Northwest Atlantic Fisheries Organization

Serial No. N719

NAFO SCR Doc. 83/VI/60
(Revised)

SCIENTIFIC COUNCIL MEETING - JUNE 1983

Status of Subarea 1 Cod and Estimates of Stock and Yield for 1983-85

by

Sv. Aa. Horsted

Grønlands Fiskeriundersøgelser
Copenhagen, Denmark

and

J. Messtorff

Institut für Seefischerei
Bremerhaven, Federal Republic of Germany

and

A. Schumacher

Institut für Seefischerei
Hamburg, Federal Republic of Germany

1. NOMINAL CATCHES 1981-82

The figure for the nominal catch of cod in Subarea 1 in 1981 used in last year's assessment was 52.238 metric tons of which 13.752 tons (or more) were taken by trawlers. Final figures reported to NAFO show a total of 53.456 tons (at least 13.753 tons by trawlers). 7.678 tons of the catch by Greenland vessels, miscellaneous gears, were reported without specifying divisions and months but are estimated to be distributed as indicated in the text to Table 1. They were further allocated on months in the same proportion as other miscellaneous-gears catches reported by division and month. The estimated distribution on divisions and gears is shown in Table 1, while the revised figures for numbers caught by age are given in Table 13.

For 1982 the total nominal catch of cod in Subarea 1 seems to be around 55.500 tons (Table 2). This figure includes a reported catch of appr. 21.000 tons for the large Greenland trawlers, a provisional figure of 26.271 tons for other Greenland vessels, and a provisional figure of 8.119 tons for trawlers of the Federal Republic of Germany. For the Greenland miscellaneous-gears catches 7.973 tons were reported without information on their distribution on divisions and months. As for 1981 this unspecified component has been allocated on divisions and months (see text to Table 2). The catch in 1982 is thus nearly exactly the same as that of 55.000 tons estimated and used as the basis for the 1983-84 prognoses in last year's assessment.

A comparison between Tables 1 and 2 shows the total catch in 1982 slightly (about 2.000 tons) higher than that in 1981, both at a level of 55.000 tons. The 1980 catch was also at this level.

The distribution of the catch on divisions and gears changed somewhat from 1981 to 1982. The 1982 catch was maintained at the 1981 level mainly due to more than a doubling of the catch by trawlers, but also to an increase in mean weight of fish (Table 13), whereas inshore catches, supposedly mainly those by pound net, seem to have dropped sharply (by 1/3) from 1981 to 1982. The decrease in the inshore catches was most pronounced in the two southern divisions, which had a relatively high catch level in 1981 due to a considerable inflow of the "last portion" of the 1973 year class. With the virtual disappearance of this year class and with a large inflow of polar ice ("Storis") the inshore catches in Div. 1E - 1F were bound to decrease abruptly from the 1980 -81 level as also predicted in the Danish Research Report for 1981 (NAFO SCS Doc. 82/VI/16).

2. TRENDS IN CATCH PER UNIT EFFORT AND TOTAL EFFORT

Since for the years 1977-81 Greenland vessels were the only ones allowed direct cod fishing, trends in catch per unit effort can be analyzed only for the Greenland trawlers although trawlers of the Federal Republic of Germany had some direct cod fishing in 1982.

Effort figures for Greenland vessels are available only for the eight large trawlers of the Royal Greenland Trade Department. For the trawlers in the 500-999 GRT tonnage class the nominal catch, the effort (hours fished), and the catch per unit effort (c.p.u.e.) for the years 1980-82 are shown in Table 3.

Considering c.p.u.e. as a mean over the whole year the overall figure rose by 163% from 1980 to 1981 but dropped again by about 1/3 from 1981 to 1982 to a level of 2.2 tons/hour, rather similar to that of 2.4 tons/hour in 1979. As in 1981 the best catch rate was obtained in Div. 1E. A small part of the fishing took place in the southernmost part of Div. 1B (Holsteinsborg Deep) while the Greenland trawlers' effort in Div. 1F remained negligible.

In Table 4 the c.p.u.e.-figures for the Greenland trawlers are given by quarter of the year for the years 1980-82.

Except for Div. 1D, second and third quarter, and for Div. 1E, third quarter, there was a decrease from 1981 to 1982 for all comparable set of figures ranging from 23 to 54%. The increase in the third quarter for Div. 1D and 1E is unfortunately based on very little effort in 1981 and may, therefore, not be considered generally indicative of stock fluctuation. The overall picture remains, therefore, a decrease in c.p.u.e. from 1981 to 1982 by about 1/3.

Figures for the trawlers of the Federal Republic of Germany are listed in Table 5. Except for Div. 1F their mean catch per hour of cod for the total year is well below that of the Greenland trawlers. In the fourth quarter, Div. 1C - 1D, the c.p.u.e. of cod is rather similar to that of the Greenland trawlers, whereas for Div. 1E the c.p.u.e. of cod is about half that of Greenland trawlers. On the other hand, the catch of all species for the German trawlers is relatively much higher than for Greenland groundfish trawlers. The German trawlers' catch of cod makes up 42% of their total

catch from the Subarea in 1982 while 95% of the Greenland trawlers' landings consisted of cod. Comparison of c.p.u.e. of cod between the two fleets may, therefore, be meaningless in terms of analyses of variation in cod stock.

If the Greenland trawlers' catch is taken as an index of c.p.u.e. for the total effort in Subarea 1 then the figures in Table 6 suggest that the overall effort in 1982 was 53% higher than that in 1981. This applies for figures based upon catch in terms of weight as well as for figures based upon catch in terms of number of fish landed. However, the conclusion about a 53% increase in effort is based upon the assumption that catchability and fishing pattern was the same in the two years compared, and that the inshore density and catchability of fish fluctuates as in the offshore area. This latter assumption seems doubtful.

For the coastal and inshore small-boat fisheries no effort figures are available. The inshore catches for the years 1979-82 are given in Table 7. The overall catch level was around 40.000 tons in 1979-81 based mainly on catches in Div. 1E - 1F, although gradually decreasing in the latter division. A significant decrease in catches in these two divisions from 1981 to 1982 resulted in the overall inshore catch decreasing by 1/3 from 1981 to 1982, although the catches in Div. 1B - 1D remained fairly stable. The high catches in Div. 1E - 1F in 1979-81 were based on the southernly distributed 1973 year class. This year class is now very much reduced due to fishing, emigration, and natural mortality.

3. THE FISHERY AND THE STOCK IN THE BEGINNING OF 1983

The winter 1982/83 has been one of the coldest, if not the coldest, in Greenland in a century, and adverse ice conditions have influenced the fishery. By late May several fiords were still covered by ice, and the inshore fishery will have a late start. By late March the inshore catches were about 200 tons, 2/3 below those of 1982 at the same time. However, in 1982 the January - March inshore catches made up only 3-4% of the total inshore catch of the year. Therefore, as long as the pound net fishery (June - September) has not been partly seen, forecast for the inshore catches are difficult to make.

The catch of the trawlers of the Royal Greenland Trade Department by 31. March 1983 was about 4.600 tons or 40% below their catch by the same time in 1982. However, effort was probably also lower than in the first quarter of 1982. In January the trawlers operated mainly in Div. 1E, and to be judged from length samples catches at this time seem to have been heavily dominated by the 1977 year class. In February - March it was rather difficult to find good concentrations of cod. The best fishing was in rather deep water at the western slope of the banks in Div. 1E. In March - April most of the fishing again took place in Div. 1E, still with the 1977 year class clearly predominating although one sample consists mainly of larger and most likely older fish. Schools of mainly small cod, most likely dominated by the 1979 year class, were found in the Fylla Bank region (Div. 1D). Catches in Div. 1C have been disappointingly low.

By the end of April the catch by Greenland trawlers, inclusive some of the larger privately owned vessels, was close to 11.000 tons. The German

trawlers' catch (18 trawlers) by the end of April reported to the Greenland authorities was about 5.000 tons of cod and 3.000 tons of redfish with minor catches of wolffish and other species. At least some of the trawlers have been operating in Div. 1F.

A sample taken from one of the Greenland trawlers fishing in Div. 1D in early May has a bimodal length frequency with one mode at 46 cm and another at 57 cm, corresponding to ages 4 and 6 (year-classes 1979 and 1977), respectively. Year-class 1977 makes up 47% of the sample (by number), year-class 1979 41%. It seems highly likely that the 1979 year class will have an even higher predominance than this in the pound-net catches in 1983, while offshore catches will show a rather varying proportion of the two year classes.

4. MEAN LENGTH AND WEIGHT OF AGE GROUPS IN 1982

The mean length and weight by age in the Danish samples of cod from Subarea 1, 1982, is given in Tables 8 and 9 for the offshore and the inshore samples, respectively. Only those samples for which direct observation on cod weight was made are included (very few samples were not weighted).

In order to get a weighted mean over the year of the quarterly mean weights Tables 10 and 11 have been set up. Table 10 lists the numbers by age caught each quarter of the year in the offshore fishery, and these figures have been used as weighting factors to achieve the weighted mean for 1982 for the offshore component of the catch (Table 12). For the inshore fisheries the material has not allowed a break down by quarters of numbers by age. Instead the likely quarterly catch as listed in Table 11 has been used as weighting factor for the inshore samples, and the result is shown in Table 12.

The mean weights in Table 12 have not been used to convert fractions of catches (represented by individual samples) to numbers caught. In the calculations the actual weight of each individual sample was used to convert the landings represented by that sample to numbers caught.

The sum-of-product (SOP) test on the mean weights by age (Table 12) on numbers caught (Table 14) gives a figure of 58.776 tons for total landings in 1982 as compared to the actual figure of 55.481 tons. Since both the inshore and the offshore SOP-figures are about 6% higher than the actual catch the mean weights for 1982 in Table 12 seem to be biased by about 6% (too high).

A comparison between mean weights found in 1982 and those used in the forecast for 1982 in last year's assessment is also found in Table 12. Using the former forecast weights on numbers caught in 1982 leads to a SOP catch of 63.820 tons, i.e. about 15% higher than the actual catch.

In order to achieve mean weights by age for forecast of the 1983 and subsequent years' catches it has been assumed that the present balance between offshore and inshore catches is maintained over the next 2-3 years, and that no drastic change in growth rate and in the quarterly distribution of landings will take place. The mean of the offshore and the inshore weight by age is, therefore, used, but due to the bias observed the weights are reduced by 6%. For age-groups older than 11 years, for which no new material was available, the figure for age-group 11 is adopted. The figures obtained in this way are plotted in Fig. 1 and

a smoothed curve fitted. Evidently, the figures for age-groups 7 and 9 differ somewhat from the curve. Accepting the curve as the best estimate the following values for weight by age in the forecasts are found:

Age group	Mean weight (kg)
3	0.83
4	1.11
5	1.70
6	2.35
7	3.20
8	4.30
9	6.50
10	9.02
11^+	9.32

The SOP check of these figures in numbers caught in 1982 (Table 14) gives a catch of 55.404 tons, very close to the actual catch of 55.481 tons. The figures applied to the 1981 catch by numbers (Table 13) gives a SOP catch of 54.059 tons, also close to the actual catch of 53.456 tons. However, further back in time the difference between SOP by these figures and the actual catch seems relatively bigger.

Mean weight at age used in the VPA runs for the years 1965-82 are shown in Table 15A.

5. NUMBERS LANDED BY AGE GROUPS IN 1981 and 1982

Numbers landed per age group for the years 1965-82 are listed in Table 15B while those for 1981 and 1982 are shown in Table 13 for the northern and southern divisions of Subarea 1 separately. The figures for 1981 are based upon the same samples as those used to achieve numbers landed for 1981 in last year's assessment, but the revised catch statistics have been taken into account (Table 1).

Figures for 1982 must be regarded as provisional figures since catch statistics are provisional, both in terms of total catch as well as in catch distribution on divisions, gears and months.

In 1982 the offshore trawl fishery of the Greenland trawlers was sampled in all months and in most divisions where fishing took place. The NAFO request (one sample per 1000 tons caught per division, month and gear) is generally met for this fraction of the fishery.

For the catch of the trawlers of the Federal Republic of Germany no samples were available except samples by the R/V "Walther Herwig" fishing with small meshed gear. The samples from Greenland trawlers have, therefore, been applied also to the German catches according to their specific distribution by time and area.

The inshore fishery was extraordinarily poorly sampled. Thus no samples were taken in Div. 1F, and for the Div. 1D pound net fishery only two samples exist, both from July and differing rather much in size and age composition. In the worst case one sample has had to be used on a catch of 6069 tons. Recalling

the many assumptions on unspecified catches' distribution on gears, divisions and months the conversion of inshore catches to numbers caught is, therefore, very uncertain and seems justified only because of the evident predominance of one year class (the 1977 year class) in so to say all catches. However, the lack of samples from Div. 1F may well mean that the 1973 year class has been underestimated and younger year classes overestimated in their contribution to the 1982 fisheries.

The year-class 1977 which made up 56% of the catches by numbers and about 35% by weight in 1981 had an even stronger predominance in 1982 (67% by number, about 55% by weight). Due to the individuals' growth from 1981 to 1982 the mean weight of fish in the catches increased from 1.77 kg to 2.06 kg, but this mean weight was below the overall mean weight for all age groups in both years.

6. RESULTS OF SURVEYS CARRIED OUT IN 1982

Under the present conditions the information available from the commercial fisheries of West Greenland does not adequately reflect the situations and development of the West Greenland cod stock and hence makes it difficult to arrive at satisfactory assessments based on fisheries data only.
Therefore the regular groundfish surveys conducted by the Federal Republic of Germany off West Greenland in late autumn were improved in 1982 by the introduction of the stratified random bottom trawl survey method in order to obtain estimates of the trawlable biomass of cod in Subarea 1.

a) Survey design

The survey design was based on the stratification scheme for Subarea 1 (excluding Div. 1E) as developed and described by D. M. Carlsson and D. Kanneworff in the NAFO-Survey Manual (Doubleday ed., 1981). A corresponding preliminary stratification of Div. 1E was added. The total survey area inside Subarea 1 is shown in Fig. 2. This area was divided into 7 strata equal to NAFO Divisions or parts thereof and each stratum again subdivided by depth zones according to 100 and/or 200 m steps. The strata areas as given in Table 16 were obtained by summing up the areas per depth zones contained in each basic stratum block (= statistical rectangles of 30' latitude x 1° longitude). The additional stratification by depth-zones was chosen because the density distribution of cod is at least partly related to depth.

As cod seem to be most evenly distributed in the survey area in autumn this time of the year was chosen for conducting the survey in order to

minimize the variances of survey results at a high level of confidence (95%).

In order to provide for an optimum coverage of the whole survey area the number of sets to be selected at random per stratum was defined according to the areas per depth zone inside each stratum.

For applying the "swept area" method to the survey results the following trawl parameters referring to the standard survey trawl were used:

Towing time	30 min.
Towing speed	4.5 knots (average)
Horizontal net opening	22 m.

Since a reliable estimate of the catchability coefficient could not be obtained, it was taken as 1.0 to avoid overestimation of the stock biomass.

b) Survey Results

The survey was based on 111 fishing stations distributed at random over the survey area. The results are related to 98 successful sets distributed as follows:

Depth zone	Stratum No.-Division 1-1B	2-1C	3-1C	5-1D	6-1E	7-1F	Total
0-200	7	6	10	16	10	15	64
201-400	4	2	5	6	6	5	28
401-600	1	0	3	2	-	0	6
Total	12	8	18	24	16	20	98

Estimates of the trawlable biomass of cod for the total area (19,864 nm^2) surveyed off West Greenland by R/V "Walther Herwig" in Nov./Dec. 1982 amounted to:

179,934 tonnes ± 37% and in

number to 109,039 x 10^3 ± 36.1% respectively.

The confidence intervals are given at the 95% significance level.
A breakdown in numbers by ages and Divisions is given in Table 17.

The abundance of cod in Division 1B (Stratum 1) and the northern part of Div. 1C (stratum 2) combined was very low and amounted to less than 1% of the total trawlable biomass in numbers consisting of mainly young cod of year-classes 1980 and 1979. Also in the southern part of Div. 1C (stratum 3) abundance was low amounting to only 4% of the total biomass in numbers with the 1979 year-class (84%) predominating. A steep increase in abundance up to 46% of the biomass of cod in Subarea 1 was observed in

Div. 1D (Stratum 5). The dominating year-classes in Div. 1D were those of 1979 (38%) and 1977 (42%). Abundance in the southern Divisions 1E and 1F (Strata 6+7) remained at about the same high level and added up to 50% of the total trawlable biomass in numbers. As compared to the age compositions in the northern Divisions (1B-D) the proportion of older cod increased southward in Division 1E and 1F. In Div. 1E, however, year-class 1979 was predominant (41%) with year-class 1977 at second place (29%), whereas the latter predominated in Div. 1F (35%) followed by year-class 1976 (22%). The formerly important year-class of 1973 has almost vanished and made up only 5% at maximum in Div. 1F.

Length frequencies of the trawlable biomass in numbers are shown in Fig. 3 for the northern Divisions (1B-D) and in Fig.4 for the southern part of Subarea 1 (Div. 1E and F). The modes correspond very well to the age compositions observed and given in Table 17. In Div. 1B plus the northern part of Div. 1C the mode was between 25 and 28 cm and in the southern part of Div. 1C at 37.5 cm. The length frequency distribution in Div. 1D is biomodal with modes at 40.5 and 55.5 cm representing mainly year-classes 1979 and 1977. A bimodal distribution also prevails in the southern Divisions 1E and 1F with modes at 37.5 and 61.5 cm, and 40.5 and 61.5 cm, respectively, again reflecting the dominating year-classes throughout Subareas 1. A small third mode at 82.5 cm in Div. 1F represents the remaining proportion of the year-class 1973.

7. INFORMATION ON FUTURE RECRUITMENT

The strength of the 1982 cod year-class can at present be estimated only on the basis of hydrographic observations in 1982 and the occurrence of cod larvae in the plankton. The Danish Research Report for 1982 will contain the relevant information. The reference temperature (Fylla Bank in June) was only 0.74°C. However, the temperature had increased by about 2°C when measured again in mid July. Also, in the areas north of Fylla Bank (Div. 1B - 1C) the surface temperatures in July were 1-2°C above those in the two previous years. Temperature conditions may thus have been more favourable for the survival of cod larvae than indicated by the June reference temperature itself.

The number of gadoid larvae found in the plankton was the highest since 1957. A mean of 14.4 larvae per half-hour haul (Stramin net, 2 m diameter) was found in the samples from the three hydrographic standard sections (Fylla Bank, Lille Hellefiskebanke, Holsteinsborg) in Div. 1D, 1C and 1B, respectively.

The difference between the larvae of Greenland cod *(Gadus ogac)* and those of cod is not known, and since Greenland cod is observed on the offshore

banks more frequently in recent years than previously one cannot rule out completely the possibility that some of the larvae observed may be *Gadus ogac*. Bearing in mind, however, the relatively favourable July temperatures, it may be allowed to be optimistic regarding the 1982 cod year class at West Greenland. It will be highly interesting and necessary to follow it closely in the following years to see whether the optimism can be maintained, viz. that the possibility of a really good year class (some hundred mio. recruits by age 3) seems to occur again after a long period with poor to moderate recruitment. A tentative figure of 200 mio. is proposed, but the year class may prove to be bigger.

For the 1981 year-class the only observation in 1982 is its occurrence in the catches by the R/V "Walther Hervig" of the Federal Republic of Germany in November - December (Section 6). The numbers caught of this year class, however, were so low that there seems no reason to change the initial proposal of last year of 20 mio. fish (by age 3) for its strength.

Also the 1980 year-class was observed during the R/V "Walther Hervig" cruise, but again in relatively small quantities. There is no evidence of the year class in the samples of the Greenland catches, 1982. It has not yet shown up in the 1983 catch samples, but may occur in the pound net catches later in the year. Thus, for the time being, there is no new information, and the initial estimate of last year, which was based upon temperature and plankton observations in 1980, is maintained for the time being, i.e. 75 mio. fish (age 3).

In last year's assessments the 1979 year-class was estimated to be of a strength in the range of 75-150 mio. fish. A number of observations in 1982 confirm the year class as a relatively important one for the mid 1980's fishery.

In the samples from the R/V "Walther Hervig" cruise the 1979 year-class makes up 31% (by number) exceeded only by the 1977 year-class (37%). The year class has also been observed both amongst the smallest individuals landed by Greenland vessels as well as in the discards (fish below 40 cm total length). The estimated numbers landed of the year class is relatively high, especially in the inshore pound net fishery (Tables 13 and 14). Unfortunately, not much information on discards was obtained in 1982. Up to 1/3 (by number) was estimated for a pound net catch in the Godthåb Fiord (Div. 1D), and the predominance (59%) of age group 3 in a pound net landing at Holsteinsborg, and the length distribution of a sample, indicates that a good part of the catch was discarded (Fig. 5). This seems also evidenced by considering samples of commercial catches (as opposed to landings) and of research catches. Thus a sample taken on board a trawler fishing in Div. 1D in December 1982 showed a predominance of 40% of 3 years old fish ranging from 35 to 47 cm with a mean of 41.5 cm (mean in total sample 51.2 cm).

In 5 hauls with fine mesh trawl (shrimp trawl) by the R/V "Adolf Jensen" on its standard station Sukkertoppen Dyb (Div. 1C) in February and in April altogether 110 cod were caught. 81% were 3 years old, and mean length was 29.6 and 31.5 cm in the two months, respectively. 3 hauls at the standard station Frederikshåb Isblink in March gave only 44 cod and only 3 of these were of age-group 3 (age-group 5 dominating).

Thus year class 1979 will no doubt be a relatively important one in the fisheries in the mid 1980-ies. It is possibly close to the upper end of the range proposed last year but will still need furhter observations to be more exactly judged. At present, however, the figure of 150 mio. fish (by age 3) is proposed.

In summary, the figures proposed for recruitment in the forecast are:

Year-class 1979	150 mio. fish at age 3
Year-class 1980	75 mio. fish at age 3
Year-class 1981	20 mio. fish at age 3
Year-class 1982	tentatively 200 mio. fish at age 3, possibly more.

8. DEFINITION OF SPAWNING STOCK BIOMASS

In previous assessments and advice of Subarea 1 cod the spawning stock has been defined as that part of the stock which has reached an age of 6 years and more. The spawning stock biomass (SSB) has been calculated as the live weight of the spawning stock applying mean weight by age to the numbers in the respective age groups. The annual change in age is considered to take place by 1 January.

The age 6 was chosen as the knife-edge point because in general for age-group 6 about half the individuals are mature fish. Also, the knife-edge definition is a simple one to use in calculations.
However, maturation of fish takes place over a span of age groups, and for more thorough studies of fluctuations in spawning stock biomass and the possible influence on recruitment, the real spawning stock biomass has to be calculated.

An improvement has been made in this paper by taking into consideration the proportion of mature individuals in each age group. Published data as well as sampling data obtained by the Institute for Sea Fisheries of the Federal Republic of Germany available since 1956 (with some years missing) have been used to construct maturity at age arrays for the period 1960 to 1983.

The original data have been grouped into certain time periods according to obvious changes in the proportion of mature fish at age as well as to cover years for which no sampling data were available. From these data a logistic curve was calculated for each period. The correlation coefficients for the curves were all above 0.9. Since it is reasonable to assume that changes in the proportions from one period to the following one have not taken place from one year to another a five-years running average was calculated for each age group for the period 1960 to 1983 (Table 18).

The difference between the SSB figures obtained by the previous definition and those obtained by the new definition varies much between years. If there were a completely steady recruitment to the stock (plus steady total mortality and mean weight by age) the difference between the two set of figures would also be constant.

By the present level of total mortality and the present weight at age the new definition generally leads to a lower SSB-figure because the mean weight of the immature fish in each age group of age 6 and older, which were previously regarded as mature fish and counted in the SSB, is much higher than for those mature fish in the younger age groups, which are now being counted as part of the SSB instead of older immatures.

In the unstable stock and the ever changing recruitment situation the difference between the two set of figures varies between years. This is illustrated in Fig. 6 . Generally, the actual-maturity definition tends to smooth the fluctuations seen by the knife-edge definition. Also, the knife-edge definition generally gives too high figures. However, in cases when a relatively very good year-class recruits to the stock after a long period of poor recruitment, the real SSB figure may exceed the knife-edge figure in the year, when the new year-class achieves age 5. This was, for instance, the case in 1978 when the 1973 year-class was recruiting to the very small stock but considered totally immature by the knife-edge definition.

The difference between the two sets of figures is highest in such years when one (or two) strong year-class(es) achieve age 6 (and 7), for instance in 1967 when the two good year-classes 1960 and 1961 were considered 100% mature in the knife-edge definition.

Although the application of maturity-at-age data in the calculations should result in more accurate figures for the SSB, the figures may still be biassed. By the present calculations we have simply applied the mean weight for all fish in each age group to the numbers of mature fish in each such group. However, further improvement of the accuracy of the SSB figures can be made by using mean weight in each age group of its mature individuals separately when calculating the SSB. This has not been possible for the present meeting, and such refinement is not likely to improve the figures nearly as much as the change from the knife-edge definition to the present.

It should be noted that the basic material on maturity by age will be used in a detailed study (thesis for the doctorate) on the biological interaction of growth, maturity and environmental conditions in the Greenland cod stocks and is, therefore, not presented in this paper.

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

At the June 1982 Meeting of the Scientific Council catch curves averaged for age-groups 6-8 over the years 1979-81 were used to estimate total mortality(Z). The value derived was 0.90. It was considered that M remained at a value of 0.20, and that the inclusion of the 1973 year-class in the data could mean an emigration coefficient of about 0.15. Thereby a terminal F-value of 0.55 for 1981 was indicated. (The VPA runs used were initially carried out with a terminal F-value of 0.54 for 1981 and were maintained.)

In the estimation of a terminal F-value for 1982 the authors again looked at catch curves but also made other, as will be seen, evidently better approaches to starting values for the VPA.

When catch curves over the years 1980-82 are considered it becomes obvious that the 1973 year-class has had a very sharp decrease from 1981 to 1982 (Z would be about 1.8 for that year class by itself). This may have been caused by extraordinarily high emigration to East Greenland - Iceland or to an under-estimate of numbers caught in 1982, and the inclusion of the 1982 value for that year-class in the analyses could, therefore, bias the overall Z value. Likewise, it seems evident that the inclusion of the relatively strong 1977 year-class would create difficulties since this year-class was not yet fully recruited in 1981 and 1980, especially. Omitting these two year-classes and age groups older than 8 years the catch curve for age groups 3-8 averaged over the years 1980-82 is presented in Fig. 7. Taking age groups 5-8 as fully or nearly fully recruited the regression line for these groups points to a value of $Z = .79$ with $r = -0.983$.

The year-classes included in the regression analysis are year-classes 1972, 1974, 1975 and 1976, all in the range of 23-61 mio. fish, and none of them expected to show extraordinarily high tendency of migration. It may, therefore be proper to consider an emigration rate of 0.05 and a natural mortality of $M = 0.20$. The terminal F-value thereby indicated is 0.54. This is virtually the same as the terminal F-value found last year by the same method.

If the plot of age-groups 3 and 4 in Fig. 7 were to be raised to fall on the regression line for ages 5-8 the number in these groups would have to be multiplied by a factor of 19.6 and 1.7, respectively. This corresponds to a partial recruitment of 5% and 59%, respectively. The values found last year were 1% and 23%, respectively. Possibly, the occurrence of shoals of the newly recruited, relatively good year-class 1977 has attracted relatively more effort to young fish than is normally the case. The same happened when the 1973 year-class recruited in 1976-77 (Horsted, 1978).
The partial F-values corresponding to a partial recruitment of 5% and 58% is 3.9% and 52.0%, respectively, of the F-value for fully recruited age groups.

A trial VPA run with a terminal F (1982) of F = 0.54 was made (Tables 19 and 20). This leaves a residual stock by 1983 in which SSB (knife edge) is only 90 thousand tons as compared to a forecast of 220 thousand tons in last year's assessment by a supposed catch in 1982 equal to that now reported and used. This could indicate that the F value obtained by the catch curve is too high.

Noting that the trawl survey referred in Section 6 was designed and carried out so as to give a figure for a minimum trawlable biomass in the Subarea the authors therefore carried out a VPA run based on the results of this survey.

The survey was carried out in November-December. The estimated numbers per age-group (with ages shifted upwards by one year) was, therefore, taken to represent the population in the sea at the beginning of 1983. The catch in numbers per age-group in 1982 was applied to this population numbers to estimate F on the single age-groups in 1982 and to perform a VPA on this basis. The results of this VPA run are given in Table 21 and in Figure 8. The average F for the most important age-groups (ages 5 to 8) in 1982 is 0.34 by this approach.

The resultant estimates of average fishing mortality for ages 5-8 and for the years 1975-80 from the two VPA's mentioned above have been correlated to data on total fishing effort in Greenland trawler units (Table 6 and Horsted 1979, 1980). The regression (Table 22 and Fig. 9) shows that, for the VPA based on the F-values derived from the catch curve mentioned, the 1981 and 1982 data points fall well above the regression line. This indicates that the estimate of F in 1982 from the catch curve is too high. The corresponding graph for the VPA based on the survey results show that the 1981 and particularly the

1982 data points are more close to the regression line.

A further comparison of the two VPA runs was made on the basis of the estimated exploitable biomass[1] of age 4 and older from the VPA's and CPUE figures from Greenland trawlers (Table 22 and Fig. 10). The results show that the estimate of the exploitable biomass for 1981 and 1982 from the VPA based on F from the catch curve is well below the regression line indicating that the estimate of F for 1982 is too high whereas in the corresponding figure for the VPA based on the survey results the 1981 and 1982 data points are close to the line.

The conclusion from these two comparisons is that the VPA based on the survey results is the more reliable one, and this is, therefore, used in the further assessment of the stock.

It should be mentioned that the mean F value of 0.34 found for age-groups 5-8 in 1982 by the VPA based on the 1983 survey stock is about the same as the F-value of 0.32 which one would conclude on the basis of last year's prognosis and the 1982 catch taking into consideration the change in mean weight by age used last year and that used in this paper.

Terminal F-values for years prior to 1980 are taken to be as in last year's assessment (Horsted, 1982).

10. 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 some non-surviving of discarded fish.

The emigration rate is proposed to be maintained at E=0.05 for age 6 and older fish since none of the year-classes 1974-82 are suspected to show the same high emigration to East Greenland and Iceland as did the 1973 year-class.

11. VIRTUAL POPULATION ANALYSES (VPA)

The VPA run based on the survey stock estimate by the beginning of 1983 is given in Table 21 while in Fig. 8 the resultant spawning stock biomass (SSB) and fishing mortality is shown together with the catches and the annual number of recruits (age 3) for the period 1962-82. Amongst recent year-classes up to 1981 the 1973 and 1977 year-classes are the two best by recruitment values around 228 mio. and 139 mio. fish, respectively. The F-values associated with the 1973 year-class

---

[1] Biomass per age-group multiplied by partial recruitment factor.

are generally above the mean for the year. This could indicate that the emigration rate was higher than usual for that year-class, and/or that this relatively strong year-class was the main target for the fishery during several years. The 1976 year-class shows a recruitment value of 61 mio. fish, well above that previously estimated (around 20 mio.). The year-class has, however, dominated much more in the catches and survey by the Federal Republic of Germany than in samples of the Greenlanders' catch. No explanation for this discrepancy can be offered at present.

12. YIELD PER RECRUIT

The data used for the catch projection (Table 23) have also been used to recalculate the yield per recruit curve (Fig. 14). The resulting values of $F_{max} = 0.348$ and $F_{0.1} = 0.184$ are somewhat lower than those used previously. This is the result of the combined effect of the revision of the partial recruitment as well as of the mean weights at age. However the new values are not inconsistent with comparable figures from other cod stocks. The present (1981 and 1982) level of F is about the F giving maximum yield per recruit.

13. FORECASTS

Without any sophisticated calculation it can be readily predicted that catches and landings in 1983-85 will be heavily dominated by the 1977 and the 1979 year-classes. Many catches are likely to be clearly bimodal in their length distribution, most clearly pronounced in 1983, less in 1984-85, when the two dominating yearslasses will have a higher degree of overlapping in their length distribution.

It seems also likely, that the major part of the catches will be from Divs 1C-1D, followed by 1E.

By 1985 the first inflow of the interesting 1982 year-class can be expected, possibly with a great amount of undersized fish in pound nets. If the year-class stands up to the expectation the 1986 catches will have a relatively low mean weight and a new bimodal length frequency can be expected, the modes made up by the 1982 year-class and of large fish mainly of the year classes 1977 and 1979.

The EEC Commission has requested a number of fisheries options analyzed. As a general guidance EEC requests a catch in 1983 equal to the TAC in 1982, i.e. 62,000 tons, as the basis for prognoses. The request is met in the forecasts presented in Table 24, but the table includes some other options. The options are illustrated in Fig. 11 while in Fig. 12 the catch in 1984 and the resultant spawning stock by January 1985 are shown for a wide range of fishing mortalities in 1984, and is based upon a catch of 62,000 tons in 1983.

14. STOCK-RECRUITMENT RELATIONSHIP

Estimates of year-class strength are available from 1947 onwards (except for 1948 and 1951) (Horsted, 1981). The data indicate two clearly distinct periods of recruitment production. Over the years 1947 to 1963 the average recruitment was 280 million of 3 year-old cod, ranging from 87 million (1954) to 585 million (1947).

In the period 1964 to 1980 average recruitment was 75 million ranging from 40 million (1967) to 150 million in 1979. In this calculation the year-classes 1969 to 1972 are excluded, since it is known that during that period the low water temperature was the governing factor in determining year-class strength. Also the 1973 year-class was excluded due to the fact that it is of mainly East Greenland origin (as several others in the earlier period).

Only since 1962 estimates of spawning stock biomass (SSB) are available at present. For this period, recruitment at age 3 is plotted against the respective spawning stock biomass as defined in this paper (see Fig. 13). An attempt was made to fit a Ricker stock-recruitment curve through the data points. For the period 1964-68 and 1974-1980, the curve has a correlation coefficient of 0.84 and indicates maximum production at a SSB level of 175,000 tons. Including the available data from 1962 and 1963 in the calculation changes the curve to give maximum recruitment at a SSB level of about 325,000 tons, however, with a smaller correlation coefficient (0.67).

The second curve further indicates that a full analysis could lead to a higher SSB level for the production of maximum recruitment if the earlier data could be fully evaluated.

It is, therefore, suggested that the level of 175,000 tons indicated by the 1964-80 curve should serve as a preliminary minimum target level for the management of the stock pending further analysis which is expected to result in a higher level of SSB required to maximize recruitment.

15. REFERENCES

DOUBLEDAY, W. G. (ed.), 1981. Manual on Groundfish Surveys in the Northwest Atlantic. NAFO Sci. Coun. Studies, 2: 1-155.

HORSTED, Sv.Aa., 1978. Subarea 1 Cod: Data for 1976-77 and first months of 1978, and estimates of biomass and yield, 1978-80. ICNAF Res. Doc. 78/VI/44, Ser. 5206 (D. c.3).

1981. Subarea 1 Cod: Data for 1980 and Estimate of Stock and Yield for 1980-84. NAFO SCR Doc. 81/VI/48 (rev.).

1982. Status of Stubarea 1 Cod and Estimates of Stock and Yield for 1982-85. NAFO SCR Doc. 82/VI/50 (Revised), Ser. N540.

SMIDT, E. (ed.), 1982. Danish Research Report for 1981. NAFO SCS Doc.82/VI/16, Ser. N568.

Table 1. Nominal catch (tonnes x 10^{-3}) of cod in Subarea 1, 1981. 7678 tonnes reported for Div. 1NK for Greenland vessels (tonnage category 0 - 3) have been allocated on divisions by the author as follows: Div. 1C 540 tonnes, 1D 3800, 1E 2225 and Div. 1F 1113 tonnes. Catches reported as month NK have been allocated on months in each division in the same proportion as catches reported by month and division. Pound - net catches are estimated as being 3/4 of total miscellaneous - gear catches in June - September for Divisions 1B-F plus in May for Div. 1D.

Division	Otter trawl (offshore)	Pound net (inshore)	Miscellaneous gear (mainly inshore)	Total
1A	-	-	281	281
1B	-	1759	1051	2810
1C	4289	2470	1669	8428
1D	4701	4981	4938	14620
1E	4508	6755	3181	14444
1F	255	6295	6323	12873
Total SA 1	13753	22260	17443	53456

Table 2. Nominal catch (tonnes x 10^{-3}) of cod in Subarea 1, 1982 (provisional figures). 7973 tonnes reported for Div. 1 NK for Greenland vessels (tonnage category 0 - 3) have been allocated on divisions by the author as follows: Div. 1C 440 tonnes, 1D 4000, 1E 2400 and Div. 1F 1133 tonnes. Catches reported as month NK have been allocated on months in each division in the same proportion as catches reported by month and division. Pound - net catches are estimated as being 3/4 of total miscellaneous - gear catches in June - September for Divisions 1B - 1F plus in May for Div. 1D.

Division	Otter trawl (offshore)	Pound net (inshore)	Miscellaneous gear (mainly inshore)	Total
1A	-	-	204	204
1B	133	1137	1314	2584
1C	6199	1450	1896	9545
1D	10945	3858	4739	19542
1E	11242	4046	2881	18169
1F	691	1558	3188	5437
Total SA 1	29210	12049	14222	55481

Table 3. Effort (hours fished), catch of cod, and catch per unit effort for the Greenland trawlers (500-999 GRT class) in 1980-82. Only figures for directed cod fishing are included.

	1980			1981			1982		
Division	tonnes	hours	kg/hour	tonnes	hours	kg/hour	tonnes	hours	kg/hour
1B	1789	727	2461	0	0	-	133	100	1330
1C	1646	1513	1088	4254	1279	3326	4023	1937	2077
1D	1768	1983	892	4701	1856	2533	7189	4084	1760
1E	1395	1092	1277	4381	952	4602	9350	3221	2903
1F	19	31	613	0	5	0	11	17	647
Total SA 1	6617	5346	1238	13336	4092	3259	20706	9359	2212
East Greenland	226	246	919	8	16	500	5	8	625

Table 4. 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 1980-82. Only figures for direct cod fishing are included.

1980

	I		II		III		IV	
Division	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

1981

	I		II		III		IV	
Division	hours	c.p.u.e.	hours	c.p.u.e.	hours	c.p.u.e.	hours	c.p.u.e.
1C	1011	3430	26	3846	-	-	242	2835
1D	358	2835	165	3400	119	824	1214	2493
1E	118	5500	662	4734	38	737	134	4254
1F	-	-	-	-	-	-	5	0
Total SA 1	1487	3451	853	4449	157	803	1595	2685
East Greenland	-	-	-	-	-	-	16	500

1982

	I		II		III		IV	
Division	hours	c.p.u.e.	hours	c.p.u.e.	hours	c.p.u.e.	hours	c.p.u.e.
1C	1009	2528	277	2498	101	713	550	1287
1D	1050	2095	334	3793	886	1428	1814	1354
1E	1168	2541	1286	3650	181	1591	586	2391
1F	-	-	-	-	17	647	-	-
Total SA 1	3227	2392	1897	3507	1185	1381	2950	1548
East Greenland	-	-	-	-	8	625	-	-

Table 5. Effort (hours fished) and catch per unit effort (kg) of cod and of all species by quarter of the year for trawlers of the Federal Republic of Germany, Subarea 1, 1982. (Provisional figures.)

Quater	I			II			III			IV			Total		
Div.	hours	cpue cod	cpue all sp.	hours	cpue cod	cpue all sp.	hours	cpue cod	cpue all sp.	hours	cpue cod	cpue all sp.	hours	cpue cod	cpue all sp.
1C	-	-	-	-	-	-	18	0	4778	1417	1495	2553	1435	1477	2581
1D	-	-	-	-	-	-	124	24	3613	2526	1414	2775	2650	1349	2814
1E	-	-	-	13	385	5077	265	392	2811	1403	1167	2914	1681	1039	2914
1F	49	408	4306	83	277	4747	150	33	3973	789	801	2290	1071	635	3260
SA 1	49	408	4306	96	292	4792	557	201	3366	6135	1297	2772	6837	1188	2860
Catch in tons	-	20	211	-	28	460	-	112	1875	-	7959	17005	-	8119	19551 t

Table 6. 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 their effort raised to total effort for Subarea 1, 1980-82.

Year	Grl. trawlers' effort (hours)	Grl. trawlers' catch of cod (tonnes and nos. x 10^{-3})	Grl. trawlers' c.p.u.e. (kg/hour and nos./hour)	Total SA 1 catch	Total effort (hours)	
1980	5346	6617	1238	54803	44276	catch by weight
1981	4092	13336	3259	53456	16402	
1982	9359	20706	2212	55481	25077	
1980	5346	2419	452	22315	49316	catch by number of fish
1981	4092	7663	1873	30195	16123	
1982	9359	10226	1093	26994	24705	

Table 7. Coastal and inshore nominal catches of cod (tonnes) by Greenland fishermen 1979-82. Catches are not reported by gear and a minor part of the catch may be by otter trawl offshore. A part of the catch is not reported by division but has been allocated by the author (see text to Tables 1 and 2).

Division	1979	1980	1981	1982
1A	420	719	281	204
1B	1848	2303	2810	2451
1C	2147	2269	4139	3346
1D	10504	7781	9919	8597
1E	11117	10647	9936	6927
1F	16319	14852	12618	4746
Total SA 1	42355	38571	39703	26271

Table 8. Mean length (total length, cm below) and mean weight (kg, round fresh) by age groups of cod in Danish offshore samples from Subarea 1, 1982. Figures are given only for age groups represented by at least five fish in the sample. OTB = bottom otter trawl.

Age group	Div.	1D	1D	1E	1C	1E	1D	1D	1E	1D	1D	1C	1B	1B	1D	1E	1E
	Month	JAN	JAN-FEB	FEB	MAR	MAR	MAR	MAR	MAY	MAY	SEP	SEP	SEP	NOV	NOV	DEC	DEC
	Gear	OTB	OTB	OTB	OTB	OTB	OTB	OTB	OTB	OTB	OTB	OTB	OTB	OTB	OTB	OTB	OTB
III	l	-	-	-	-	-	-	40.0	-	-	-	-	47.3	45.0	46.1	-	-
	w	-	-	-	-	-	-	0.6	-	-	-	-	1.1	0.8	1.0	-	-
IV	l	-	43.8	-	48.5	-	-	48.9	46.0	-	48.3	50.3	46.7	49.1	50.0	49.9	48.4
	w	-	0.7	-	1.0	-	-	1.1	0.6	-	1.1	1.3	1.0	1.1	1.3	1.6	1.1
V	l	56.2	53.7	56.8	53.8	62.4	54.5	54.6	54.4	56.1	56.8	58.0	58.6	62.0	61.1	60.2	57.8
	w	1.8	1.6	2.0	1.4	2.4	1.6	1.4	1.1	1.6	1.8	1.9	2.0	2.3	2.3	2.1	2.0
VI	l	64.3	61.7	63.3	63.0	66.9	60.8	62.8	62.6	64.4	66.1	65.7	69.5	73.0	69.4	70.8	67.3
	w	2.7	2.4	2.7	2.4	2.7	2.1	2.1	1.8	2.4	2.7	2.7	3.1	3.7	3.3	3.2	3.1
VII	l	72.4	66.2	71.5	68.5	71.9	60.7	67.8	72.6	71.5	71.9	74.2	75.4	79.0	76.1	73.9	77.5
	w	3.9	2.9	4.2	3.1	3.5	2.3	2.6	2.9	3.2	3.5	3.8	4.0	5.1	4.5	3.8	4.8
VIII	l	80.6	68.5	75.7	-	78.0	72.5	74.9	69.6	77.4	77.3	80.4	81.2	88.1	82.1	79.8	-
	w	5.5	3.6	5.1	-	4.5	4.1	3.5	2.6	3.9	4.1	5.0	5.1	7.1	5.6	4.6	-
IX	l	87.0	78.4	83.8	-	88.9	66.2	70.9	71.5	75.3	82.1	84.2	84.8	90.1	89.8	78.6	-
	w	7.1	5.2	6.7	-	6.9	2.8	3.0	2.8	3.7	5.1	5.9	5.7	7.7	7.4	4.9	-
X	l	-	-	99.3	-	-	-	-	-	-	87.3	-	-	-	94.6	-	-
	w	-	-	12.5	-	-	-	-	-	-	6.5	-	-	-	7.7	-	-
XI	l	98.8	-	101.8	-	99.8	-	85.5	-	-	94.9	101.2	-	101.4	-	-	-
	w	9.9	-	14.3	-	9.7	-	4.8	-	-	8.2	11.0	-	10.7	-	-	-
Overall $\bar{l}$		71.1	55.4	61.6	54.3	75.9	55.4	55.6	56.3	59.2	60.7	61.2	61.7	66.0	63.7	63.2	63.2
Overall $\bar{w}$		4.0	1.8	2.75	1.5	4.4	1.7	1.5	1.2	1.9	2.3	2.3	2.4	3.0	2.4	2.5	2.6

Table 9. Mean length (total length, cm below) and mean weight (kg, round fresh) by age group of cod in Danish coastal and inshore samples from Subarea 1, 1982. Figures are given only for age groups represented by at least five fish in the sample. (FPN = pound net, LHP = hand line.)

Age group	Div. month Gear	ID JUN FPN	ID JUN FPN	IB JUL FPN	IB AUG LHP	IE AUG FPN
III	l	41.6	-	43.4	-	-
	w	0.7	-	0.9	-	-
II	l	42.1	42.0	48.4	-	52.7
	w	0.8	0.6	1.2	-	1.3
V	l	49.3	56.3	56.2	61.5	56.9
	w	1.2	1.7	1.9	2.0	1.7
VI	l	48.0	74.3	60.3	-	63.3
	w	1.0	4.3	2.3	-	2.3
VII	l	-	78.3		78.9	69.3
	w	-	5.3		4.2	3.1
VIII	l	-	-		85.9	72.7
	w	-	-		5.2	3.6
IX	l	-	-		94.0	81.4
	w	-	-		6.7	4.6
X	l	-	-		-	-
	w	-	-		-	-
XI	l	-	-		-	-
	w	-	-		-	-
Overall $\bar{l}$		47.5	59.0	46.3		60.0
Overall $\bar{w}$		1.1	2.2	1.1		2.0

TABLE 10. Number of cod per age group and quarter of the year caught in the offshore area of Subarea 1, 1982.

Age group	QUARTER 1	2	3	4	TOTAL
III	1	-	2	280	283
IV	8	17	16	219	260
V	2061	2598	1537	3947	10143
VI	184	331	279	227	1021
VII	728	126	80	374	1308
VIII	213	44	21	141	419
IX	88	24	28	101	241
X	10	2	2	12	26
XI+	54	3	5	18	80
Total	3347	3145	1970	5319	13781

TABLE 11. Nominal catch of cod in Subarea 1, 1982, by quarter of the year.

Quarter		1	2	3	4
Offshore catch	tonnes	7812	6694	1772	12932
	%	26.7	22.9	6.1	44.3
Coastal and inshore catch	tonnes	949	3331	13813	8178
	%	3.6	12.7	52.6	31.1

Table 12. Mean weight (kg, round fresh) of Subarea 1 cod, 1982, as obtained from samples listed in Table 7 and 8. Weighting factors to obtain weighted annual mean are the catches listed in Table 10. For comparison the figures obtained in 1980 and 1981 are listed together with those used for forecast for 1982 and subsiquent years' catches in assessments carried out in 1982.

Age group	Unweighted mean by quarter 1	2	3	4	Weighted mean by quarter 1982	1981	1980	Forecast weights 1982
III	0.60	-	1.10	0.90	0.90	-	1.10	0.70
IV	0.93	0.60	1.13	1.28	1.22	1.23	1.27	1.24
V	1.74	1.35	1.90	2.18	1.84	1.94	2.08	1.97
VI	2.44	2.10	2.83	3.33	2.63	2.72	3.13	2.85
VII	3.21	2.85	3.77	4.55	3.59	3.75	4.35	3.95
VIII	4.38	3.25	4.73	5.77	4.75	4.68	6.41	5.10
IX	5.28	3.25	5.57	6.67	5.69	-	4.82	6.40
X	12.50	-	6.50	7.70	9.60	-	-	7.80
XI	9.68	-	9.50	10.70	9.92	7.39	-	9.00
III	-	0.70	0.90	-	0.86	-	0.74	
IV	-	0.70	1.25		1.14	1.20	1.18	
V	-	1.45	1.86		1.78	1.75	2.03	
VI	-	2.65	2.30		2.36	2.61	2.67	
VII	-	5.30	3.65		3.97	2.83	4.01	as above
VIII	-	-	4.40		4.40	4.05	5.07	
IX	-	-	5.65		5.65	4.21	7.86	

Table 13. Number of cod (in thousands) per age group in nominal catches in Subarea 1, 1981 and 1982, and mean weight of fish in landings.

Age group	1981			1982		
	1A-1D	1E-1F	SA 1	1A-1D	1E-1F	SA 1
III	12	-	12	1072	132	1204
IV	13252	3612	16864	1089	121	1210
V	2732	3642	6374	10882	7078	17960
VI	1605	786	2391	532	2433	2965
VII	394	659	1053	1217	861	2078
VIII	297	3085	3382	485	322	807
IX	7	38	45	335	275	610
X	39	26	65	31	14	45
XI	-	1	1	54	34	88
XII	1	-	1	8	1	9
XIII	-	-	-	3	1	4
XIV	-	-	-	1	-	1
XV+	-	7	7	2	11	13
Total	18339	11856	30195	15711	11283	26994
Nominal catch(tonnes)	26139	27317	53456	31875	23606	55481
Calculated mean weight (kg, round fresh)	1.43	2.30	1.77	2.03	2.09	2.06

Table 14. Number of cod (in thousands) per age in nominal catches in Subarea 1, 1982, grouped in offshore and inshore (coast and fiords) catches, the latter being maximum possibly including some offshore catches taken by gears other than otter trawl.

Age group	Offshore catch	Inshore catch	Total
III	283	921	1204
IV	260	950	1210
V	10143	7817	17960
VI	1021	1944	2965
VII	1308	770	2078
VIII	419	388	807
IX	241	369	610
X	26	19	45
XI+	80	35	115
Total (nos)	13781	13213	26994
Total (tonnes) reported	29210	26271	55481
Calculated weight with figures in table 12	31020	27756	58776

Table 15. Subarea 1 cod: (A) mean weight-at-age, and (B) catch at age, 1965-82.

WEIGHT AT AGE (A)

Age	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	0.580	0.580	0.580	0.580	0.580	0.580	0.580	0.580	0.580
4	1.280	1.280	1.280	1.280	1.280	1.280	1.280	1.280	1.280
5	1.720	1.720	1.720	1.720	1.720	1.720	1.720	1.720	1.720
6	2.510	2.510	2.510	2.510	2.510	2.510	2.510	2.510	2.510
7	3.520	3.520	3.520	3.520	3.520	3.520	3.520	3.520	3.520
8	4.660	4.660	4.660	4.660	4.660	4.660	4.660	4.660	4.660
9	5.070	5.070	5.070	5.070	5.070	5.070	5.070	5.070	5.070
10	5.680	5.680	5.680	5.680	5.680	5.680	5.680	5.680	5.680
11	5.370	5.370	5.370	5.370	5.370	5.370	5.370	5.370	5.370
12	8.650	8.650	8.650	8.650	8.650	8.650	8.650	8.650	8.650
13	9.580	9.580	9.580	9.580	9.580	9.580	9.580	9.580	9.580
14	9.600	9.600	9.600	9.600	9.600	9.600	9.600	9.600	9.600
15	9.600	9.600	9.600	9.600	9.600	9.600	9.600	9.600	9.600

Age	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	0.650	0.710	0.850	0.740	0.650	0.720	0.870	0.830	0.830
4	0.990	1.300	1.210	1.238	1.150	1.230	1.330	1.110	1.110
5	1.680	1.850	2.030	1.714	2.180	2.020	2.060	1.700	1.700
6	2.770	2.670	2.710	2.118	2.890	2.710	3.000	2.350	2.350
7	3.840	3.990	3.420	3.614	3.690	3.780	4.280	3.200	3.200
8	4.720	4.430	4.580	4.580	4.580	4.900	5.840	4.300	4.300
9	5.340	5.060	4.490	4.812	5.060	6.400	6.400	6.500	6.500
10	5.340	5.600	5.880	5.600	5.600	7.800	7.800	9.020	9.020
11	5.480	7.920	7.020	6.000	6.000	9.000	9.000	9.320	9.320
12	5.390	5.160	6.460	6.600	6.600	9.700	9.700	9.320	9.320
13	8.700	6.110	5.140	7.700	7.700	10.200	10.200	9.320	9.320
14	10.190	8.510	9.030	9.900	9.000	10.400	10.400	9.320	9.320
15	10.740	10.110	12.870	10.500	10.500	10.500	10.500	9.320	9.320

CATCH AT AGE (B)

Age	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	14163	1530	1727	3764	662	49	272	15	131
4	56928	7872	15091	7976	12399	2768	2519	10039	2302
5	52451	62130	30457	36670	8709	10342	10172	9786	16378
6	9055	39941	61848	29824	27433	6465	9283	12020	3065
7	9890	5915	24562	34591	14664	13985	5237	4081	2605
8	15395	4955	2700	10005	12411	4365	9158	2550	1406
9	2849	6912	1996	1725	4784	2810	2077	2660	1203
10	566	1289	5237	833	513	1280	1841	624	552
11	488	283	352	2348	237	149	953	954	165
12	1911	130	93	187	704	85	78	709	237
13	75	981	166	37	41	201	51	130	93
14	37	139	453	42	62	27	134	57	37
15+	276	247	85	303	8	41	56	122	44
SumN	164084	132324	144767	128305	82627	42567	41831	43747	28218
SumW	341113	320103	376298	350076	245139	132786	134381	117359	68447

Age	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	343	275	10760	634	287	286	2999	12	1204
4	1079	3595	4026	46649	5494	10656	4513	16864	1210
5	2384	2677	2243	6053	30039	12505	4580	6374	17960
6	6938	1803	1216	1515	1004	18970	1978	2391	2965
7	1135	5855	302	618	509	709	8014	1053	2078
8	1806	1388	1594	425	83	400	125	3382	807
9	800	619	139	446	41	78	60	45	610
10	194	291	148	168	13	52	24	65	45
11	177	84	53	79	7	55	1	1	88
12	152	38	27	88	7	80	16	1	9
13	272	9	17	22	7	5	3	0	4
14	147	12	14	1	1	5	1	0	1
15+	11	10	26	1	1	16	2	7	13
SumN	15438	16656	20565	56699	37493	43817	22316	30195	26994
SumW	48477	50027	32789	80316	77591	97068	59808	54060	55405

Table 16. Strata areas in square nautical miles off West Greenland (territorial waters excluded).

Depth zone (m)	Stratum No.-Division 1 - 1B	2 - 1C	3 - 1C	5 - 1D	6 - 1E	7 - 1F	SA 1 Total
0-100	865	593	598	1,475	276	-	-
101-200	1,256	1,574	1,902	875	1,662		
0-200	2,121	2,167	2,500	2,350	1,938	2,568	13,644
201-300	297	259	708	628	464	-	-
301-400	209	54	280	390	278	-	-
201-400	506	313	988	1,018	742	971	4,538
401-500	149	122	156	176	33	-	-
501-600	215	293	78	83	24	-	-
401-600	364	415	234	259	57	353	1,682
Total	2,991	2,895	3,722	3,627	2,737	3,892	19,864

Strata boundaries:	Latitudes	Longitudes
1 = Div. 1B	66°15'-67°00'N	57°00'W
2 = Div. 1C	65°30'-66°15'N	57°00'W
3 = Div. 1C	64°15'-65°30'N	55°00'W
(4 = Div. 1C+D	63°45'-65°30'N	55°00'-57°00'W, not included in survey area)
5 = Div. 1D	62°40'-64°15'N	55°00'W
6 = Div. 1E	60°45'-62°30'N	53°00'W
7 = Div. 1F	59°00'-60°45'N	44°00-50°00'W

Due to recent revisions the given areas may not correspond to those given in the NAFO Survey Manual.

Table 17. West Greenland (Subarea 1) cod, age composition of trawlable biomass (Nos. x 10^{-3}) based on R/V "Walther Herwig" survey results Nov./Dec. 1982.

Year-class	Age	Stratum No.-Division 1 - 1B +2 - 1C	3 - 1C	5 - 1 D	1B - D Total	6 - 1E	7 - 1E	1E - F Total	SA 1 Total
81	1	60	-	16	76	65	19	84	160
80	2	351	259	90	700	15	7	22	722
79	3	299	3,387	18,862	22,550	8,951	5,191	14,141	36,691
78	4	14	278	4,151	4,442	2,854	3,523	6,379	10,821
77	5	10	86	21,238	21,335	6,214	11,241	17,454	38,789
76	6	-	11	3,903	3,913	2,613	7,091	9,705	13,618
75	7	-	2	1,082	1,084	627	3,046	3,670	4,754
74	8	-	-	270	270	115	661	777	1,047
73	9	-	-	335	335	227	1,443	1,671	2,006
72	10	-	-	30	30	22	74	96	126
71	11	-	-	75	75	5	5	10	85
70	12	-	-	70	70	-	-	-	70
69	13	-	-	-	-	-	-	-	-
68	14	-	-	-	-	-	13	13	13
	NK	-	-	38	38	67	32	99	137
Total		734	4,023	50,161	54,918	21,775	32,346	54,121	109,039

Table 18. Subarea 1 cod: percent maturity at age as running average over 5 years of each individual year's data.

Age	≤1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
3	1	1	1	1	1	1	1	0	0	1	1	1
4	4	4	4	4	3	3	2	2	1	2	3	4
5	10	10	11	11	10	9	7	6	4	6	8	10
6	22	25	28	30	28	26	22	18	14	18	22	26
7	43	49	54	59	57	55	50	45	40	44	48	52
8	67	72	77	82	82	81	78	75	72	74	76	78
9	84	87	90	93	94	94	93	92	91	91	92	92
10	93	95	96	98	98	98	98	98	98	98	98	98
11	97	98	99	99	99	100	100	99	99	99	99	99
12	99	99	100	100	100	100	100	100	100	100	100	100
13+	100	100	100	100	100	100	100	100	100	100	100	100

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	≥1983
3	2	2	2	1	1	1	1	1	1	1	1	1
4	5	5	5	4	4	3	3	4	4	4	3	3
5	13	14	14	13	13	12	13	14	15	16	16	15
6	30	34	35	35	35	36	39	43	46	48	50	48
7	56	62	64	65	67	69	72	76	79	81	84	83
8	80	83	85	87	88	90	91	93	94	95	96	96
9	93	94	95	96	96	97	98	98	99	99	99	99
10	98	98	98	99	99	99	99	100	100	100	100	100
11	99	99	99	100	100	100	100	100	100	100	100	100
12	100	100	100	100	100	100	100	100	100	100	100	100
13+	100	100	100	100	100	100	100	100	100	100	100	100

Table 19. **Subarea 1 cod. VPA. Resultant F-values.**

FISHING MORTALITY

Age	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	0.075	0.007	0.026	0.052	0.011	0.001	0.004	0.001	0.013
4	0.177	0.058	0.097	0.171	0.254	0.062	0.099	0.192	0.261
5	0.325	0.298	0.328	0.359	0.286	0.348	0.337	0.675	0.542
6	0.388	0.453	0.562	0.638	0.514	0.366	0.624	0.882	0.475
7	0.553	0.506	0.600	0.775	0.824	0.579	0.612	0.671	0.506
8	0.455	0.642	0.488	0.563	0.776	0.674	1.059	0.747	0.552
9	0.633	0.404	0.628	0.721	0.623	0.420	0.880	1.204	1.102
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	0.341	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
$\bar{F}_{(5-8)}$	0.430	0.475	0.495	0.587	0.600	0.492	0.658	0.744	0.519

Age	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	0.022	0.014	0.058	0.016	0.008	0.010	0.033	0.002	
4	0.144	0.348	0.309	0.403	0.199	0.445	0.218	0.279	0.280
5	0.473	0.625	0.382	1.072	0.493	0.926	0.350	0.541	0.540
6	0.480	0.836	0.677	0.496	0.513	0.695	0.362	0.319	0.540
7	0.343	1.077	0.334	0.987	0.326	0.923	0.783	0.355	0.540
8	0.871	1.004	1.128	1.219	0.348	0.491	0.426	1.024	0.540
9	0.768	0.943	0.256	1.376	0.357	0.691	0.131	0.283	0.540
10	0.546	0.775	0.662	0.597	0.121	1.166	0.502	0.216	0.540
11	1.150	0.517	0.323	1.018	0.045	1.145	0.057	0.036	0.540
12	1.627	0.910	0.330	1.577	0.229	1.090	1.577	0.079	0.540
13	1.415	0.383	1.820	0.522	0.511	0.269	0.102	0.032	0.540
14	2.110	0.199	2.307	0.511	0.041	0.934	0.083	0.005	0.540
15	0.350	0.350	0.300	0.820	0.820	0.820	0.630	0.550	0.540
$\bar{F}_{(5-8)}$	0.542	0.886	0.630	0.944	0.420	0.759	0.480	0.560	0.540

Table 20. **Subarea 1 cod. VPA. Resultant stock size in numbers x 10^{-3}. The table corresponds to F-values in** Table 19.

Age	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	225253	244171	77237	86361	69133	39653	85756	14849	12126
4	385655	154750	179582	55740	60755	50649	29340	63303	10990
5	207470	264474	119595	133419	38451	38589	38970	21750	42788
6	31540	122736	160687	70553	76306	23651	22305	22769	9065
7	26023	16657	60759	71332	29038	35536	12772	9305	7341
8	47141	11660	7820	25965	25587	9923	15512	5395	3704
9	6776	23290	4777	3738	11517	9175	3939	4191	1991
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
TOT. NO's	939383	844947	625443	455201	315205	214064	217075	146702	90685
SP. ST. NO's*	109053	97283	92025	74405	64523	50033	42454	31641	22016
TOT. BIOM.	1480691	1387801	1249732	967805	687072	475479	399054	297864	189889
SSB		340234	325466	287761	258251	202099	172258	118720	77812

Age	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
3	18496	22738	220653	45994	44166	34512	106072	7357	150000	75000
4	8871	13408	16610	154251	33530	32474	25323	76011	5441	110090
5	6928	6291	7749	9981	84431	22506	17032	16671	47069	3367
6	20369	3535	2757	4331	2798	42212	7300	9832	7942	22457
7	4388	9817	1193	1091	2053	1305	16414	3957	5566	3605
8	3448	2426	2603	665	317	1154	404	5842	2162	2526
9	1661	1124	692	656	153	174	550	205	1634	981
10	515	600	341	417	129	83	68	376	121	742
11	286	233	216	137	179	89	20	32	236	55
12	207	71	108	122	39	133	22	15	24	107
13	395	32	22	60	20	24	35	4	11	11
14	182	75	17	3	28	9	14	25	3	5
15	19	17	48	1	1	21	3	10	19	1
TOT. NO's	65765	60366	253008	217710	167844	134496	173257	120336	220228	218947
SP. ST. NO's *	17820	13411	9346	10568	15826	25541	22040	19921	21948	23185
TOT. BIOM.	141785	116825	255059	265895	271682	239652	260538	185224	270771	280083
SSB *	65958	52489	26630	24389	38523	70797	80266	58694	61754	66383

* FROM MATURITY OGIVE

Table 21. Subarea 1 cod: VPA results.

	FISHING MORTALITY																	
AGE	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	M
3	.0754	.0073	.0262	.0517	.0111	.0014	.0037	.0012	.0119	.0219	.0138	.0561	.0160	.0065	.0055	.0253	.0067	.0093	0.30
4	.177	.058	.097	.171	.254	.062	.099	.192	.262	.135	.253	.301	.386	.197	.367	.118	.204	.096	0.20
5	.325	.298	.328	.359	.286	.348	.337	.672	.542	.475	.572	.389	1.016	.463	.915	.266	.243	.348	0.20
6	.388	.453	.562	.638	.514	.366	.624	.882	.471	.480	.843	.575	.512	.459	.621	.354	.222	.175	0.25
7	.553	.506	.600	.775	.824	.879	.612	.671	.506	.338	1.078	.339	.704	.341	.745	.628	.343	.324	
8	.455	.642	.488	.563	.776	.674	1.059	.747	.552	.872	.976	1.130	1.260	.196	.526	.291	.642	.514	
9	.633	.404	.628	.721	.623	.420	.880	1.204	1.101	.767	.944	.243	1.382	.384	.302	.144	.171	.236	
10	.455	.718	.659	.631	.520	.354	.576	.789	.980	.545	.773	.664	.553	.122	1.372	.151	.243	.272	
11	.631	.461	.463	.766	.330	.295	.520	.728	.527	1.150	.516	.322	1.025	.041	1.165	0	.009	.641	
12	.527	.361	.285	.512	.589	.249	.262	1.034	.421	1.627	.910	.329	1.563	.231	.914	1.690	.101	.107	
13	.193	.610	1.204	.185	.210	.350	.245	1.001	.370	1.415	.383	1.820	.520	.500	.273	.076	0	.768	
14	.086	.699	.687	1.408	.569	.220	.444	.506	.991	2.110	.199	2.307	.513	.041	.892	.084	0	.625	
15+	.46	.54	.62	.80	.55	.35	.35	.35	.35	.35	.35	.30	.82	.82	.82	.63	.54	.811	
$\bar{F}$(5-8)	.430	.475	.495	.584	.600	.492	.658	.743	.518	.541	.867	.608	.873	.365	.702	.385	.363	.340	
																			1983
	STOCK SIZE IN NUMBERS (X 10^{-3})																		
3	225 254	244 181	77 241	86 366	69 131	39 803	85 760	14 813	12 836	18 292	23 264	227 869	46 286	51 633	60 523	139 095	19 654	150 000	75 000
4	385 656	154 751	179 582	55 741	60 755	50 646	29 445	63 299	10 961	9 397	13 257	16 999	159 596	33 746	38 004	44 591	100 474	14 550	110 090
5	207 470	264 475	119 595	133 419	38 453	38 591	38 967	21 836	42 785	6 904	6 721	7 626	10 299	88 796	22 683	21 548	32 440	67 079	10 821
6	31 540	122 737	160 682	70 553	76 306	23 653	22 308	22 767	9 134	20 366	3 516	3 107	4 230	3 057	45 772	7 441	13 523	20 825	38 789
7	26 023	16 657	60 759	71 332	29 038	35 536	12 773	9 307	7 339	4 442	9 815	1 178	1 362	1 975	1 503	19 162	4 067	8 437	13 618
8	47 141	11 660	7 820	25 965	25 587	9 923	15 516	5 396	3 705	3 447	2 468	2 601	654	525	1 093	556	7 960	2 247	4 754
9	6 776	23 290	4 777	3 738	11 517	9 175	3 939	4 191	1 992	1 662	1 123	724	655	144	336	503	323	3 262	1 047
10	1 735	2 802	12 105	1 986	1 415	4 812	4 694	1 272	979	516	601	340	442	128	77	193	339	212	2006
11	1 163	857	1 064	4 880	823	655	2 629	2 054	450	286	234	216	136	198	88	15	130	207	126
12	5 216	482	421	522	1 766	434	380	1 218	772	267	71	108	122	38	148	21	12	100	85
13	480	2 399	262	246	243	763	264	228	337	395	32	22	61	20	24	46	3	8	70
14	506	303	1 015	61	160	154	419	161	65	182	75	17	3	28	9	14	33	2	3
15+	426	361	119	398	12	70	96	209	75	19	17	48	1	1	21	3	10	21	10
STOCK NO	939 386	844 955	625 442	455 207	315 209	214 215	217 190	146 751	91 430	66 115	61 194	260 855	223 847	180 285	170 281	233 188	178 968	266 955	256 419
SP. ST. NO*	109 053	97 283	92 025	74 405	64 523	50 033	42 462	31 652	22 052	17 874	13 496	9558	10 934	16 715	27 838	26 280	27 600	36 110	44 518
STOCK BIOM.	1 481	1 388	1 250	968	657	476	399	298	190	142	118	262	274	288	277	338	269	367	386
SSB *	404	340	325	288	258	202	172	119	78	66	53	29	25	41	77	94	79	102	137
(1000 t)																			
* FROM MATURITY OGIVE																			

Table 22. Subarea 1 cod: values used for regression shown in Fig. 9 and 10.

Year	Total effort	(A) $F_{(5-8)}$	(B) $F_{(5-8)}$	CPUE (t/hr)	(A) Exploit. biom.	(B) Exploit. biom.
1975	60.721	.867	.886	.789	93.1	94.2
1976	53.173	.608	.630	.626	58.9	58.8
1977	56.757	.873	.944	1.293	145.1	142.1
1978	22.084	.365	.420	3.327	235.6	230.0
1979	41.704	.702	.759	2.378	210.8	198.4
1980	44.276	.385	.480	1.238	188.5	153.7
1981	16.402	.363	.560	3.259	199.1	139.3
1982	25.077	.340	.540	2.212	234.3	143.5

(A) $F_{(5-8)}$ 1982 from survey results = 0.34.

(B) $F_{(5-8)}$ 1982 from catch curve = 0.54.

Table 23. Subarea 1 cod: parameters used for projection of catch and stock size

Age	Stock No. 1983	Rel. M	$\bar{W}$ (kg)	% Mature	Rel. F		Recruits at age 3 x 10^{-6}
3	75,000	1.50	0.83	1	0.039	1984	20
4	110,090	1.00	1.11	3	0.52	1985	200
5	10,821	1.00	1.70	15	1.0	1986	20
6	38,789	1.25	2.35	48	1.0		
7	13,618	1.25	3.20	83	1.0		
8	4,754	1.25	4.30	96	1.0		
9	1,047	1.25	6.50	99	1.0		
10	2,006	1.25	9.02	100	1.0		
11	126	1.25	9.32	100	1.0		
12	85	1.25	9.32	100	1.0		
13	70	1.25	9.32	100	1.0		
14	3	1.25	9.32	100	1.0		
15+	10	1.25	9.32	100	1.0		

Table 24. Subarea 1 cod: projection of spawning stock biomass at the beginning of each year and catch during the year for various levels of F and for a constant catch of 62,000 tonnes.

	Stable catch 62,000 t	$F_{0.1}$ = 0.5 x F_{81}	F_{max} ≃ F_{82}	$F = F_{81}$	$F = 1.25 \times F_{81}$	F = 0.6
1983						
SSB	137	137	137	137	137	137
F	.294	.294	.294	.294	.294	.294
CATCH	62	62	62	62	62	62
1984						
SSB	157	157	157	157	157	157
F	.240	.184	.348	.363	.454	.60
CATCH	62	49	86	89	107	133
1985						
SSB	194	204	174	172	158	137
F	.236	.184	.348	.363	.454	.60
CATCH	62	52	80	81	91	100
1986						
SSB	226	250	184	179	151	116
F	.204	.184	.348	.363	.454	.60
CATCH	62	61	86	88	94	100
1987						
SSB	247	275	180	174	139	98

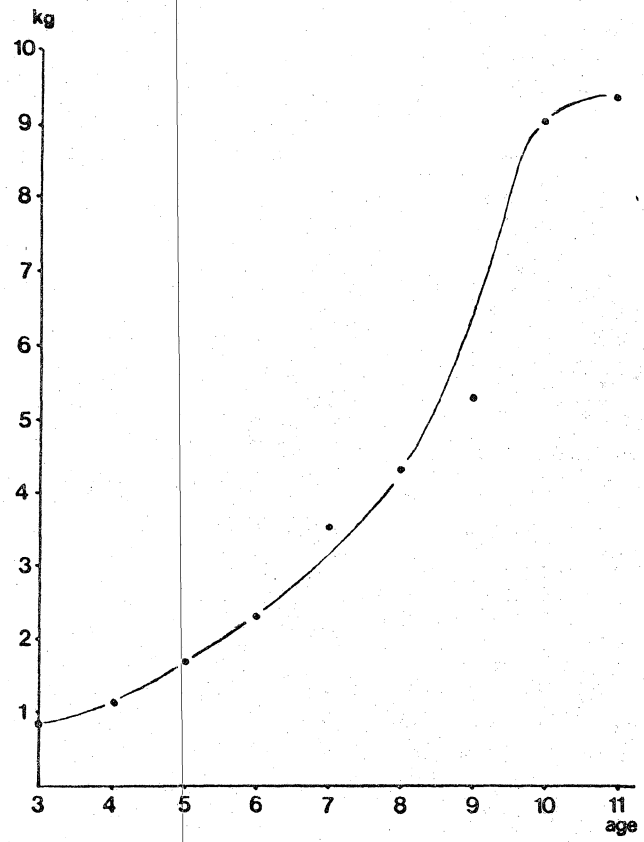


Fig. 1. Subarea 1 cod, 1982. Weighted mean weight by age for ages 3-11, see Table 12 and text in Section 4.

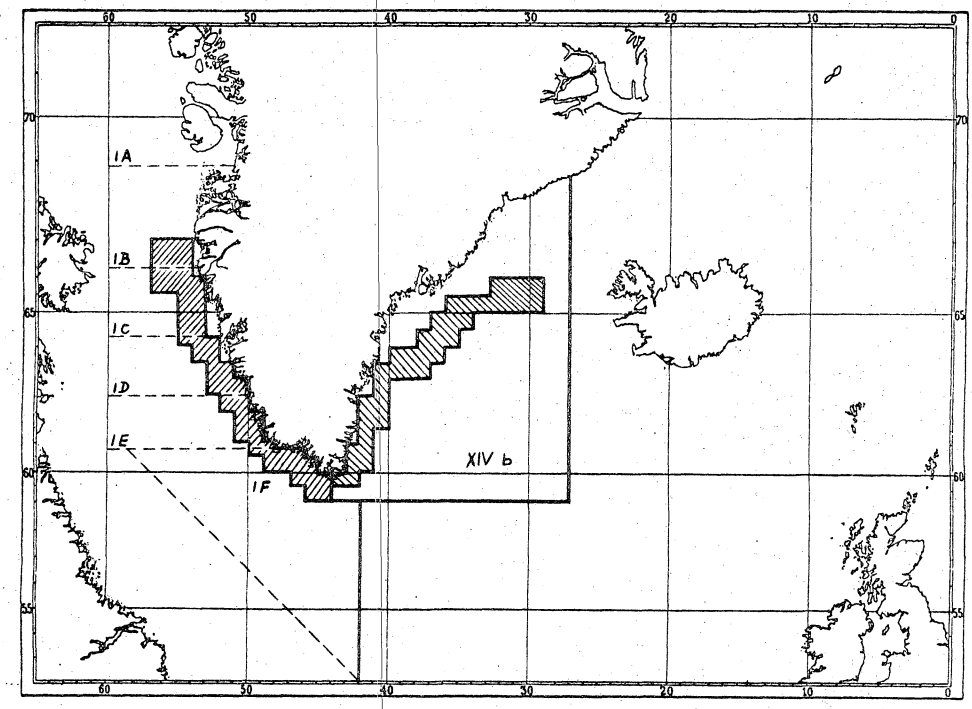
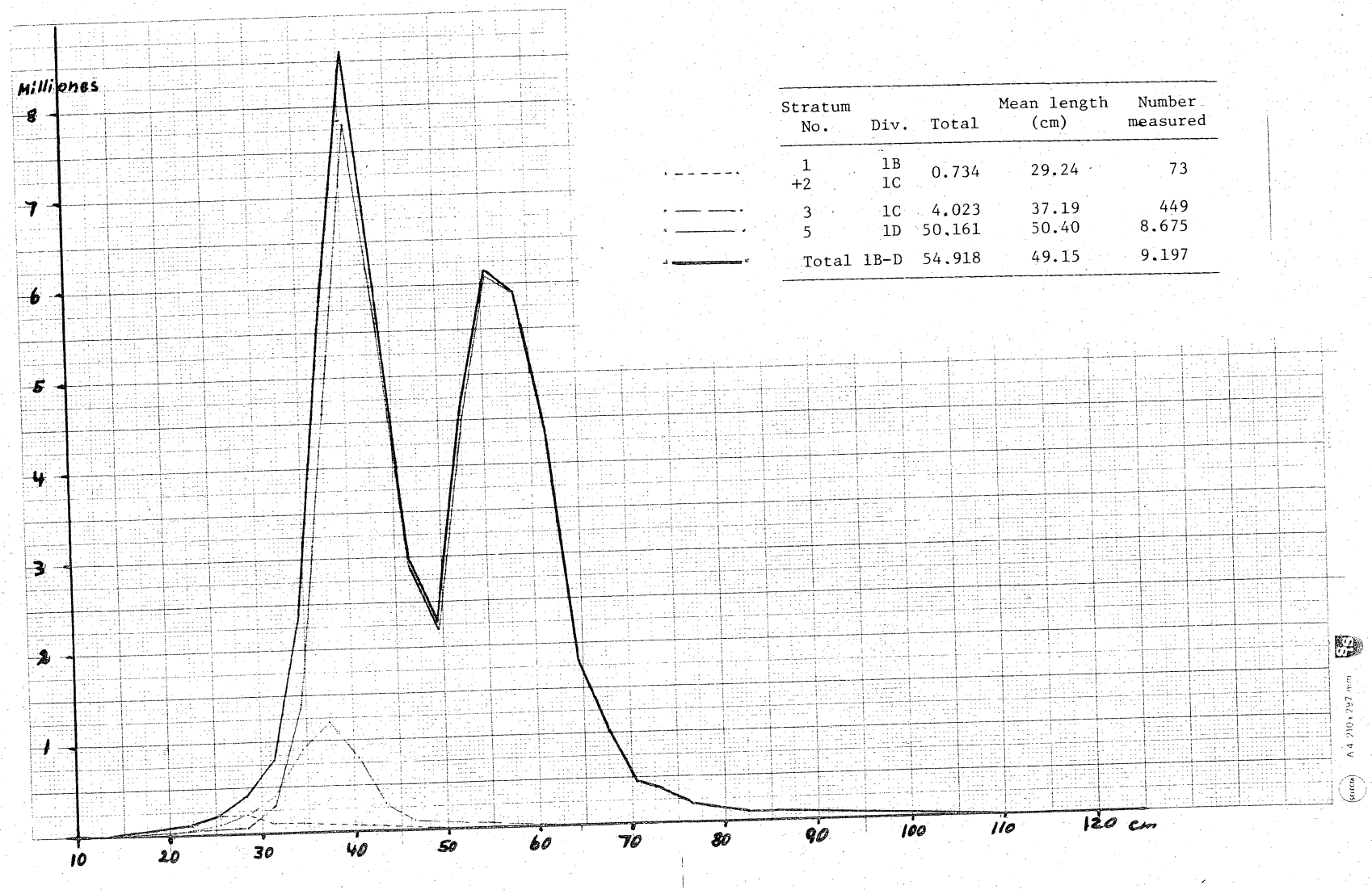
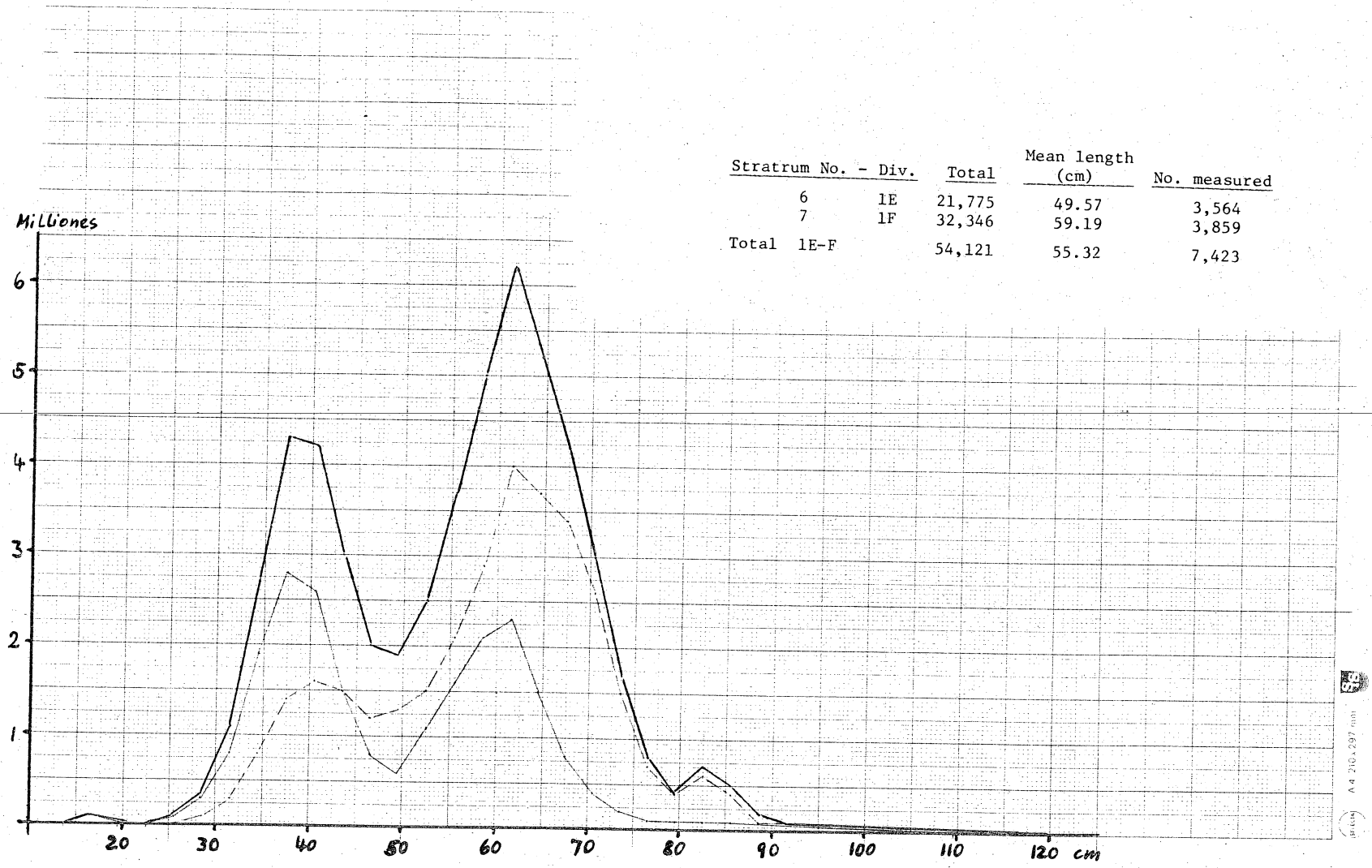


Fig. 2. Survey areas (hatched) for which trawlable biomasses of cod were calculated based on data from stratified random bottom trawl surveys off East Greenland in 1980-82 and off West Greenland in 1982.



Stratum No.	Div.	Total	Mean length (cm)	Number measured
1 +2	1B 1C	0.734	29.24	73
3	1C	4.023	37.19	449
5	1D	50.161	50.40	8.675
Total	1B-D	54.918	49.15	9.197

Fig. 3. West Greenland (SA 1) cod, length frequencies of trawlable biomasses per Division (in millions) obtained from survey results, R/V *Walther Herwig*, Nov./Dec. 1983.



Stratrum No.	Div.	Total	Mean length (cm)	No. measured
6	1E	21,775	49.57	3,564
7	1F	32,346	59.19	3,859
Total	1E-F	54,121	55.32	7,423

Figure 4. West Greenland (SA 1) cod, length frequencies of trawlable biomasses per division (in millions) obtained from survey results, R/V *Walther Herwig*, Nov./Dec. 1982.

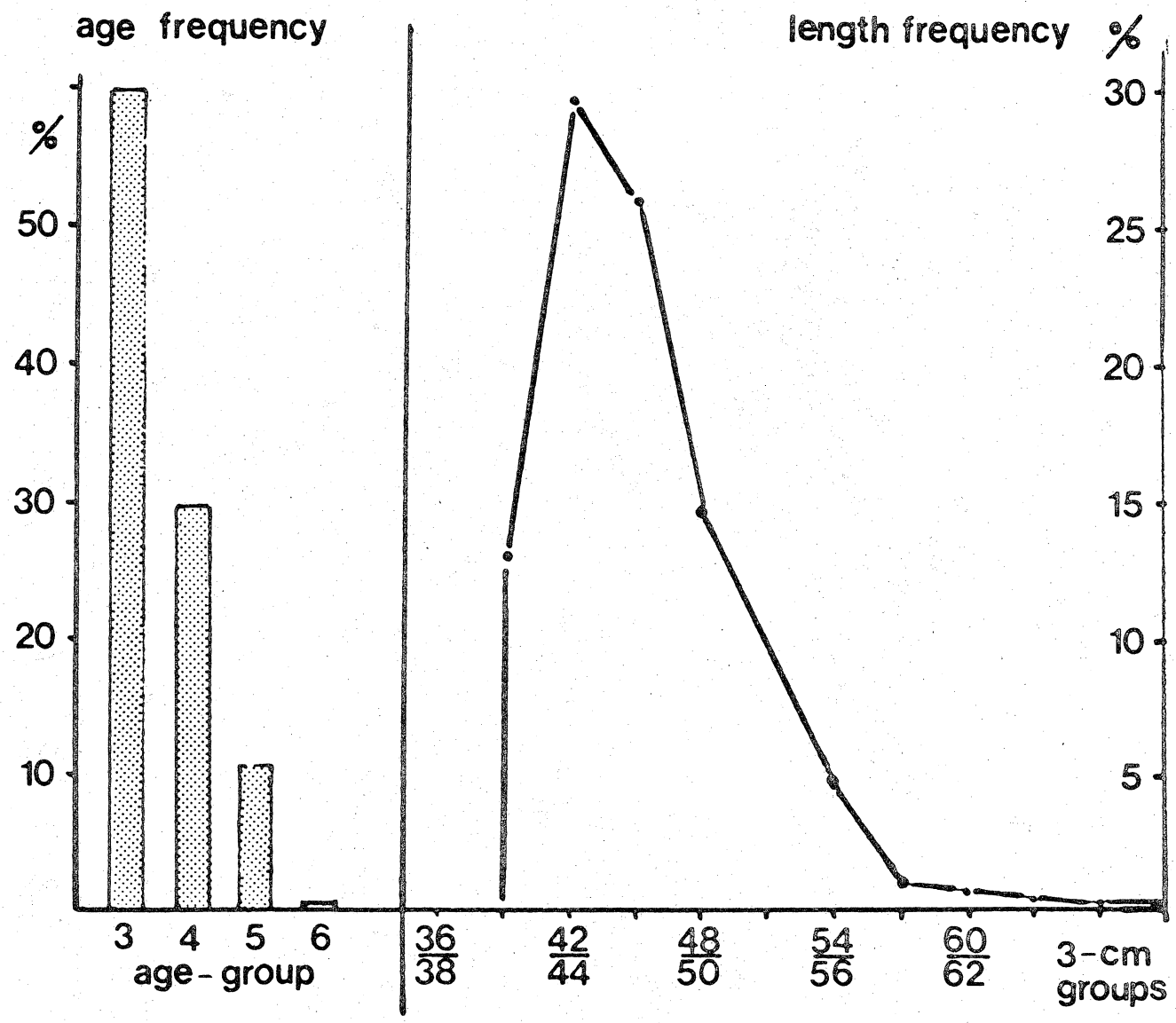
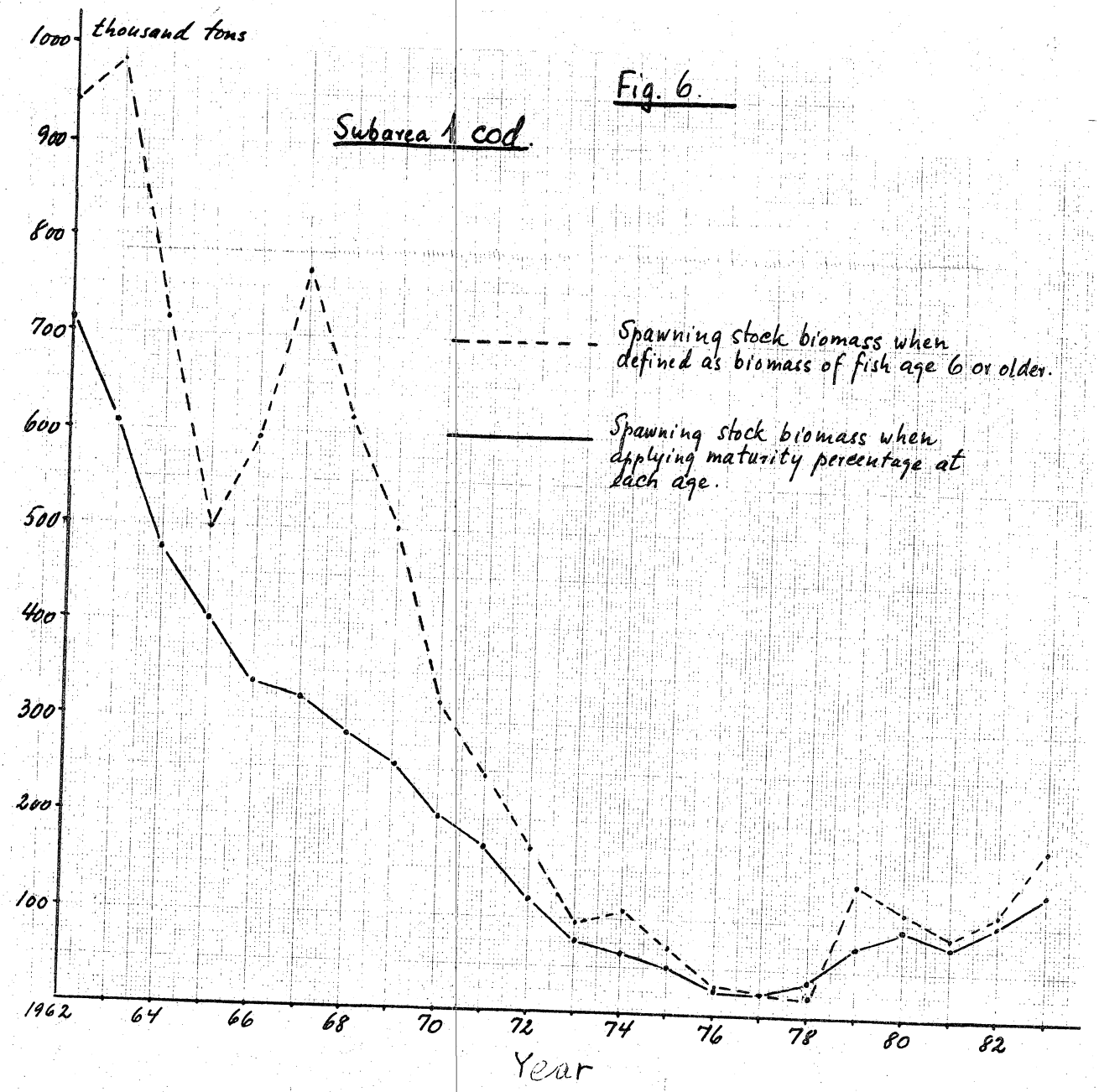


Fig. 5. Age and length frequency of a sample of cod landings from pound net at Holsteinsborg, Div. 1B, July 1982.

Fig. 6.


Subarea 1 cod.
thousand tons
1000
900
800
700
600
500
400
300
200
100
1962
64
66
68
70
72
74
76
78
80
82
Year
Spawning stock biomass when defined as biomass of fish age 6 or older.
Spawning stock biomass when applying maturity percentage at each age.

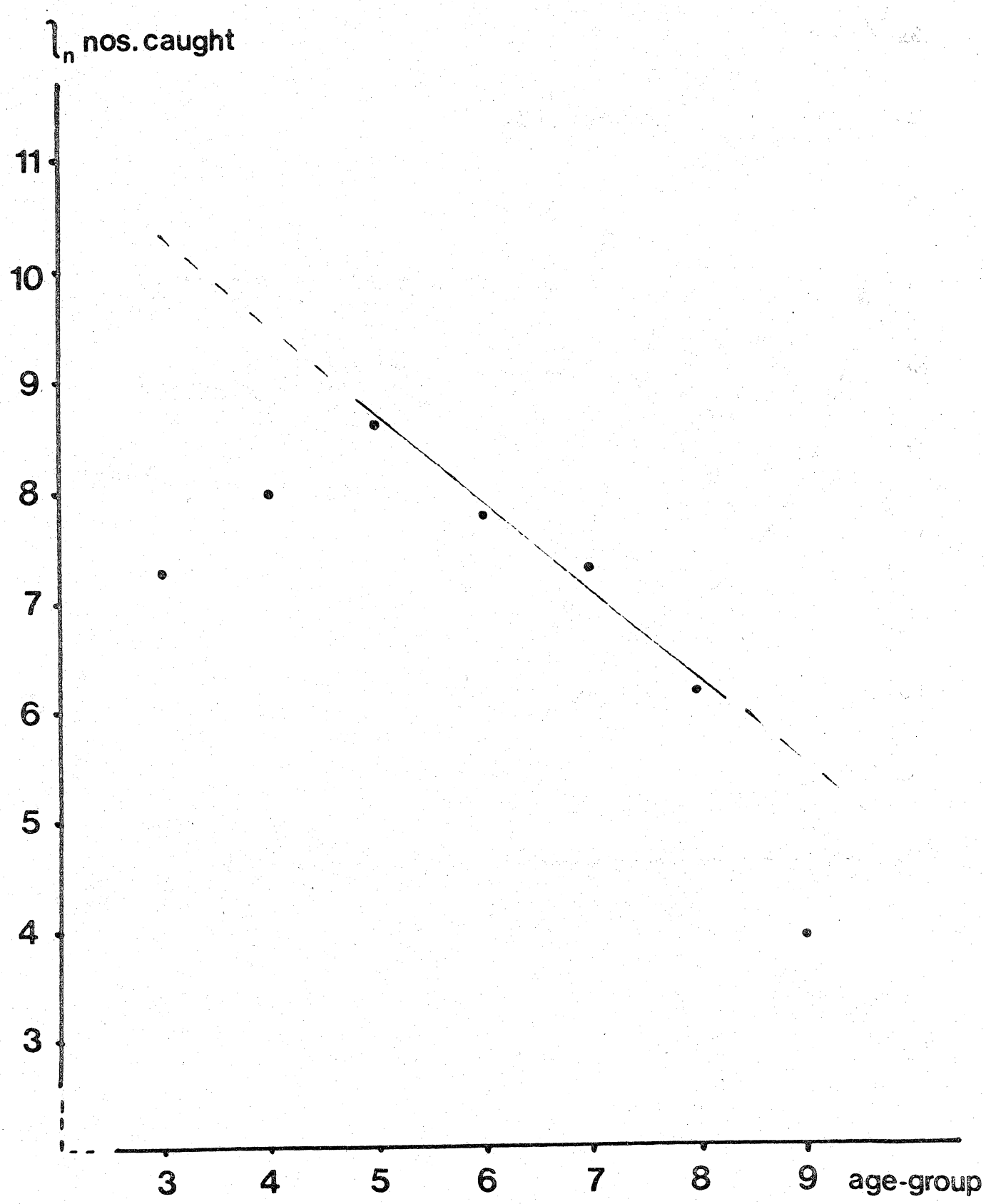


Fig. 7. Catch curve (l_n of numbers caught by age) averaged over the years 1980-82, excluding year-classes 1973 and 1977. Regression line for ages 3-8 shown. The equation for the line is y = 12.58 - 0.785 x , with r = - 0.983.

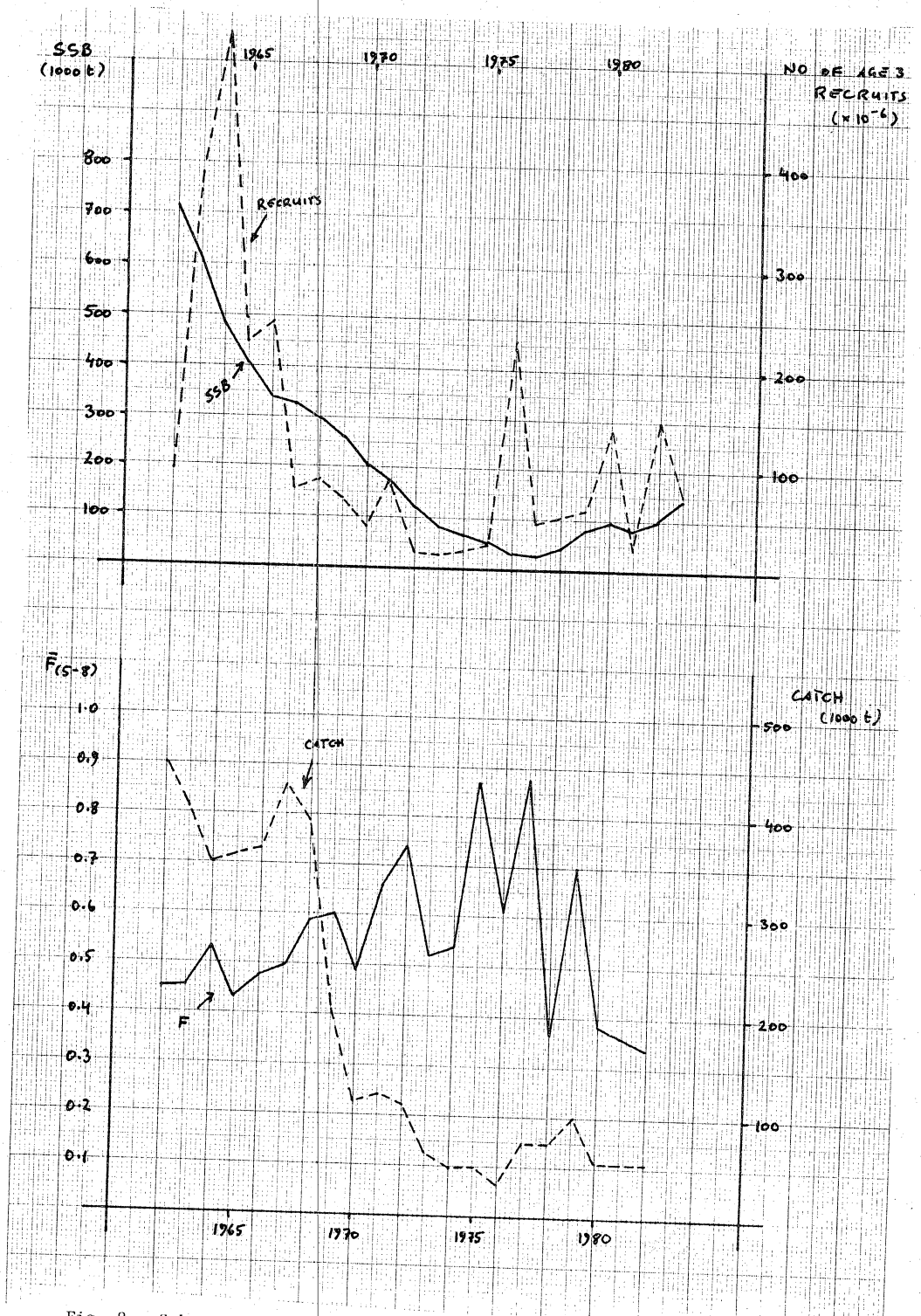


Fig. 8. Subarea 1 cod: spawning stock biomass (SSB), recruitment, fishing mortality and catch 1962-82.

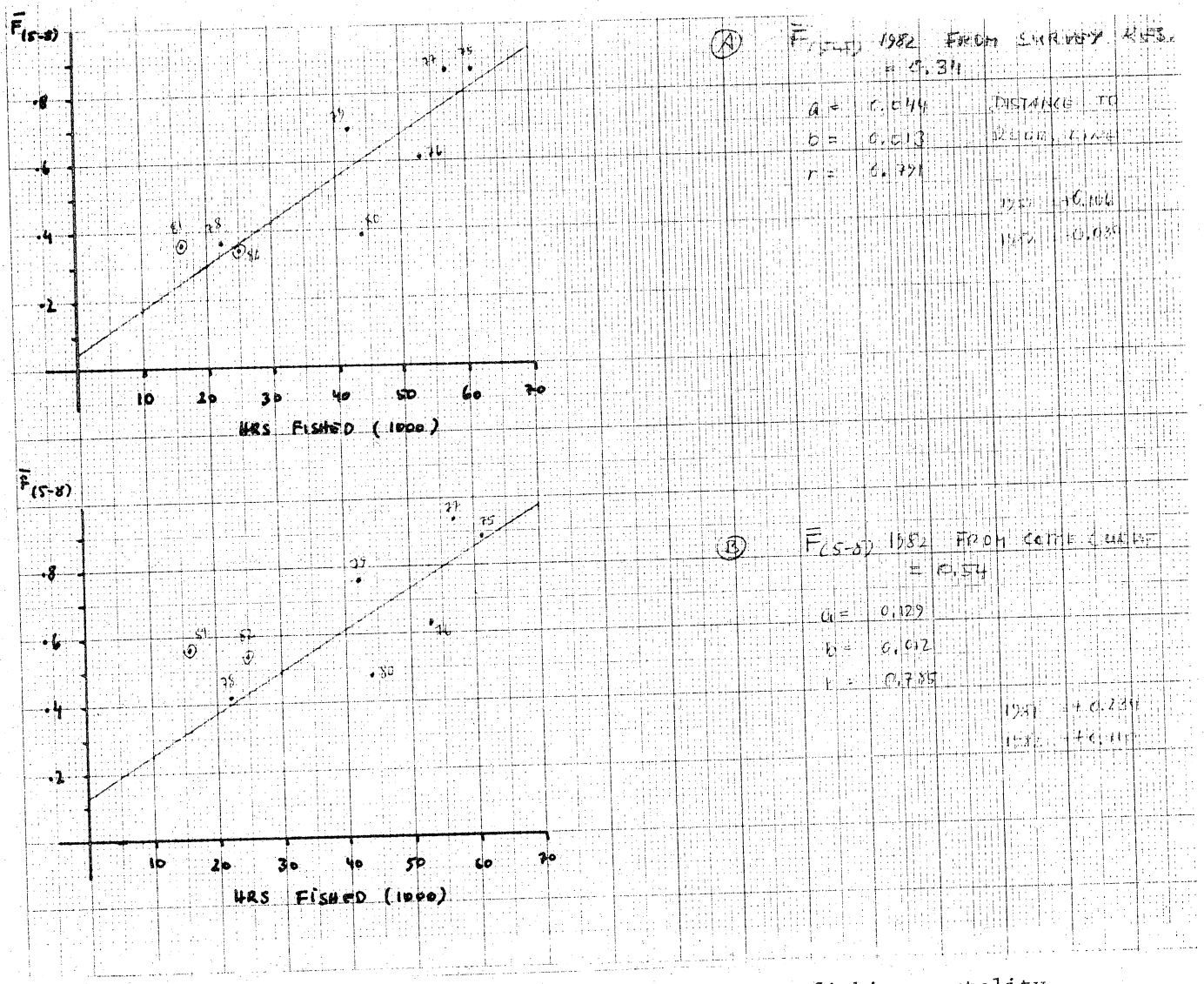


Fig. 9. Cod, West Greenland (SA 1): regression of mean fishing mortality (age 5-8) against total effort in no. of hours fished by Greenland trawlers (years 1981 and 1982 not included in the calculation).

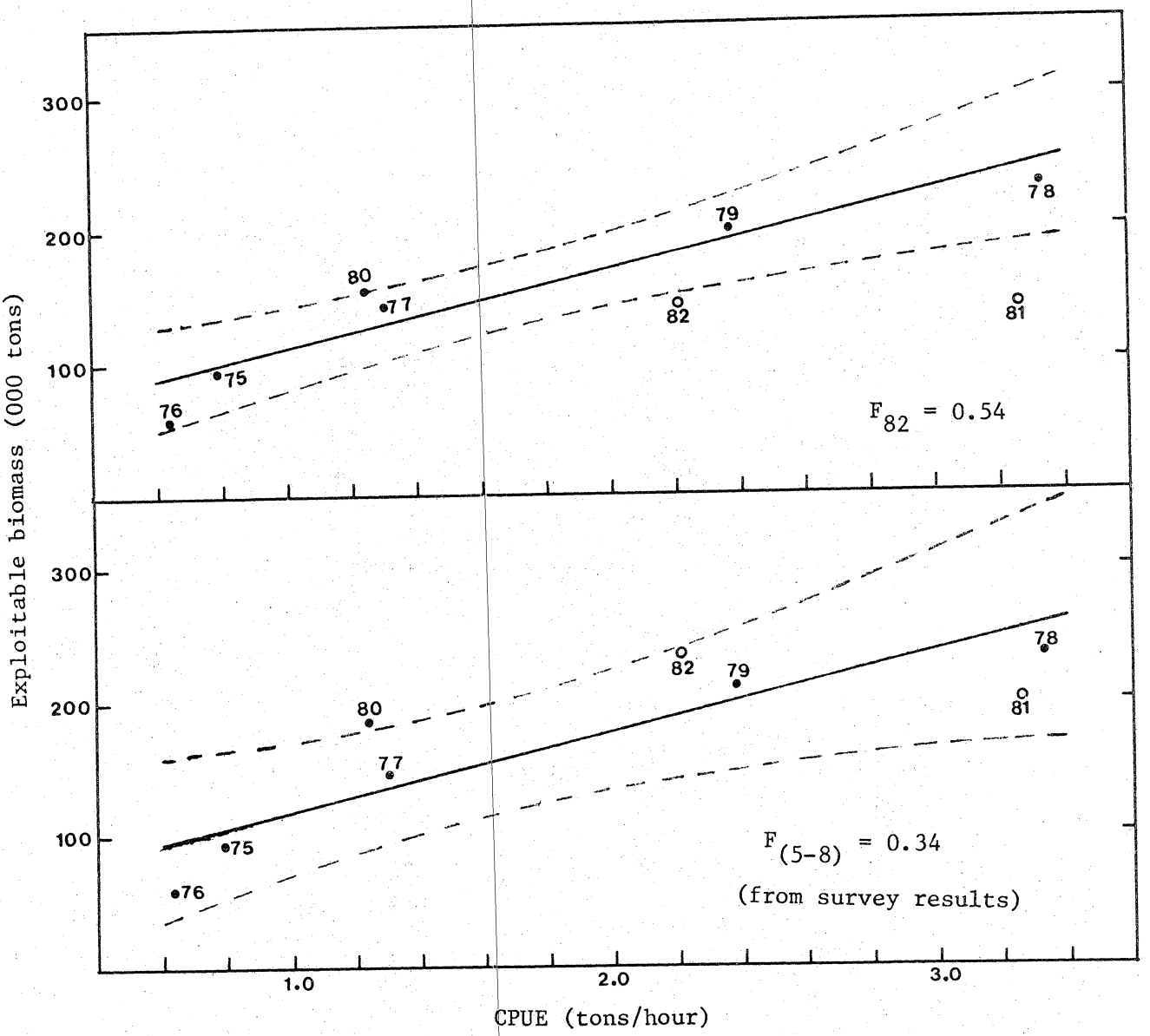


Fig. 10. Subarea 1 cod: regression of explitable biomass (age 4+) on CPUE of Greenland trawlers (1981 and 1982 points not included in the calculation).

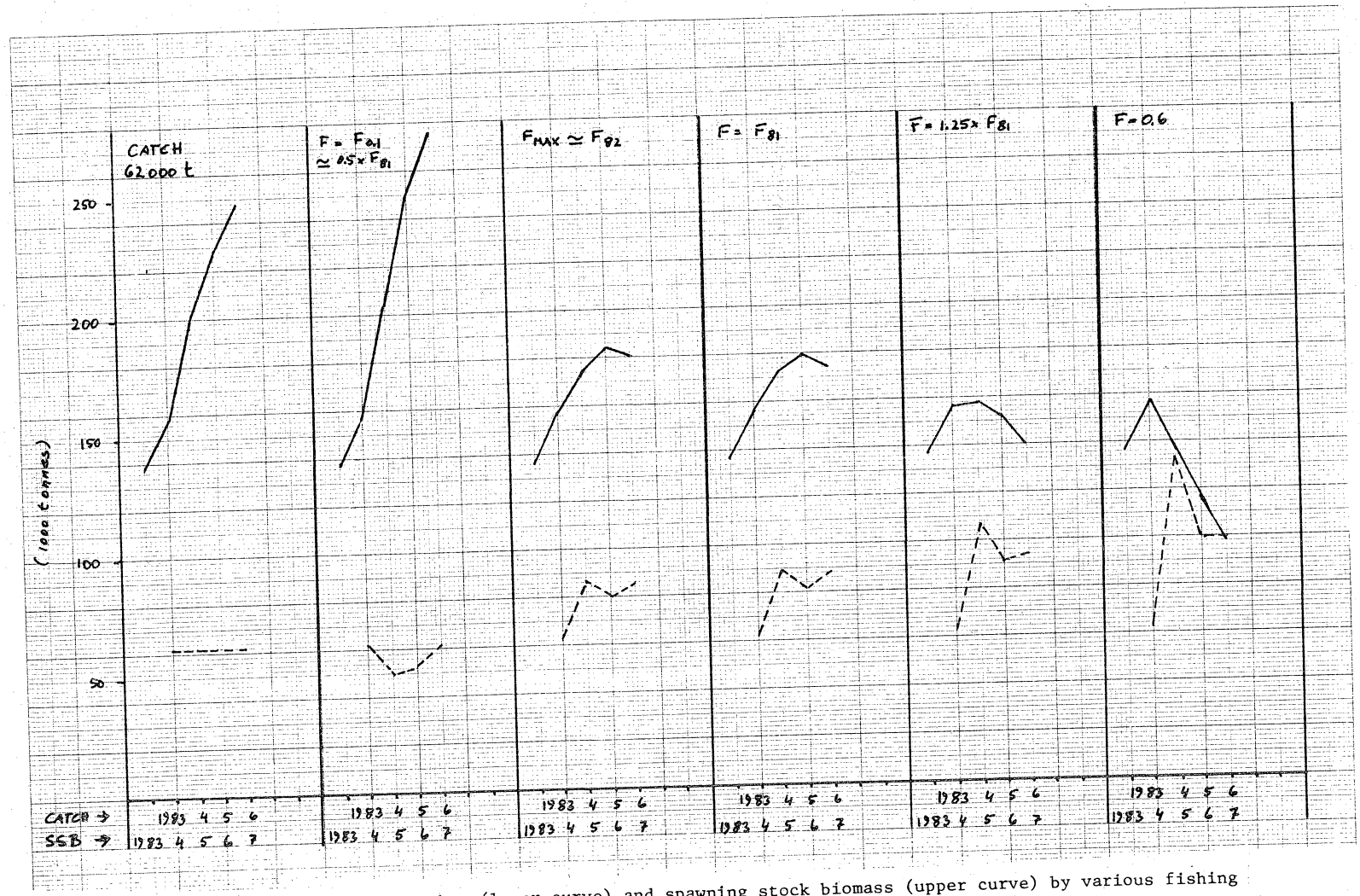


Fig. 11. Subarea 1 cod. Project catches (lower curve) and spawning stock biomass (upper curve) by various fishing strategies and assumptions of catch in 1983. Spawing stock is given by the beginning of each calendar year.

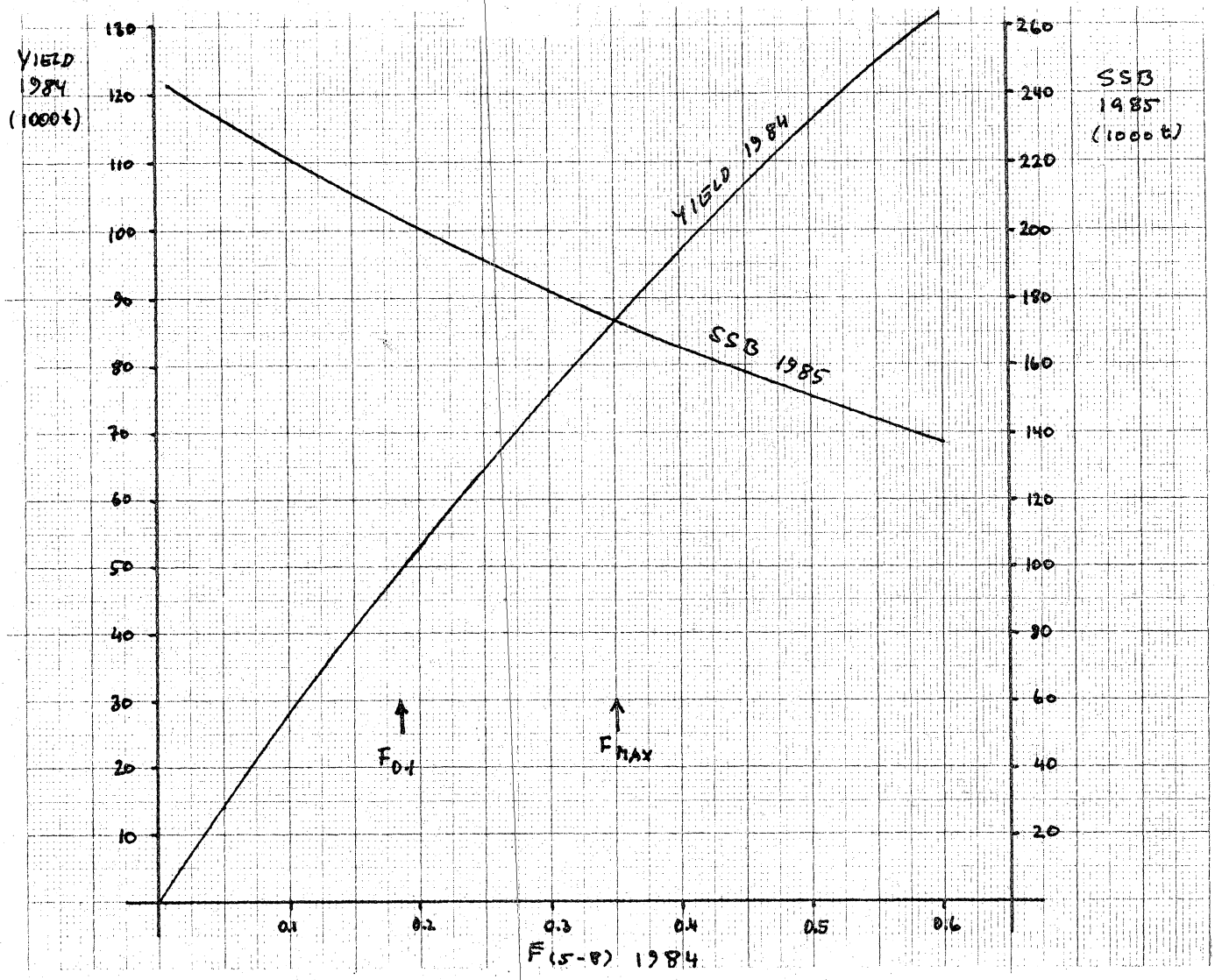


Fig. 12. Subarea 1 cod. Estimated yield in 1984 and resultant spawning stock biomass by January 1985 for various levels of fishing mortality in 1984, assuming the 1983 catch to be 62,000 tons.

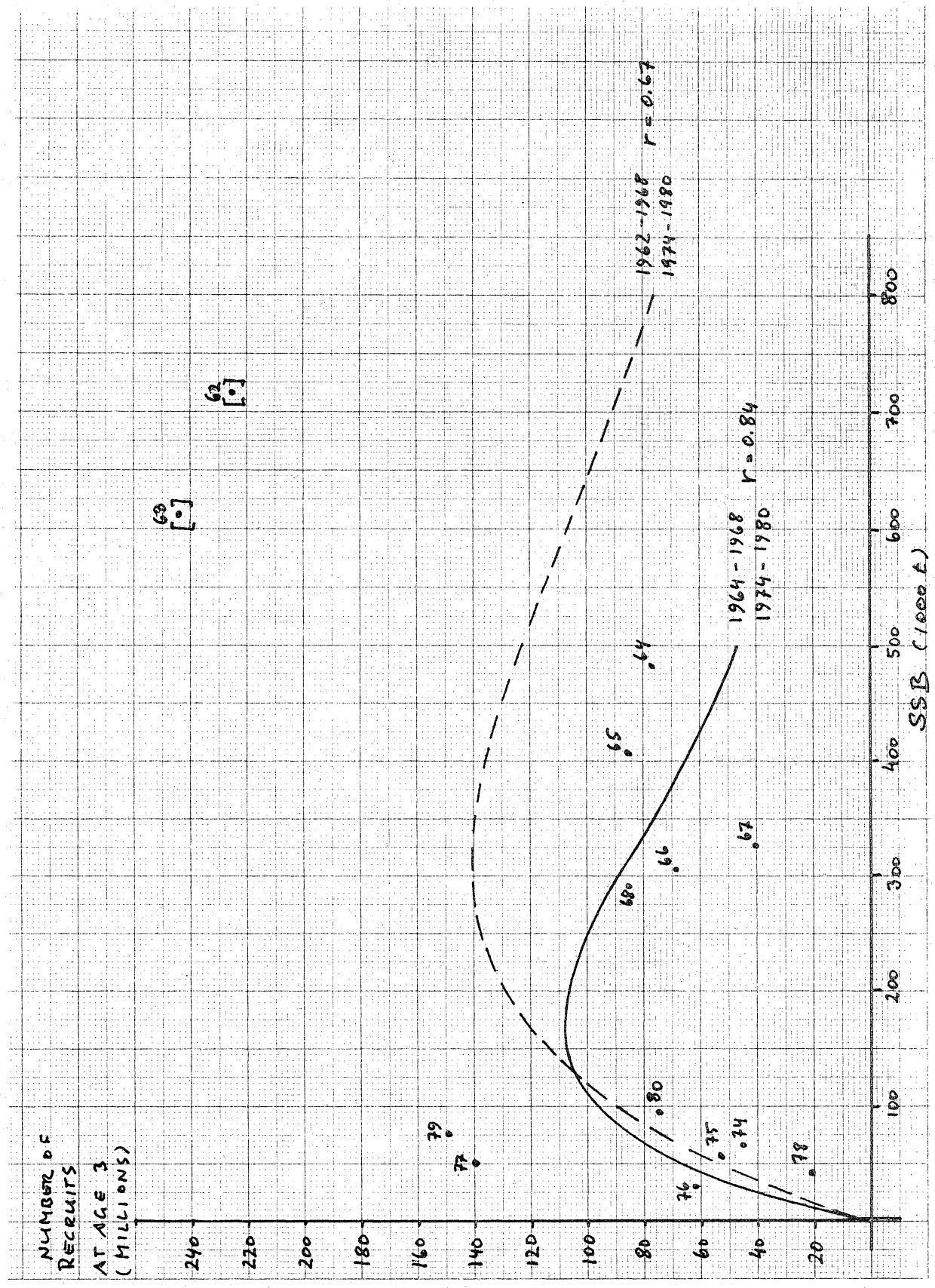


Fig. 13. Subarea 1 cod. Recruitment and spawning stock biomass 1963-80.

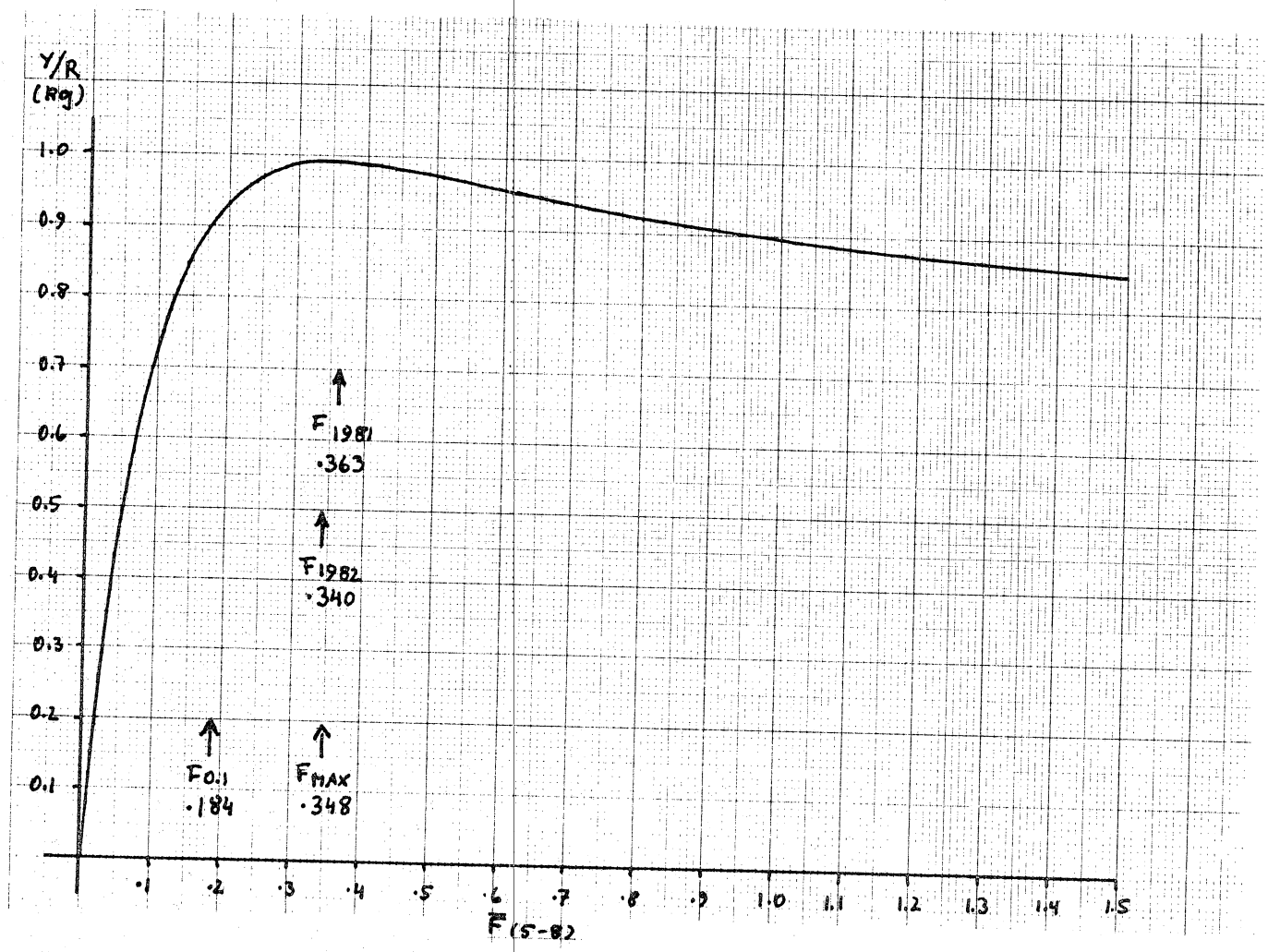


Fig. 14. Subarea 1 cod. Yield per recruit curve.