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Status of Subarea 1 Cod and Estimates of Stock and Yield for 1982-85

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1. NOMINAL CATCHES 1980-81

The figure for total nominal catch of Subarea 1 cod in 1980 used in last year's assessment was 51023 tonnes. Final figures for Greenland are about 3800 tonnes higher than the provisional figures used. If the estimate of 9000 tonnes for non-Greenlandic trawlers is maintained (see Horsted, 1980 and 1981) the total nominal catch of cod in Subarea 1 in 1980 to be used in the assessment is 54083 tonnes. The estimated distribution of this catch on gears and divisions is given in Table 1. Figures for numbers landed have been revised accordingly (Table 13).

For 1981 the nominal catch of Subarea 1 cod seems to be around 52000 tonnes. This figure includes final figures for the large Greenland trawlers (13336 tonnes) and provisional figures for trawlers of the Federal Republic of Germany (416 tonnes, Schumacher pers. comm.). Figures for other Greenland vessels are provisional as reported by licensed vessels (above 80 GRT) or so far as smaller vessels are concerned by the fishing plants buying their catch. The estimated distribution of the 1981 nominal catch on gears and divisions is given in Table 2.

It occurs from Tables 1 and 2 that the catch in 1981 was at the same level as that in 1980, possibly slightly below. The distribution between divisions changed somewhat with an increase of about 3000 tonnes for Division 1D + 1E and a decrease of the same order for Division 1F. In contrast to the 1980 situation no trawling for cod in Division 1B is reported for 1981, and the nominal catch in that division seems to have decreased by about 1300 tonnes. Thus the main part (3/4) of the 1981 catch was taken in Division 1C - E.

2. TRENDS IN CATCH PER UNIT EFFORT AND TOTAL EFFORT

As for the years 1977-80, in 1981 Greenland vessels were the only ones allowed direct cod fishing. Effort figures are available only for the eight large trawlers of the Royal Greenland Trade Department (KGH). Only four of these trawlers, all in the 500-999 GRT tonnage class, were involved in the cod fishery in 1981, the other four vessels fishing for shrimp only.

The nominal catch, the effort (hours fished), and the catch per unit effort (c.p.u.e.) for the Greenland trawlers for the years 1979-81 are shown in Table 3.

Considering c.p.u.e. as a mean over the whole year the figure decreased by about 48% from 1979 to 1980 but increased by 163% from 1980 to 1981, leading to a figure for 1981 about 37% above that for 1979. The best catch rate in 1981 was obtained in Division 1E, but catch rate as such increased in all three divisions fished (Division 1C - 1E). Contrary to the situation in 1980 no fishing by trawlers occurred in Division 1B, and the effort in Division 1F is negligible in all three years covered by Table 3.

Trawlers' c.p.u.e. is highly dependent upon the distribution of cod being highest when fishable shoals are found. Cod frequently form shoals in the first half of the year, either as spawning concentrations and/or due to hydrographic conditions, whereas in the third quarter of the year cod is more evenly spread feeding over a wide area. The c.p.u.e. figures for the Greenland trawlers by quarter of the year are given in Table 4 for the years 1979-81. Unfortunately, figures for the third quarter of the year, which otherwise would have been the best index for the overall density of fish are based upon very little effort or missing. A comparison between 1980 and 1981 does, however, show a significant increase (a doubling or more) in c.p.u.e. for all comparable figures.

Tables 3 and 4 compare c.p.u.e. in terms of total weight of fish caught. Variation between years is, therefore, influenced not only by fluctuations in the amount of fish but also by the individuals' increase in weight. If catches and catch rates are given by numbers rather than by weight the variation between years is influenced mainly by mortality, migration, and recruitment (in both cases supposing the same catchability in the years compared). The c.p.u.e. in terms of number of fish caught by the Greenland trawlers is set up in Table 5 for the years 1979-81.

If the Greenland trawlers' catch rate is taken as an index of c.p.u.e. for the total effort in Subarea 1 then the figures in Table 5 suggest that the overall effort in 1981 was about one third that in 1980. However, for this conclusion to be valid, it is assumed that catchability and fishing pattern did not vary between the two years. Whether this assumption holds cannot be properly tested.

For the coastal and inshore small-boat fisheries no effort figures are available. The trend in inshore catches is given in Table 6 for the years 1979-81. The tendency over these three years seems to be a rapid decrease of catch in Division 1F, a slight decrease in Division 1E, a significant increase for Division 1C, and to some extent also for Division 1B. For Division 1D there was a decrease from 1979 to 1980, but catches increased again in 1981. These trends seem to be closely connected with the southern displacement and emigration (to East Greenland-Iceland) of the important 1973 year class and with the recruitment of the 1977 year class which seems to have its present distribution mainly in Division 1B -1D.

3. THE FISHERY AND THE STOCK IN THE BEGINNING OF 1982

The winter 1981/82 has been extraordinarily cold in Greenland, and adverse ice conditions have been influencing the fishery, especially the shrimp fishery, in the first quarter of 1982. The large Greenland trawlers have, therefore, been

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concentrating on cod fishing, and this seems the main reason for an approximately 25% increase in total catch of cod by the beginning of May as compared to the same time in 1981.

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Samples of trawl-caught fish from Division 1D in February again show great variation in age composition. A sample of cod caught on Fyllas Bank (Division 1D) thus is composed nearly exclusively (90%) of fish of the 1977 year class, while a sample of cod caught close to the first one is predominated by fish of the 1975 year class (42%) followed by the 1977 year class (30%), and the 1973 year class (14%). Evidently the latter sample has been from a fishery on spawning concentrations. It seems highly likely that fishing in 1982 will be concentrated on the 1977 year class both in the offshore and the inshore fishery, and that the major part of the catch will be from Division 1C - 1E as in 1981.

4. MEAN LENGTH AND WEIGHT OF AGE GROUPS IN 1981

The mean length and weight by age groups in the Danish samples of cod from Subarea 1, 1981, are given in Tables 7 and 8 for offshore and inshore samples, respectively. Only those samples for which direct observations on weight were made are included, i.e. length samples for which otoliths and weights from other samples have been used to achieve age composition are not included.

In Table 9 the quarterly mean of the figures in Tables 7 and 8 is given. The weighted average for the year has been obtained by weighting with the quarterly catches of Greenland vessels as listed in Table 10.

The mean weight by age in Table 9 has not been used as such to convert catches by weight to numbers caught. In the calculations the actual weight (calculated or observed) of each basic sample has been used and the number of fish in the sample raised to the total catch considered to be represented by the sample in question. The mean-weight figures in Table 9 are derived in order to get likely mean weight by age for the forecasts. Plotting the unweighted quarterly mean as well as the weighted mean for the year has been made in Figure 1. The figure as well as Table 9 points to somewhat lower estimates of mean weight by age in the 1981 samples than in the 1980 samples, especially for age-group 7 and older fish, and especially for the inshore samples. However, the inshore samples are nearly exclusively from the third quarter of the year, and mean weight for this quarter may well be below the mean for the year (see Horsted, 1981, Figure 1). Thus the 1981 inshore figures may be biassed (lower than to be expected in forecasts). The author, therefore, decided to substitute the inshore figures suggested by Figure 1 with those from the 1980 samples. Both sets of figures are given in Table 11 together with figures suggested as offshore values by Figure 1. For ages 9 and older no new material has become available. Hence figures adopted in previous years' assessment have been used in the forecasts. Also these figures are listed in Table 11. The final figures for forecast are made upon the assumption of an equal share of the catch between the offshore and the inshore fisheries. The resultant figures are listed in Table 11 and plotted in Figure 2.

5. NUMBERS LANDED BY AGE GROUPS IN 1980 AND 1981

Numbers landed per age group for the years 1965-79 are listed in Table 12 while those for 1980 and 1981 are shown in Table 13 for the northern and southern divisions of Subarea 1 separately. The figures for 1980 are based upon exactly the same samples as those used to achieve numbers landed for 1980 last year. The figures have been revised according to the final catch statistics for Greenland vessels for 1980 (see Section 1).

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Figures for 1981 must be regarded as provisional since statistics are provisional, and not all samples were analysed by the time the assessment was made. However, unless final statistics should differ much from the provisional, the numbers given in Table 13 would not be changed to any noteworthy degree.

In 1981 the offshore trawl fishery was sampled in all divisions where it took place, i.e. Division 1C - 1F, and fairly well throughout the year. Nevertheless it has been very difficult to calculate numbers landed. This is due to the fact that the age composition of the samples (and the catch) shows great variation from one part of a fishing ground to another part. Some hauls fished concentrations of mature (spawning) fish, other hauls contained mainly immatures. Data were not available to allow more than a rough estimate as to what proportion of the landings each sample should be considered as representing. This difficulty especially arose in Division 1D in the first half of the year. Figure 3 shows some of the samples of trawl-caught cod to illustrate the great variation in age composition of trawl catches in 1981.

The inshore fishery was sampled in Division 1B - 1F, mainly as landings from the pound-net fishery which is the major part of the inshore fishery. In some cases also the actual catch was sampled, in some other cases discards were sampled. Division 1E - 1F landings were sampled only in August/September. For these divisions age composition seems to differ much between various landings, and the same difficulty as mentioned for the trawl fishery in raising numbers in samples to landings applies to the inshore fishery in the two divisions. For Division 1B - 1D all samples show the 1977 year class as the major one, but also with a significant inflow of the 1976 year class. The 1975 year class has contributed significantly to the offshore catches, but less to the inshore catch. Figure 4 shows some of the samples from the inshore fishery.

6. INFORMATION ON FUTURE RECRUITMENT

Most samples from the fisheries in Subarea 1 usually contain fish of age 3 and older. However, most of the samples from 1981 are lacking 3-year-olds (and younger). Therefore, for forecasts it seems necessary to obtain estimates of future recruitment of fish of year class 1978 and younger fish.

The strength of the <u>1981 year class</u> can at present be estimated only on the basis of hydrographic observations in 1981 and the occurrence of cod larvae in the plankton. The Danish Research Report for 1981 will contain this information, but the conclusion is that the 1981 year class will be rather poor. As a tentative figure for prognosis 20 mio. fish (by age 3) is proposed. The <u>1980 year class</u> was regarded with some optimism based on the temperature and occurrence of larvae in 1980. The individuals of the year class were still so small in 1981 that they escaped commercial gears. Thus for the time being no revision of last year's value of 75 mio. fish is proposed, although considering it similar to the 1975 year class as originally proposed would lead to a figure about half that value. However, as discussed in Section 9 the 1975 year class may have had quite a bit more individuals at age 3 than shown by the present VPA.

Last year the <u>1979 year class</u> was considered to be of a strength between the 1975 and the 1977 year classes and with a northward distribution into Division 1B. Little new information on the occurrence of this year class has become available through the 1981 fisheries and research. The individuals were still of a length where they escape commercial trawlers, and they do not seem to have recruited to the pound-net fishery in 1981 (or they escaped also this gear). The most noteworthy observation is the occurrence in Holsteinsborg Deep (southernmost part of Division 1B) in shrimp catches in September. A sample of small cod amongst the shrimp showed mode of 19 cm with far most fish measuring 17-22 cm. These were likely two year old fish, i.e. fish of the 1979 year class.

Generally, one will have to await observations in 1982 before more firm conclusions can be drawn to the size of the 1979 year class. Maintaining last year's rough estimate of a strength between the 1975 and the 1977 year class leaves one with a wide range between 40 mio. and 185 mio. fish. The lower figure may be unrealistically low (see discussion of the 1975 year class in Section 9). It is suggested to consider the range 75-150 mio. fish as a more proper one, and to carry out forecast with the said upper and lower limits.

Individuals of the <u>1978 year class</u> ought to have been retained in large amounts although to a great extent discarded by trawlers if the year class were a significant one. However, reports by observers on trawlers do not indicate any high degree of discarding, and in those cases where discards were sampled their length indicates that they were the lower end of the normal distribution of the 1977 year class rather than younger fish. The same applies to most cases where the catches and/or discard in pound nets have been sampled. Thus the 1978 year class is still regarded as a poor one, and the figure of 20 mio. fish by age 3 suggested last year has been maintained.

Thus to sum up, the figures proposed for recruitment in the forecast are:

ear class	1978	20 mio.	fish	at	age	3
- 1	1979	75-150 -	-	-	-	-
	1980	75 -	-	-	- -	- ¹ ,
· · -	1981	20 -	- '	-	- '	-

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

At last year's meeting of the Scientific Council of NAFO it was considered that the total mortality (Z) for 1978-80 of the value 0.83 was a reasonable estimate. This was derived from catch curves averaged for age groups 5-7 over the period.

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Looking upon the trends in effort and catch it occurs that effort may have decreased further (see Section 2 and Table 5). To be judged purely on the trawlers' statistics the overall effort may have been cut to 1/3 of its 1980 level. It does, however, seem doubtful whether it is allowed to raise trawlers' effort by their c.p.u.e. to cover also the inshore fishery. The variation in availability and catchability of cod to inshore gears, especially to the dominating pound net, may not be the same as the variation in the trawl fishery. With the success of the inshore cod fishery in 1979 and 1980 it seems highly unlikely that the local interest and hence effort in fishing for cod have dropped that much in 1981. Unless quite specific circumstances such as ice prevent pound nets from being set one would expect that the actual activity in setting pound nets would differ little between one year and the next. There seems to be no obvious reason for a considerable decrease of inshore effort from 1980 to 1981. It is, therefore, proposed to consider the inshore component as having maintained its effort but consider the offshore c.p.u.e. by trawlers as having roughly tripled.

In terms of landed weight the inshore fishery accounts for up to 70% of the 1980 catch (Table 1) and up to 74% of the 1981 catch (Table 2). If the terminal F-figure of 0.63 achieved last year is reasonable the inshore fishery accounted for a F-value of about 0.44, and the offshore for a value of about 0.19. If the inshore F is maintained in 1981 while the offshore is halfed an overall value of 0.50 would be considered a possible terminal F-value.

Looking at catch curves for the years 1979-81 for age-groups 6-8 (Figure 5) (i.e. an approach similar to that made last year) leads to a Z-value of 0.90. The age groups used in this catch curve are all mature and to a great extent influenced by the 1973 year class which is the only year class occurring in all three years' material. The 1973 year class seems to have had a higher than normal tendency of migration to East Greenland waters. Hence, to achieve a F-value from the Z-value found it may be proper to deduct the natural mortality of 0.20 and the emigration coefficient of 0.15 usually applied to the Division 1E - 1F cod. This approach would lead to a F-value of 0.55 which is very close to the value of 0.50 suggested by the first approach in this section. The mean of the two approaches would be 0.53. However, in the first version of the paper, a value of 0.54 was used, and it was not found reasonable to revise the tables so slightly, as would be the case, by using 0.53 instead.

If the plots of age groups 3 and 4 were to be raised to fall on the regression line for ages 6-8 the number in these groups would have to be multiplied by a factor of 100 and 4.4, respectively. This corresponds to a partial recruitment of 1% and 23%, respectively. Last year's values were 1.2% and 17%, but it was argued, that due to the inflow of the 1973 year class the regression line of the catch curve used (ages 5-7) was at a higher level than that which would be proper for comparison with the plots of ages 3 and 4, and figures of 2% and 33% partial recruitment were proposed and used.

Although the partial recruitment value found this year for age group 4 is higher than that of last year, and although the 1977 year class has formed attractive shoals in 1981 the regression line used as basis may still be at a level

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leading to some downward bias of the estimates of partial recruitment. It is, therefore, proposed to maintain the estimates used last year, i.e. 2% and 33% partial recruitment for age group 3 and 4, respectively.

The partial F-values corresponding to this partial recruitment are 1.5% and 27.4% of the F-values for fully recruited age groups.

Terminal-F values for years prior to 1980 are taken to be as in last year's assessment (Horsted, 1981, Schumacher et al., 1980).

8. NATURAL MORTALITY RATE AND EMIGRATION

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

Emigration rate most likely varies between years and year classes and is likely to have been higher for the 1973 year class when and after its individuals became mature from 1975/76. Most of the younger year classes seem to have a more northern distribution than the 1973 year class, and it is, therefore, proposed to maintain the overall value of 0.05 for emigration of fish six years old and older in the present analyses.

9. VIRTUAL POPULATION ANALYSES (VPA)

The VPA analysis with the parameters suggested in the preceeding sections is shown in Tables 14a and 14b. It is seen that the important year class 1973 now seems to have had a strength of 231 mio. fish at age 3, another upward adjustment, although in this case a very slight change from last year's result of 225 mio. fish.

The 1977 year class would occur to be of a strength about 186 mio. fish at age 3. This corresponds very closely to the suggestion made last year of a year class around 200 mio. fish.

The 1974, 1975 and 1976 year classes all show up in the order of 30-40 mio. fish. The author has previously expressed his surprise of such small a figure for year class 1975 (but not for 1974 and 1976), and in the 1980 assessment adjustment of partial F for that year class was made to allow the year class to achieve a higher value in the VPA. However, the year class has now been contributing to the catches for so many years that the evidence from the samples must have the greater scientific weight. Hence, it seems that this year class has been much overestimated in its first years of life and/or - as was suggested last year - that the explanation for the relatively few individuals in the catches in 1980-81 could be due to a high discard rate for the 1975 year class when it occurred as small fish in the catches in 1977-79 together with the many larger fish of year class 1973.

10. FORECASTS

Catches in 1982-84 are likely to become heavily dominated by the 1977 year class. The uncertainty as to the strength of that year class now seems much less

than last year, and the residuals occurring in the VPA run, i.e. 95 mio. fish by January 1982 (Table 14b) have been used for the forecasts. The same apply to the residuals of age groups 6 and older by January 1982. The VPA figure for the strength of the 1978 year class seems too unrealistic, and it is proposed to maintain the year-class estimate by age 3 as 20 mio. fish (which is, indeed, a small year class). This leaves 14.7 mio. residuals by January 1982.

The great uncertainty in terms of recruitment is connected with the 1979 year class and the 1980 year class. The latter will be less significant for the period considered in the forecast than the former. Consequently, although the suggestion in Section 6 of 75 mio. fish for year class 1980 is rather preliminary no upper and lower limits are proposed this year. For 1979 the uncertainty and the implication on forecasts is greater, and although the figures of 75 and 150 mio. recruits are proposed (Section 6) as upper and lower limits future observations may well change the estimate of the strength of this year class.

For all forecast runs a catch in 1982 of 55.000 tons has been assumed. Runs have been made with various constant levels of fishing mortality and with a constant catch of 55.000 tons. The results for options requested by EEC and some other runs are shown in Table 15 and illustrated in Figure 6 while Figure 7 illustrates the catch in 1983 and the spawning biomass by January 1984 for a wide range of fishing mortalities in 1983.

11. ACKNOWLEDGEMENT

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Dr. A. Schumacher, the Federal Republic of Germany, kindly undertook the work of revising Table 15 and Fig. 6 and 7 when this showed necessary at the June 1982 Meeting of the NAFO Scientific Council.

A special thank to captains and crew of the various Greenland trawlers on which members of the staff of the institute have been on board sampling and to the masters in the various fish plants for great help in sampling the landings.

12. REFERENCES

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- Schumacher, A., J. Messtorff, Sv. Aa. Horsted and P. Kanneworff, 1980: Some further analyses of Subarea 1 Cod. NAFO SCR Doc. 80/VI/113, Ser. No. 169, 12 pages (mimeo).

Table 1. Nominal catch (tonnes x 10⁻³) of cod in Subarea 1, 1980. The figures include figures for Greenland as reported to NAFO (STATLANT 21 B-forms) plus an estimate of 9000 tonnes for non-Greenlandic trawlers. Pound-net catches are estimated as being 3/4 of total miscellaneous-gear catches in June-September for Division 1B - 1F.

Division	Otter trawl	Pound net	Miscellaneous gear	Total
	(offshore)	(inshore)	(mainly inshore)	
1A	0		719	719
1B	1800	1266	1037	4103
1C	7862	1478	791	10131
1D	4430	3171	4610	12211
1E	2100	6524	4123	12747
1F	40	7539	7313	14892
Total Subare	a 1. 16232	19978	18593	54803

<u>Table 2</u>. Provisional figures for nominal catch (tonnes x 10^{-3}) of cod in Subarea 1,

1981. The figures include a provisional figure of 416 tonnes for the Fed. Rep. of Germany (Schumacher, pers. comm.), while the remainder is provisional figures for Greenland vessels. Vessels for which no information on gear is supplied are included under miscellaneous gear so that otter trawl catches listed are minimum figures for that gear. Pound-net catches are estimated as being 3/4 of total miscellaneous-gear catches by vessels below 80 GRT in June-September for Division 1B - 1F and May for Division 1D.

Division	Otter trawl (offshore)	Pound net (inshore)	Miscellaneous gear (mainly inshore)	Total
1A		_	202	202
1B		1728	1114	2842
1C	4288	2701	3220	10209
1D	4701	3446	5545	13692
1E	4508	3992	5648	14148
1F	255	5330	5560	11145
Total Subarea	1.13752	17197	21289	52238
		1		· · · · · · · · · · · · · · · · · · ·

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Table 3. Effort (hours fished), catch of cod, and catch per unit effort for the Greenland trawlers (500-999 GRT class) in 1979-81. Only figures for directed cod fishing are included.

de la caractería A construir a construir A construir a c	1	1979			1980			1981	
Division	tonnes	hours	kg/hour	tonnes	hours	kg/hour	tonnes	hours	kg/hour
				in de la composition de la composition La composition de la c		and the second sec		al Maria	en e
1B	0	. 0	-	1789	727	2461	0	0	
1C	6428	2983	2155	1646	1513	1088	4254	1279	3326
1D	3586	1163	3083	1768	1983	892	4701	1856	2533
1E	711	365	1948	1395	1092	1277	4381	952	4602
1F	24	9	2667	19	31	613	0	5	0
Total Subarea 1.	10749	4520	2378	6617	5346	1238	13336	4092	3259
East				· · · · · · · · · · · · · · · · · · ·					
Greenland	1525	760	2007	226	246	919	8	16	500

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 1979-81. Only figures for direct cod fishing are included.

			<u>1</u>	979				
		I		II	III	с	I	V
Division	hours	c.p.u.e.	hours	c.p.u.e.	hours	c.p.u.e.	hours	c.p.u.e.
1C	2727	2059	256	3180	_		·	-
1D	711	2942	452	3305	-		-	-
1E	123	675	242	2595	-		· · · -	-
1F	· · · ·	-	-	_	-	-	9	2667
Total SA	1. 3561	2187	950	3091	-	-	9	2667
East Greenland	-	-	-		-	-	760	2007

			198	30				
		I .	II		I	II		εv
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

		I		II	II	I .	I.	/
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	a –	-	-	-	-	- -	16	500

Table 5. Effort (hours fished), catch of cod by weight as well as by numbers, and catch per unit effort for the Greenland trawlers (500 - 999 GRT class), and total effort for Subarea 1, 1979-81.

Year	Grl. trawlers'	Grl. trawlers	' Grl. trawlers'	Total SA 1 catch	Total effo	rt
	effort	catch of cod	c.p.u.e.	(including		
	(hours)	(tonnes and nos. x 10 ⁻³)	(kg/hour and nos./hour)	estimates)		-
1979	4520	10749	2378	99172	41704	Cat we
1980	5346	6617	1238	54803	44263	cch
1981	4092	13336	3259	52238	16029	by 1t
1979	4520	5136	1136	43817	38567	nun
1980	5346	2419	452	22315	49316	ber b
1981	4092	7663	1873	29365	15678	Ye Y
		an a]			

Table 6. Coastal and inshore nominal catches of cod (tonnes) by Greenland fishermen 1979-81.

	1 A A A A A A A A A A A A A A A A A A A		
Division	1979	1980	1981
1A	420	719	202
1B	1848	2303	2842
1C	2147	2269	5921
1D	10504	7781	8991
1E	11117	10647	9640
1F	16319	14852	10890
Total SA 1	42355	38571	38486

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Table 7.

Mean length (total length, cm below), and mean weight (kg, round fresh) of age groups in Danish offshore cod samples from Subarea 1, 1981. Figures are given only for age groups represented by more than five fish in the sample, and only for samples where both length and weight was recorded. OTB = bottom otter trawl.

Age	Div.	1C	1C	1D	1D/E	1D	1E	1D	1C
group	Month	February	March	March	Мау	June	June	November	December
	Gear	OTB	OTB	OTB	OTB	OTB	OTB	OTB	OTB
III	1	-	-	-	-			_	-
	w			-	· -	1 <u>-</u> 1	-	-	· -
IV	1	47.4	46.6	49.0	47.4	48.6	48.4	51.4	52.5
	W	1.05	1.01	1.15	0.92	1.27	1.24	1.44	1.53
v	1	55.5	55.2	59.1	55.0	56.8	56.9	62.1	60.1
	W	1.68	1.65	2.01	1.55	1.78	1.77	2.48	2.18
VI	1	60.4	61.7	65.6	62.7	64.9	65.9	68.3	67.5
	w	2.26	2.40	2.82	1.69	2.52	2.64	3.45	3.31
VII	1	67.0	68.4	73.8	-	73.1	74.0	76.9	
	w	2.65	3.07	3.34		3.46	3.54	4.81	-
VIII	1	- 1 - 19		82.7	71.6	77.9	78.8	84.1	с. — с. н. н. н. — с. н. н. н. н.
	W	-	n lan A rti n yang sa	4.35	2.62	4.30	4.29	5.89	-
IX	1		- <u>-</u>	-	-	-	-		
	w	- 20		-	-		-	<u> </u>	
x	1			-	-	91.7	87.3	-	-
	W	1. 1	-		- 1, 1 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1	7.39	6.40		- 1
Overall	ī	49.9	49.1	65.9	50.0	62.1	68.0	53.9	53.6
Overall	w	1.26	1.22	2.60	1.05	2.46	3,.06	1.74	1.66

														•											
ich coactal	red by more	•		1 E	September	GNS		· • •	48.8	1.17	54.1	1.62	63.8	2.45	66.1	2.65	75.8	4.26		۰ ۱.	, i	1	52.6	1.54	
ned ni sou	s represent	as recorded		Ē	September	LHP		- 5. - 1	51.9	1.39	57.8	1.93	65.4	2.58	67.5	2.74	77.9	4.56		. 1	1		67.2	3.15	
) of age ard	or age group	nd weight wa	- - - -	1E	September	FPN			48.6	1.16	56.2	1.78	· 1	1	ı"	1	72.9	3.88	1	1	r		54.7	1.71	
round fresh	iven only f	th length a		1F	September	GNS	1	1	50.3	1.27	57.7	1.85	64.1	2.40	65.1	2.61	71.5	3.36	.1	, 1 ,	, 1 ,	ľ	63.1	2.45	
mean weight (kg.	81. Figures are g	samples where bo	t gill net.	н Н Н	August-September	ГНР		I	50.8	1.30	54.7	1.63	67.4	2.83	67.4	2.87	76.2	3 . 83	1	1	1		62.7	2.46	
ow), and	irea 1, 19	only for	GNS = se	- - -	August	FPN		 1.	. I	ĩ	62.5	2.72	69.0	3.00	71.0	3.29	77.4	4.34	.1	I.	I	١.	76.2	4.17	
, cm bel	rom Suba	ple, and	nd line,	1E	August	FPN		1	51.8	1.36	55.9	1.80	63.7	2.50	65.1	2.70	75.4	4.10	I	i	1	r	66.3	2.99	
l length	amples f	the sam	LHP = ha	1E	August	FPN		I.	48.9	1.14	59.5	1.83	64.6	2.52	68.4	2.92	77.1	4.07	77.8	4.21	I I		73.5	3.63	
h (tota	e cod s	fish in	d-net,	10	June	FPN	I	1	46.2	1.09	49.3	1.36	I	ł	, I	I	Ļ	ı	I	1	ł	1	47.7	1.21	
n lengt	inshor	n five	= pound	1D	June	FPN		- F .	43.7	0.95	47.4	1.21	1	I I	1	1	 	1	ł	I	1	1	45.2	1.05	
Mea	and	tha	FPN	Div.	Month	Gear	Ч	3	4	3	Ч	м	Ч	3	н,	З	г	З	Ч	3	1	3	ы	13	1
Table 8				Age	droup		III	• •	IV		Λ		IN		ΛII		IIIV		IX		×		Overall	Overall	

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Table 9. Subarea 1 cod, 1981. Mean weight (kg, round fresh) by age as obtained from samples listed in Tables 7 and 8. Weighting factors to obtain weighted annual mean are the catches listed in Table 10. For comparison figures obtained in 1979 and 1980 are listed.

			Unwe	eighted mear	n by quarter	Weighte	Weighted mean by quarter				
Age	group		1	2	3	4	1981	1980	1979		
	III		n de la composition de la comp	-		_		1.10	_		
	IV		1.07	1.14	-	1.49	1.23	1.27	1.10		
es	v		1.78	1.70	_	2.33	1.94	2.08	1.94		
[dur	VI		2.49	2.28	-	3.38	2.72	3.13	3.17		
ŝ	VII		3.02	3.50	-	4.81	3.75	4.35	4.04		
ore	VIII		4.35	3.74	-	5.89	4.68	6.41	6.47		
sho	IX		-		-	-		4.82	6.77		
Off	х		<u> </u>	-	-	-			7.58		
• . •	XI	а 	<u>-</u>	7.39	-	-	7.39	_	9.16		
	III		-		4000 (1990) 1490 - 1990 (1990)		1	0.74	1.01		
Ŋ	IV		<u> </u>	1.02	1.26		1.20	1.18	1.51		
ple	v		-	1.29	1.90	. <u>-</u>	1.75	2.03	2.19		
sam	VI		4	_	2.61		2.61	2.67	3.15		
re	VII		_	-	2.83	_	2.83	4.01	3.57		
sho	VIII			-	4.05		4.05	5.07	6.45		
ц	IX		-		4.21	-	4.21	7.86	e e <u>_</u> ent		

Table 10. Nominal catch of cod by Greenlandic vessels in Subarea 1, 1981, by quarter of the year.

Quarter 1 2 3	4
Offshore tonnes 7082 5490 1730	6130
8.5	30.0
Coastal and inshore 1127 6134 18264	5865
% 3.6 19.5 58.2	18.7

Table 11. Weight (kg, round fresh) by age of Subarea 1 cod suggested by Fig.2 as estimates for forecasts in the present paper. However, since the inshore figures may be biassed (see text Section 4) these are substituted by figures found from the 1980 samples (Horsted, 1981, Table 10). Average has been calculated by assuming that 50% of the catches will be taken inshore.

	Mean wei	ght 1981	Mean weight 1980	Weighted average
nge group	offshore	inshore	inshore	and 1980 inshore
III	0.65	0.70	0.75	0.70
IV	1.23	1.20	1.25	1.24
V	1.94	1.75	2.00	1.97
VI	2,80	2.40	2.90	2.85
VII	3.70	3.00	4.20	3.95
VIII	4.70	3.75	5.50	5.10
IX				6.40
X			the second second	7.80
XI	Values	taken as	in previous	9.00
XII	uears	assessmen	it	9.70
XIII				10.20
XIV		· · · ·		10.40
XV				10.50

TABLE 12.	Subarea 1 cod:	Catch	in numbers	by age	used in	VPA.	(See Ta	able
	13 for the years	1980	and 1981.)					1.1

CATCH	AT AGE							an a
age	1965	1966	1967	1968	1969	1970	1971	1972
34567890 101123 1123 114 15+	1492 52455 9895 15246 19895 2846 481 1917 77 276	1537301 781301 781301 639595959 469512930 1288301 19837 24 24 24 24 24 24 24 24 24 24 24 24 24	1727 15097 30457 618462 27000 1926 5237 352 93 166 453 85	3764 79766 366704 340005 17253 2348 187 37 303	18746611 237093 144611 4477813 744611 4477813 7041 68	2768 10342 64655 2810 12809 851 201 201 27 41	2517237 201283787 201283787 201283787 201285751 201771 201771 205751 155 155 155	100139 97860 120200 25500 26604 9544 7090 1307 122
Sum	164084	132324	144767	128305	82627	42567	41831	43747
						egia de	e status (* 1995) a statueri	
age	1973	1974	1975	1976	1977	1978	1979	
34567890112345 1112345 1112345	131 2302 16378 3065 2605 1406 12552 165 237 37 44	343 1079 2384 11806 1806 18094 1772 147 1572 141	2755 35973 26773 58555 13889 291 284 389 12	10760 2243 1202 1594 1302 1594 1399 148 277 14 26	634 66493 1515 425 4468 1798 22 1	287 5494 30039 1004 509 83 41 13 7 7 7	2856 1225770 1897707 555 555 16	
sum	28218	15438	16656	20565	56699	37493	43817	

Age		1980			1981	
group	Div. 1A-1D	1E-1F	SA 1	1A-1D	1E-1F	SA 1
III	2923	76	2999	15	-	15
IV	3962	551	4513	13781	3099	16880
V	4097	483	4580	2341	3247	5588
VI	1420	558	1978	1653	739	2392
VII	1745	6269	8014	407	603	1010
VIII	47	78	125	343	2971	3314
IX	41	19	60	9	35	44
x	22	2	24	39	29	68
XI	-	-		en e	1	1
XII	5	11	16	1	-	1
XIII		3	3	e de la constante de <mark>la</mark> constante de la constante	_	· · · · · -
XIV		1	1	n na star Regelse an e se		-
XV+	<u>-</u>	2	2		6	6
Total	14262	8053	22315	18589	10776 ^{x)}	29365 ^x
Estimate	d					
Nom. cat	ch					41 1 1
(tonnes	27164	27639	54803	26945	25293	52238
Calculat	ed					
mean wei	aht					
(kg)	1.90	3.43	2.46	1.45	2.35	1.78

Table 13. Number of cod (in thousands) per age group in nominal catches in Subarea 1, 1980 and 1981.

x) incl. 1 figure of 46 for age group II.

	1978	00000000000000000000000000000000000000	0.481					
e stock in	1977	0-0-1-10-1-0 0-0-1-0 0	0.855					
ers in th	1976	00000-0000-00 00000-000000000000000000	0.754		d Vd			
d by numb	1975	00000000000000000000000000000000000000	1.004	-	weighte			
+, weighte	1974	00010000000000000000000000000000000000	0.558		F-values s 6-15+ , age group			
ages 6–15	1973	000000-00000 000000000000000 000000000	0.570		Resultant n for age in each			
l mean for	1972	COJJOC-2000000000000000000000000000000000000	0.845		od. VPA. ghted mea the stock			
s weighted	1971	00000-00000000000000000000000000000000	0.731		barea 1 c an is wei mbers in			
. Mean i	1970	00000000000000000000000000000000000000	0.494		14 a. Su Me nu			
t F-values	1969	50000000000000000000000000000000000000	0.629		Table			
Resultan	1968	00000000000000000000000000000000000000	0.686					
cod. VPA. roup.	1967	C4406408800040 08004000000000 C640500000000 C640500000000	0.575	1981	00000000000000000000000000000000000000	00000	0.540	
Subarea 1 each age g	1966	900990990990600 900406404060 600064660694 600090140460000	0.470	1980	220000000 0044000-0 6400x004x 6000000000	000-20	0.561	
le 14a.	1965	00000000000000000000000000000000000000	0.471	1979	-00.3-0000 -00000 -00000 -00000 -0000 -00000 -00000 -000000	0.0000	0.617	
Tab	8 G e	1400-000-01-01-10 00-01-01-10 00-01-10-10 00-01-10-10 00-01-10 00-00-00-00 00-00-00-00 00-00-00-00 00-00-		6 0 6	M4N0200000	NW410		

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Table 14b. Subarea 1 cod. VPA. Resultant stock size in number x 10⁻³. First sum for age groups 3-15+. Second sum for age groups 6-15+.

	1978	миф 71001 1000- 1000-0000 100-0000000000000	163947									
	1977	20000000000000000000000000000000000000	221088		d							de.t.
	1976	N ML 090-09000- 090-09000- 090-09000- 090-09000- 09000-09000- 09000-09000- 09000-09000- 09000-09000- 09000-0900- 00000-0900- 00000-0900- 0000-0900- 0000-0900- 0000-0900- 0000-0900- 0000-0900- 0000-0900- 0000-0900- 0000-0900- 0000-0900- 0000-0900- 0000-0900-0900- 0000-0900-0900- 0000-0900-0900- 000-090-09	262138		ck size i							
	1975	01000400000000000000000000000000000000	58854		ltant sto	3-15+ ₅ 6-15+						
	7261 .	C 0 C 0 C 0 C 0 C 0 C 0 C 0 C 0 C 0 C 0	64288 31318		VPA. Resu	sdnorg ege						
	1973	10000000000000000000000000000000000000	90173 24592		1 cod	x 10-5. sum for af sum for a						
	1972	40100 401000 5001 5001 5001 500 500 500 500 500	146340		2. Subare	numbers First s Second						
	1971	801001- 0080101010 0080101010 0000000000	216786 63010		fable 14 1							
	1970	мамим 900000000000000000000000000000000000	213690 85174									
	1969	00000000 0000000000000000000000000000	315178									
	1968	4 5 5 5 5 5 5 5 5 5 5 5 5 5	455202	1982	9 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	44 804000 00 00 00 00 00 00 00 00 00 00 00 0		15	2			
)-3	1967	211 211 211 211 211 211 211 211 211 211	625445 249029	1981	1321 1351 1450 1450 1464 107 107 107 107 107	8 9 8 8 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 7 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 3 8 7 9 7 8 7 8 7 9 8 7 9 8 7 9 8 7 9 8 7 9 7 9	ͽ	170181 18309 age 3 to	40 L 0	SA1-004		
3ERS X 10	1966	2020 2020 2020 2020 2020 2020 2020 202	844959	1980	1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	000 000 000 000 000 000 000 000 000 00	-0m	248154 26704 stock		cation:	26	
stock IN NUHE	1965	4 MWN NG2004 NG4 NG4 NG4 NG4 NG4 NG4 NG4 NG	939386	e 1979	2020 13020 1000 100	800-0-0-0 90-0 90-0 90-0 90-0 90-0 90-0	+	128718 49715 sum of		i dentifi.	•	
	8 0 8	UPW0400000000000000000000000000000000000	EJS	ິ		6		5				

various values of F (options 2-10) or by a constant catch level of 55.000 tonnes (option 1). First Prognoses for spawning biomass at the beginning of each year and for catch throughout the year by part of the table made on the assumption that the 1979 year class contribute

Table 15

		at trass contributes /5 mio. recruite at
when yower part of the table that	it contributes 150 mic	D. FPORTUITS B James .
F max to be 0.48 (Schumacher et al.,	1980)。	of the second of the second of the second of the second seco

	6		65 65 .268 .268 55 55	220 220 0.600 0.700 121	141 128 0.600 0.700	126 126 106 0.600 0.700	
	80		65 .268 55	220 0.550 101	148 0.550 94	138 0 .550	
	7		65 . 268 55	220 0.400 78	172 0.400 81	178 0.400	
	9		65 .268 55	220 0.300 61	190 0.300 68,	213 0.30 0	
	S		65 • 268 55	220 0.200 42	210 1.200 5 1	253 3.20 0	
	4		65 • 268 55	220 0 .10 0 22	232 0 .100 29.	303 0 .100	· · ·
	e		65 • 268 55	220 0•480 90.	159 0.480 89	155 0.480	Ĺ
	2		65. 55	0.250 52.	200 0.250 60.	232 0.250	750
			65 • 268 55	220 0.267. 55.	197 • 229 55.	234 .211	020
Ont ion so		1982	SP. biomass Fishing mort. Catch	Sp. biomass Fishing mort. Catch	1984 Sp. biomass Fishing mort. Catch	1985 Sp. biomass Fishing mort.	1986 Sp. biomass

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cont....

Tahle 15 cont.

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Figure 2. Subarea 1 cod, 1981. Weighted mean weight by age for ages 3-8, and as used in previous years' assessments for ages 9 and older (see Table 11).

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Figure 3. Subarea 1 ∞ d, 1981. Some of the samples from the offshore fishery by otter trawlers. The uppermost sample taken ashore from landings, the other samples taken from the catch on board vessels.

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Figure 4. Subarea 1 cod, 1981. Some of the inshore samples from pound nets. The samples from Div.1C and 1D are from catches before discarding undersized fish (below 40 cm), the other samples from landings at fish plants.

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Figure 5. Subarea 1 cod. Natural logarithm of numbers caught by age aværaged over the years 1979-81, and regression line for age groups 6-8. The equation for the line is y = 14.38 - 0.902 x, with r = -1.000







Figure 7. Subarea 1 cod. Estimated yield in 1983 and resultant spawning stock biomass by January 1984 for various levels of fishing mortality in 1983. Upper yield curve corresponds to the assumption of 150 mio. recruits from the 1979 year class, lower curve to 75 mio. recruits.