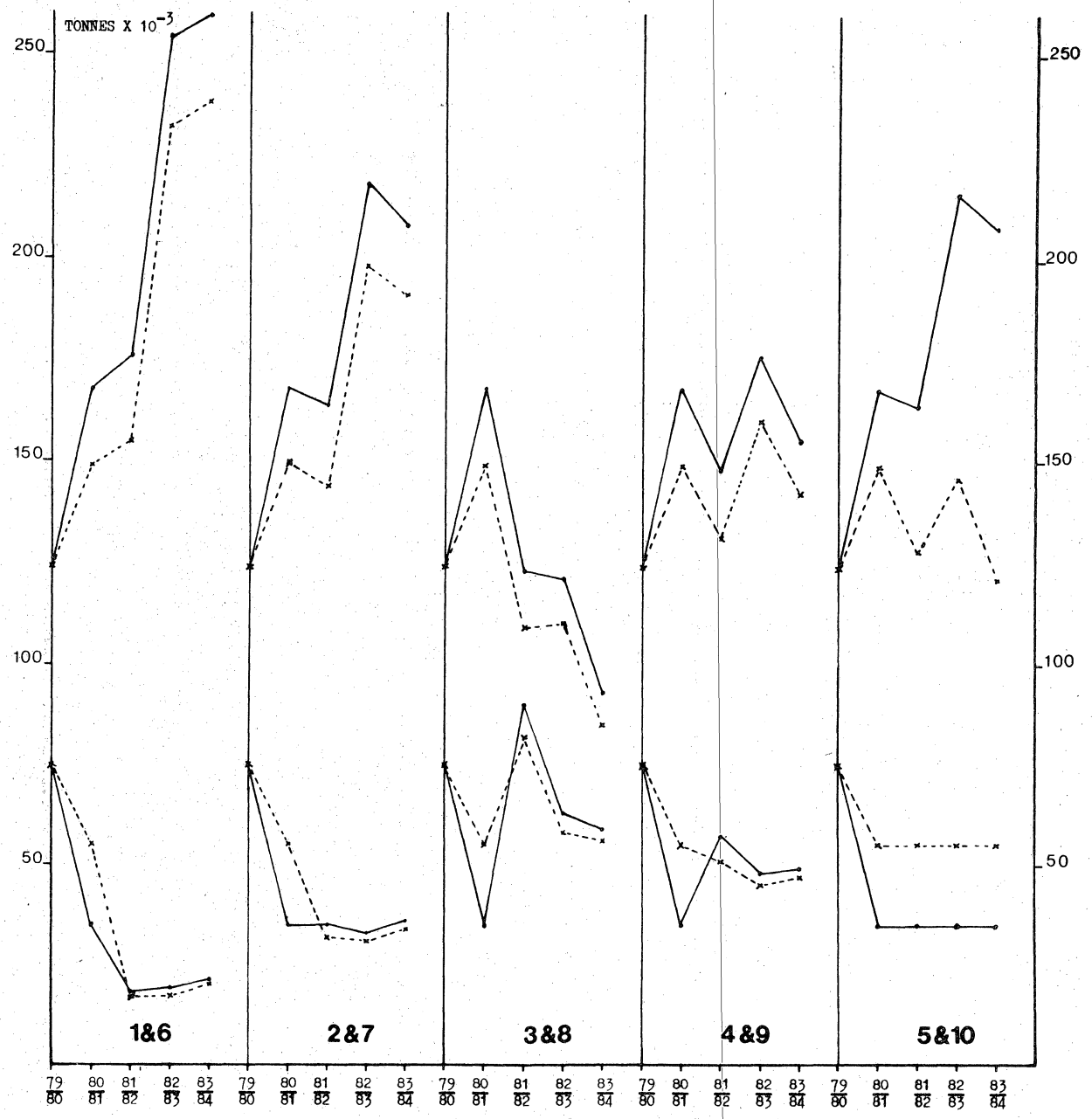

Fig. 7. Projected catches and spawning biomass by various fishing strategies and assumptions of catch in 1980 (see text Section 10 ii). Results illustrated in this figure are based upon a mean of upper and lower limits of catch in 1979. The figure corresponds to Table 19. Figures at the bottom of each section refer to strategy numbers in the Table.
Upper year refers to catch, lower year to spawning biomass at the beginning of that year. Full line by assumed catch in 1980 = 35,000 tons, broken line 55,000 tons.