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International Commission for the Northwest Atlantic Fisheries

Serial No. 5028
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ADDENDUM

ANNUAL MEETING - JUNE 1977

Subarea 1 cod: Data for 1975-76 and estimates of yield for 1977-79

by

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Subarea 1 Cod

As a result of the discussion of Res.Doc. 76/VI/8 at the Meeting of the Subcommittee on Assessments, April 1977, the Subcommittee felt that some further tabulation of possible future catches and stock size would be valuable for further discussion. Such further tabulation should be based on a partial recruitment pattern as the one used in Run NS 76 D (pages 21-22) in the document.

Analyses were, therefore, made on the basis of a composition of the stock in 1976 as given on page 21 of the document and on the assumption that the relatively good year-class 1973 attracts the fishing effort so that the year-class can be considered fully recruited. All runs were made so that the catch in 1977 comes out close to the set TAC, but in the following years different F-values were applied. F-1977 was found to be about 0.18 to give a catch of 30.5 thousand tons. The results of the various runs are shown in the table below.

Stock size 1976		103760			
Spawn. biomass -		92092			
Stock size 1977		219308			
spawn. biomass -		102439			
Catch -		30494			
F 1978-80*	0.15	0.25	0.35	0.40	0 (1978) 0.25 (1979-80)
Stock size 1978	238440	238440	238440	238440	238440
Spawn. biomass -	118664	118664	118664	118664	118664
Catch -	27344	43565	58404	65435	0
Stock size 1979	237884	219199	202154	194062	269526
Spawn. biomass -	150908	136547	123553	117527	175329
Catch -	27274	39959	49267	52855	49738
Stock size 1980	236685	202967	174757	162252	243547
Spawn. biomass -	156013	128782	106330	96629	163031
Catch -	27433	37320	42801	44255	45220

* The figures given apply to fully recruited age groups (6+) and to the 1973 year-class. For age groups 3-5 (except the 1973 year-class) the relation F-values are 60%, 72% and 88% respectively, corresponding to the C-values for partial recruitment.

A theoretical sum was also made to show the effect which would have occurred by a zero TAC in 1977, assuming a level of F of 0.25 to be applied in 1978-80. This gave the following results:

Stock size 1978	275325
Spawn. biomass -	141181
Catch -	50758
Stock size 1979	248937
Spawn. biomass -	162732
Catch -	45793
Stock size 1980	225437
Spawn. biomass -	151252
Catch -	41755

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1. INTRODUCTION

The present paper follows the same lines as the paper on Subarea 1 cod presented last year (Res.Doc. 76/VI/17). However, for these parameters which have been assumed to be equal to those used last year no detailed text is given.

Although some statistical information on the 1976 fisheries may still occur the 1976 data seem to be fairly fully reported at the time when the paper was produced just prior to the April 1977 Assessment Meeting. However, the adequacy of sampling is still far from good except for the trawl fisheries. Thus no samples at all exist for the gill-net and long-line fisheries which in 1976 made up about 1/4 of the total catch in the Subarea. For these fisheries it has been necessary to construct some samples as shown in Appendix I to the paper.

2. NOMINAL CATCHES 1975 AND 1976

Complete statistics for 1975 have been published recently in Stat.Bull. Vol.25. As was the case for 1974 all catches of cod (except 209 tons) have been reported by division, but some catches are still not reported by gear and/or by month.

Table 1 gives the 1975 nominal catch by division and gear category.

For 1976 most of the major cod fishing countries have supplied statistical information directly to the author. This information covers 29100 tons. In addition to these catches it has been estimated from catch quota reports that a further 3500 tons were fished in 1976 so that the total catch of cod in 1976 in the Subarea was about 32600 tons, a decrease by about 1/3 from 1975. The provisional 1976 catches are given in Table 2.

The overall decrease from 1975 to 1976 is not evenly distributed. In fact, for the two southernmost divisions (Divs.1E-1F) there seems to have been an increase by 3-4000 tons (25-30%) so that for Divs.1A-1D the decrease is rather severe, about 19000 tons (50-55%). In 1975 the catches in Divs. 1A-1D made up about 75% of the total Subarea 1 cod catch, whereas in 1976 there is a roughly even share between Divs.1A-1D and Divs.1E-1F. For both years the otter-trawl catches made up about 60% whereas gill-net plus long-line catches made up about 25% of the catch.

3. TRENDS IN EFFORT AND CATCH PER UNIT EFFORT

Except for the very small fishery by the UK the only effort data at present available for 1976 are those for the Greenland trawlers (500-999 tonnage class). Their effort, catch and catch per unit effort for 1975 and 1976 is given in Table 3. The data indicate that the best fishing in 1975 was found in Div.1C whereas in 1976 the best fishing has been in Div.1E. There seems to have been a southward movement in the fishery. A likely explanation for this is that in 1975 the most important year class for the fishery was the 1968 year class. This year class is likely to have had a southward spawning migration (and also migration to East Greenland). At the same time the only year class of any noteworthy strength in recent years, the 1973 year class, has to some extent recruited to the fishery, especially in the last part of the year and in Div.1E, where catch per unit effort has increased. For Subarea 1 as a whole the catch per unit effort decreased only slightly (by about 10%). This refers to c.p.u.e. in terms of weight. As will be demonstrated later the overall catch in terms of number of fish did, in fact, increase in 1976 as a result of the early harvest of the 1973 year class.

4. MEAN LENGTH AND WEIGHT OF AGE GROUPS IN 1976

Apart from a length sample supplied by the UK only the Danish samples contain information on length and weight by age groups in 1976. The Danish material is set up in Table 4.

Only two samples exist from the inshore pound net fishery and very few fish of age 7 years or more are found in these samples. In the following only the offshore samples, all taken by otter trawl, are considered.

For each age group and for each quarter and unweighted mean of the mean weights given in Table 4 is taken. This unweighted mean is given in the left-hand part of Table 6. An overall weighted mean of the quarterly mean figures is given at the right-hand part of the same table, weighting factor being the quarterly catches in 1976 given as percentage of the total catch in that year as shown in Table 5.

A comparison between figures found for 1975 and those for 1976 show only slight differences between the two set of figures for the most significant age groups in the catches (age groups III-VIII). Probably the most significant difference is the one found for 3-years old fish. It would even seem proper to increase the figure of 0.85 kg given for that age group in Table 6 since, in fact, this age group was recruiting to the offshore fishery in the last half of the year. A value of about 0.90 kg mean weight seems more proper according to Table 4.

For age groups older than 8 years the material is rather scarce. It does, therefore, seem most proper to adopt the same slowly increasing set of figures as used last year. Thus the two set of figures used to calculate numbers landed in 1975 and 1976 are as follows (kg round, fresh weight)

Age group	1975	1976
III	0.71	0.90
IV	1.30	1.21
V	1.85	2.03
VI	2.67	2.71
VII	3.99	3.42
VIII	4.43	4.58
IX	5.06	5.06
X	5.60	5.60
XI	6.00	6.00
XII	6.60	6.60
XIII	7.70	7.70
XIV	9.00	9.00
XV+	10.50	10.50

5. NUMBERS LANDED BY AGE GROUPS IN 1975 and 1976

Numbers landed per age group for the years 1965-73 were given in Res. Doc. 75/31, and figures for 1974 are found in Res.Doc. 76/VI/17 together with provisional figures for 1975.

Revised figures for 1975 and provisional figures for 1976 are found in Table 7. It will be seen that the 1968 year class was the most important for the 1975 fisheries and still plays a major role in 1976, especially for the gill-net and long-line fisheries as will be shown later on in this section. The most striking feature is, however, the expected entrance to the 1976 fishery of the relatively good year class 1973, which has been harvested by about 10 mill.fish but probably also with some extra mortality due to discarding. The entrance of this new year class to the fishery has resulted in a rather steep decline in the mean weight of fish in the landings. Table 4 indicates that for some catches the mean weight has been as low as only slightly above 1 kg.

Otter-trawl landings have been fairly well sampled both in 1975 and 1976 although not completely up to the ICNAF minimum requirement. Also some samples from the inshore pound net fishery are available. However, there is a complete lack of samples of gill-net and long-line catches. These gears are known from previous years to heave a selectivity quite different from trawls and pound net. It has, therefore, been necessary to construct the likely age composition of the gill-net and long-line landings. This was also done in last year's assessment (Res.Doc.76/VI/17) by comparing Portuguese gill-net samples for 1972 and 1973 to Danish otter-trawl samples for the same years and divisions. For the 1976 samples another method has been used based on some information of the ratio between four market categories of Faroese landings by gill-netters. The method is shown in more details in Appendix I.

For the fisheries off Southeast Greenland one sample is available for 1976 (Table 4). However, statistics for this area (ICES XIV) for 1976 have only been submitted by Denmark(F) 594 tons and Denmark(G) 109 tons. Major parts of the total catch are, therefore, likely not yet to have been reported and no attempt has been done to estimate the actual amounts and numbers fished in this area. The age composition in the sample is rather similar to that in Div.1E OT-catches in August except that the inflow of age group III is rather less in the SE-Greenland sample than in the 1E sample.

6. INFORMATION ON FUTURE RECRUITMENT

Recruitment of Subarea 1 cod to the fisheries normally starts at an age of 3-4 years. The year classes in question for recruitment in 1977-79 are thus year-classes 1973-76.

Predictions of the strength of the 1976 year class can at present be made only on hydrographic and plankton observations in 1976. These will be described in the Danish Research Report, 1976, but it could be stated that all present observations point to this year class as a very poor one.

The 1975 year class has not yet had a chance to occur in any of the 1976 samples due to gear selectivity. Thus there is no new information to add to the 1975 observations on plankton and temperature. From these observations it was stated that the year class possibly could be of moderate to average size.

The 1974 year class so far has shown no signs of a noteworthy strength. It has occurred in few specimens in pound net and shrimp trawl catches but not to a degree which changes the impression of a poor year class.

By far the greatest interest for the fisheries in the late 1970ies will be the 1973 year class. As will be seen from Table 4 it has at least to some extent recruited to the fishery in 1976, and it has been completely dominating in research hauls with fine meshed trawls on the Danish standard stations in Divs. 1D and 1E (further details will occur in the Danish Res. Rep., 1976). It has been discarded in great quantities (about 50% by number) in some pound-net catches, and it is estimated to have been landed in a quantity of about 10 mill fish in 1976 (Table 7). Table 8 illustrates it's growth throughout 1976 and it will be seen that the year class is likely to occur as small fish of 40-50 cm length in trawl and pound-net catches in 1977 whereas it is not yet likely to contribute much to the gill-net and long-line catches.

The occurrence of the 1973 year class in the Danish research catches throughout 1976 seems to confirm the judgment made last year that the 1973 year class is of the same order as the 1966 and 1968 year classes, i.e. about 60 mill fish in Divs. 1A-1D and about 25 mill fish in Divs. 1E-1F. However, in 1976 cod was scarce in Divs. 1A-1B and the trends in the fishery as described in Section 3 show the main occurrence of the 1973 year class to be in Divs. 1C-1F. It is, therefore, suggested that the year class be estimated as having a size of about 40-45 mill fish (by the beginning of 1976) in each of the two regions Divs. 1A-1D and Divs. 1E-1F respectively.

The following values of recruitment (thousands of 3-years old fish) have been used in the forecasts, but actual forecasts have been made only for the Subarea as a whole since the occurrence of the 1973 year class indicates this as the most proper exercise.

Year class	Numbers x 10^{-3} at age 3 1A-1D	1E-1F	Subarea 1
1973	45000	40000	85000
1974	10-20000	10000	20-30000
1975	30000	10000	40000
1976	10000	10000	20000

7. VALUES OF INSTANTANEOUS FISHING MORTALITY RATE (F) FOR VIRTUAL POPULATION ANALYSES

On the basis of analyses of trends in fishing effort in the period 1968-74 a set of F values for fully recruited age groups was proposed in last year's assessment for the years 1965-75 (Run 3 in Res.Doc.76/VI/17).

The trends in effort and catches as described in Section 3 and illustrated in Tables 1-3 indicate that effort has dropped by about 1/4 in Divs. 1A-1D as well as in Divs. 1E-1F from 1975 to 1976. This figure is obtained by raising the Greenland effort in Table 3 to total catches for the two regions and for the two years. If the effort has declined by about 1/3 then a possible F value for 1976 would be about 0.25 in both regions. The main analyses are, therefore, carried out with the following set of F values for fully recruited age groups (6+ in Divs. 1A-1D, 7+ in Divs. 1E-1F).

	1965	1966	1967	1968	1969	1970-75	1976
1. Subarea 1	0.46	.54	.62	.80	.55	.35	.25
2. Divs. 1A-1D	0.45	.52	.68	1.00	.59	.35	.25
3. Divs. 1E-1F	0.49	.61	.55	.50	.50	.35	.25

Analyses were made both with 1975 and with 1976 as the last year of data. However, since the 1976 sampling seems at least as good as the 1975 sampling and since 1976 contributes information on the 1973 year class the forecasts considered in this paper are those based on the 1976 data.

8. PARTIAL RECRUITMENT

In former years' analyses the partial recruitment was considered to be of the same values by age as those found by the ICES/ICNAF Working Group on Cod Stocks in the North Atlantic (Anon., 1973). This implied that cod was not considered as fully recruited until an age of 6 or 7 years. The values for 3-years-old cod was set as low as 1% for Divs. 1E-1F and 9% for Divs. 1A-1D. Whereas it may still be true that full recruitment is not achieved until an age of 6 years it seems likely that the low values for younger age groups have increased in recent years. In fact, if the former partial recruitment was applied to the 1976 data then one would have to accept either that the 1973 year class had a strength of at least 370-400 mill individuals at age 3 or that F in 1976 was very much higher than argued above. It is, however, much more likely that recruitment pattern has changed in recent years. As was demonstrated by the samples in Table 4 the inshore pound-net catches and the otter-trawl catches from the last half of 1976 consisted to a great extent of the 1973 year class. It could be assumed that the year class was fully recruited to the pound-net fishery. The trawlers formerly concentrated on the mature, schooling fish in the first half of the year, and landings from this fishery made up the major part of the catches. This concentrated fishery has now been substituted by a fishery more evenly distributed throughout the year. The low stock level has meant that it has been difficult to find concentrations of cod. Thus, when the 1973 year class started to recruit as a relatively strong year class it evidently attracted the fishing effort which in previous years would have had options for fishing bigger fish.

Table 8 shows that the year-class 1973 had a mean length of about 41-42 cm in the last two quarters of 1976. This corresponds roughly to the 50% retention length for a 130 mm mesh or is possibly somewhat above (Bohl, 1967a and 1967b. Meyer, 1967. Horsted, 1969). It could thus be assumed that about 50% of the individuals were recruited to the trawl fishery in the last half of the year, when trawlers may have caught about half their total catch for that year. One could thus argue that the year class was exploited by about 1/4 of the F exerted by trawlers and by the full F exerted by pound nets. In terms of weight 1/4 of the trawlers' catch plus an estimated 4000 tons caught by pound nets make up about 1/4 of the total catch of 1976 (Table 2). In terms of numbers and thereby fishing mortality the relative catch by these gears will be much higher, possibly about half the year's catch. It would thus be reasonable to assume that the 1973 year class was fished by about 50% of the F value for fully recruited age groups in 1976. Thus, if a value of F for fully recruited age groups is considered to be about 0.25 the value for age group 3 may have been 0.10-0.15. Analyses were, therefore, made for two sets of figures for partial recruitment, viz.

Age group	Set B	Set C
3	40%	60%
4	60	72
5	80	88
6 and older	100	100

(The two set of figures are denoted B and C respectively for convenient computer registration. The figures previously used are denoted by an A).

9. OTHER PARAMETERS FOR VPA-ANALYSES AND PROGNOSES

With reference to Res.Doc.76/VI/17 the following parameter values were used again.

M = 0.20

Coefficient of emigration for 7+ fish: 0.15 for Divs. 1E-1F, 0.05 for Subarea 1 as a whole (none for Divs. 1A-1D).

Weight-by-age values for prognoses are those given for 1976 on page 3.

Recruitment figures for prognoses are given in Section 6. Two set of values were used in the prognoses, viz. one set with the lower value of year-class 1974 (20 mill for the Subarea as a whole) and another with the higher value of that year class (30 mill fish).

The model further has to get an input for recruitment in 1975, i.e. of year-class 1972 as 3-years-old fish. This has initially been set at a value of 25 mill fish. However, when the VPA runs were analysed the year class showed up as slightly higher. Consequently some runs were made with values of 35-37 mill fish at partial recruitment B and about 30 mill fish at partial recruitment C.

Prognoses were carried out for several sets of future F values (for fully recruited age groups). Details of parameters and coding for the various runs are given in Appendix II.

10. RESULTS OF THE ANALYSES AND DISCUSSION

i) The virtual population analyses

The various VPA runs gave results very similar to those obtained last year, especially so far as the stock in numbers in the various years is concerned. The exception is the run based on 1976 catch data (by number of fish caught) and maintaining the previously used figures for partial recruitment. This run (NS76-A page 16) did, for instance, lead to quite unacceptable figures for number of recruits in the order of 100-200 mill fish for the presumed very poor year classes of 1970-72 and total stock sizes 3-4 times those obtained in other runs. Clearly these figures have to be disregarded. They are caused by the assumed very low partial-recruitment figures for age-groups 3-5. As argued in Section 8 the partial-recruitment figures must have changed considerably in the last few years. The two sets of values denoted B and C used on the 1976 data lead to figures very close to those obtained last year and considered reliable (runs NS76-B and NS76-C, pages 17-20). The B and C runs naturally result in exactly the same stock size by age groups up to and including 1973 since they both have the same input values of F in 1976 for age groups 6 and older. The three acceptable runs (NS75-A, NS76-B and NS76-C, pages 14,18,20) all show the 1968 year class as being of a strength of about 100 mill fish (3 years old), the 1966 year class as about 65 mill and the 1963 year class as about 216 mill fish. Runs NS76-B and C results in estimates of the 1973 year class as 80-117 mill fish, thus being in conformity with the suggestion made last year that this year class is about the same size as were the 1966 and 1968 year classes.

The run based on 1975 data and the low values for partial recruitment (run NS75-A, page 14) results in estimates of the 1972 year class as 7.7 mill fish (3 years old). However, through 1976 Table 7 shows that about 3.8 mill fish of this year class were caught. Clearly the estimate of 7.7 mill fish (3 years old) is much too low, again likely due to an underestimated partial recruitment in 1975 of age-group 3. The 76 B and C runs lead to more likely estimates of some 30 mill recruits of this year class. As mentioned in Section 9 a value of 25 mill recruits was used initially in the prognoses. This latter figure should, therefore, be "on the safe side". Prognoses runs were, however, also made for values of 30-37 mill fish as indicated on page 9. Also the number of recruits (3 years old) from the 1971 year class differs between run 75 A and runs 76 B-C, the former leading to a figure of about 57 mill fish or more than twice the figures from the 76 B-C runs of 26-24 mill fish. This year class has contributed about 6.2 mill fish to the fisheries through the last three years and the figures of about 25 mill fish do, therefore, occur the most likely ones. This again seems to indicate that the change in partial recruitment also applied to some extent in the 1975 fisheries

ii) Forecasts

Forecasts of catches, stock sizes and spawning biomass will, of course, differ somewhat between the various runs due to differences in estimated recruitment and other parameters. Whether one or the other run reflects the true situation could be discussed. In terms of advice on future management it is, however, important to note that all predictions point to a low stock size and low catches and that for each run the relative changes in catches and stock size has the same pattern by various strategies (choise of F values). Higher F (= higher effort) would, of course, initially lead to higher catches but also to greater reduction of stock size and thereby future spawning biomass. The entrance of the relatively good 1973 year class to the spawning biomass in 1979 opens the possibility of an increase in spawning stock by that time, if fishing is kept at a low level. All runs indicate, that fishing mortality (F) should be kept at a level round 0.25 to maintain the present low spawning stock up to that time and that this level of fishing would maintain the increased spawning stock by 1979 through at least two years. Fishing below the level of F = 0.25 would allow for some increase in spawning stock from 1977 to 1978 whereas fishing above the said level would lead to further reduction of spawning stock and especially would mean that the increase in spawning stock by 1979 and 1980 will be much less than by a lower level of effort.

Table 9 illustrates predicted catches and spawning stock size by various (constant) levels of fishing mortality and by various assumptions of recruitment of the 1972 and 1974 year classes using highest estimates (year class 1972: 35-37 mill recruits by partial recruitment B, 30 mill by partial recruitment C. Year class 1974 30 mill recruits in both cases) and lowest estimates (year class 1972: 25 mill recruits for both sets of partial recruitment, year class 1974: 20 mill recruits). A concentrate of the table is given here (all figures are thousands of tons).

F =	0.15	0.25	0.35	0.40	0.60
1977 catch	19-21	30-34	41-45	46-51	64-71
1977 spawning stock	73-76	73-76	73-76	73-76	73-76
1978 catch	24-26	36-39	45-49	49-53	60-65
1978 spawning stock	82-98	74-90	69-82	68-78	53-65
1979 catch	26-29	36-41	42-48	44-50	47-54
1979 spawning stock	152-174	128-148	107-125	98-116	69-84
1980 spawning stock	149-182	115-142	88-111	77-98	45-61

It will be seen that the predicted catches and spawning stock size vary little between the highest and lowest estimates of recruitment for the two year classes mentioned. This is due to the fact that their inflow is relatively low in any case due to the predominance of the 1973 year class in the stock (and catches). In 1977 the 1973 year class is predicted to account for about 1/3 of the catch (by weight, much more by number), in 1978 and 1979 it will account for about 40% (by weight) of the catches, and when it enters the spawning stock in 1979 it will make up more than half the spawning biomass in 1979 as well as in 1980 (see figures in brackets in Table 9). Together with those year classes which have not yet been directly observed in the fisheries (year-classes 1974-77) the 1973 year class makes up about 60% of the predicted 1978 catch and about 70% of the predicted catches in 1979 and also about 2/3 of the spawning biomass by 1980. This illustrates the importance of proper estimates of the strength of the year classes which will recruit in the period for which forecast is made.

Table 9 also shows - as one would expect - that the spawning stock by 1979 will be higher than in 1977 except if fishing in the meantime exceeds a level of about F = 0.60. However, keeping fishing at a low level will result in an increase of the spawning biomass, about a doubling by 1979-80 if fishing is kept at a level of F = 0.15. By maintaining the present level of F (about 0.25) catches in 1978-79 should increase slightly but of course with less improvement in the spawning stock than by a lower level of fishing. In this connection it may be worth while to illustrate the development, which would occur in the analyses, if the 1977 catches were kept at the zero level recommended by STACRES (but not set by the Commission). The exercise has been carried out for the upper values of estimates of recruitment of the 1972 and 1974 year classes and for a level of F = 0.25 for those years where fishing takes place in the example. The exercise has also been carried further to show the effect of a zero TAC in 1977 as well as in 1978 (but with F = 0.25 in 1979), and also to show the effect if TAC was set at zero in 1978 only. The following figures arise (all in thousands of tons).

Strategy:		1	2	3	4
		F 1977-79=0.25	No fishing in 1977 F 1978-79=0.25	No fishing in 1977 and 1978 F 1979 = 0.25	F 1977 = 0.25 No fishing in 1978 F 1979 = 0.25
1977	Catch	33.3	0	0	33.3
	sp.stock	76.0	76.0	76.0	76.0
1978	catch	39.2	41.7	0	0
	sp.stock	89.7	113.6	113.6	89.7
1979	catch	40.8	42.3	51.5	44.1
	sp.stock	147.7	178.7	223.6	184.9
1980	sp.stock	141.9	168.6	207.8	175.2

The exercise demonstrates that the benefit of a zero TAC in 1977 only (Strategy 2) would have meant an increase in spawning stock by 1979-80 of about the same order as the "non-taken catch" in 1977 whereas catches in 1978 and 1979 would be only 4-6% higher than by the present management. The advise of a zero TAC in 1977 was, however, based on the desirablity of improving the spawning stock. If the 1977 as well as the 1978 fishery were stopped (Stategy 3) then again the spawning stock by 1979-80 would increase by a figure close to the combined "non-taken catches" of 1977-78, and the 1979 catch could have been allowed an increase of about 25% of the present catch estimate for 1979. Finally, if the present level of F is allowed through 1977 but fishing stopped in 1978 and re-opened in 1979 by a level of F = 0.25 (Strategy 4) then again the increase in spawning stock by 1979-80 as compared to Strategy 1 would be of about the same size as the "non-taken catch" (39 thousand tons) and the 1979 catch would be about 8% higher than in Strategy 1. The benefit to the 1979-80 spawning stock by a zero TAC in 1978 would be slightly better than that which would have been obtained through a zero TAC in 1977.

In last year's Assessment Report it was stated that a zero TAC for 1977 would ensure a better yield per recruit of the 1973 year class. That year class is expected to occur in the 1977 catches in great numbers as fish of a length between 40 and 50 cm and a mean weight of 1-1.5 kg. The mean weight would be assumed to increase by about 2/3 from 1977 to 1978. This was part of the background for the advice of a zero TAC in 1977. From 1978 to 1979 the mean weight of the individuals of this year class is likely to increase by about 1/3 (and die by a rate of close to 20% annually) so although the argument is weaker than last year it would still be true that an improvement in yield per recruit of the year class would be gained by keeping fishing at a lew level until 1979.

A comparison of the spawning stock size given in last year's report (Redbook 1976, page 70) and the present analyses shows that the estimate of the spawning stock size by 1 January 1977 according to last year's assessment was about 130 thousand tons whereas it is estimated to be only 73-76 thousand tons in the present estimates. The change is not reflecting an actual event in the spawning stock between the two years (except that emigration of the 1968 year class to East Greenland may have been higher than presumed) but is the effect of revised data. The 1975 data were probably less reliable, especially in the age composition of catches, than the present 1976 data. At the same time the change in estimated partial recruitment between the two assessments would lead to some decrease in estimates of stock size (see discussion of VPA in Section 10 i). The true stock size may not be given by any of the figures since both may be biassed. It could, for instance, well be the case that the entrance of the 1973 year class to the fishery has meant that the major part of the effort has been directed specifically at this year class (which physically could be possible if the 3 year olds form separate schools) so that F on other year classes is lower than presumed (this would raise the calculated spawning stock size)[x)]. In any case the spawning stock is definitely low, and the various strategies will reflect the relative changes in the situation whether the stock size is correctly estimated or somewhat biassed.

11. COD AT EAST GREENLAND

As explained in Section 5 it has not yet been possible to estimate catches and numbers caught by age groups for this area in 1976. No specific analyses

x) See VPA-run 76D, page 22.

for the combined ICNAF Divs. 1E-1F + ICES Subarea XIV cod fisheries have, therefore, been carried out. However, if the distribution of cod in the combined area is as assumed in last year's assessment (which to a great extent was based upon the report of the ICES North-Western Working Group, 1976) then the suggestion from last year's Assessment Report could be reiterated, viz. that a catch for the Greenland area as a whole (ICNAF Subarea 1 + ICES Subarea XIV) would be about 25% greater than that at West Greenland for the same level of F at East and West Greenland. The importance of the East Greenland area as a potential spawning area for the West Greenland cod stock(s) should, however, be borne in mind. It seems most likely that the East Greenland area is the main spawning area for the 1968 year class in 1976-77 (and following years), and it is also most likely that the 1973 year class will have this region as it's major spawning area when it forms the major part of the spawning stock in the period from 1979/80 and until it is substituted by new significant year classes (if any).

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VIRTUAL POPULATION ANALYSIS COD

1A-1D + 1E-1F

FISHING MORTALITIES BY YEAR AND BY AGE

AGE	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
3	0.08	0.01	0.03	0.05	0.01	0.00	0.00	0.00	0.01	0.01
4	0.18	0.06	0.10	0.17	0.25	0.06	0.08	0.14	0.15	0.05
5	0.34	0.31	0.34	0.37	0.29	0.34	0.32	0.51	0.35	0.23
6	0.40	0.46	0.58	0.65	0.52	0.37	0.59	0.76	0.29	0.25
7	0.55	0.51	0.60	0.78	0.82	0.57	0.60	0.58	0.37	0.17
8	0.46	0.64	0.49	0.56	0.78	0.67	1.03	0.71	0.43	0.51
9	0.63	0.40	0.63	0.72	0.62	0.43	0.88	1.12	0.98	0.49
10	0.45	0.72	0.66	0.63	0.52	0.35	0.59	0.78	0.81	0.43
11	0.63	0.46	0.46	0.77	0.39	0.29	0.52	0.76	0.52	0.72
12	0.53	0.36	0.29	0.51	0.59	0.25	0.26	1.03	0.46	1.57
13	0.19	0.61	1.20	0.19	0.21	0.35	0.25	1.00	0.37	1.80
14	0.09	0.70	0.69	1.41	0.57	0.22	0.44	0.51	0.99	2.11
15	0.46	0.54	0.62	0.80	0.55	0.35	0.35	0.35	0.35	0.35
MEAN-F A>= 7	0.50	0.51	0.60	0.72	0.76	0.54	0.78	0.75	0.49	0.41

AGE	1975
3	0.04
4	0.09
5	0.18
6	0.28
7	0.35
8	0.35
9	0.35
10	0.35
11	0.35
12	0.35
13	0.35
14	0.35
15	0.35
MEAN-F A>= 7	0.35

THE LAST AGEGROUP IS A PLUS GROUP

RUN. 770404 / 1336
RUN NO. ~~N075-1~~

NS 75 A

VIRTUAL POPULATION ANALYSIS COD

1A-1D + 1E-1F

STOCK IN NUMBERS AT BEGINNING OF YEAR

AGE	1965	1966	1967	1968	1969
3	200025	216372	68779	79336	65880
4	376394	150990	175768	54752	61558
5	201604	256895	116516	130297	37643
6	30270	117943	154491	68037	73756
7	26023	16657	60759	71146	29050
8	47141	11660	7820	25965	25443
9	6776	23290	4777	3738	11517
10	1735	2802	12105	1986	1415
11	1163	857	1064	4880	823
12	5216	482	421	522	1766
13	480	2399	262	246	243
14	506	308	1015	61	160
15	426	361	119	398	12
	897756	901016	603896	441364	309266

AGE	1970	1971	1972	1973	1974
3	43463	103998	21793	28266	56582
4	53340	35540	84901	17829	23024
5	39245	41173	26826	60463	12523
6	22991	22842	24569	13197	34795
7	35818	13019	10397	9392	8050
8	9933	15730	5586	4547	5040
9	9065	3947	4357	2138	2315
10	4812	4608	1278	1105	627
11	655	2629	1986	455	382
12	434	380	1218	722	210
13	763	264	228	337	355
14	154	419	161	65	182
15	70	96	209	75	19
	220743	244645	183511	138591	144104

AGE	1975
3	7733
4	46016
5	17876
6	8108
7	22246
8	5274
9	2352
10	1106
11	319
12	144
13	34
14	46
15	17
	111 271

RUN 770404 / 1336
RUN NO

NS 75 A

VIRTUAL POPULATION ANALYSIS COD

1A-1D + 1E-1F

FISHING MORTALITIES BY YEAR AND BY AGE

AGE	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
3	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
4	0.07	0.02	0.04	0.06	0.10	0.02	0.04	0.06	0.09	0.03
5	0.34	0.31	0.34	0.37	0.29	0.36	0.34	0.68	0.42	0.44
6	0.40	0.46	0.57	0.64	0.52	0.37	0.63	0.85	0.47	0.32
7	0.55	0.51	0.60	0.77	0.80	0.57	0.59	0.65	0.45	0.33
8	0.46	0.64	0.49	0.56	0.77	0.64	1.03	0.71	0.53	0.70
9	0.63	0.40	0.63	0.72	0.62	0.42	0.79	1.11	0.96	0.70
10	0.45	0.72	0.66	0.63	0.52	0.35	0.57	0.63	0.79	0.41
11	0.63	0.46	0.46	0.77	0.39	0.29	0.52	0.72	0.36	0.69
12	0.53	0.36	0.29	0.51	0.59	0.25	0.26	1.03	0.41	0.71
13	0.19	0.61	1.20	0.19	0.21	0.35	0.25	1.00	0.37	1.36
14	0.09	0.70	0.69	1.41	0.57	0.22	0.44	0.51	0.99	2.11
15	0.46	0.54	0.62	0.80	0.55	0.35	0.35	0.35	0.35	0.35
MEAN-F A>= 7	0.50	0.51	0.60	0.72	0.75	0.54	0.77	0.77	0.55	0.59

AGE	1975	1976
3	0.00	0.03
4	0.05	0.06
5	0.27	0.13
6	0.71	0.20
7	0.50	0.25
8	0.92	0.25
9	0.59	0.25
10	0.64	0.25
11	0.34	0.25
12	0.33	0.25
13	0.08	0.25
14	0.18	0.25
15	0.35	0.25
MEAN-F A>= 7	0.55	0.25

THE LAST AGEGROUP IS A PLUS GROUP

RUN: 770404 / 1350
RUN NO.: ~~NS76-1~~

NS 76 A

VIRTUAL POPULATION ANALYSIS COD

1A-1D + 1E-1F

STOCK IN NUMBERS AT BEGINNING OF YEAR

AGE	1965	1966	1967	1968	1969
3	1095470	1220490	364331	380483	361802
4	2030990	884109	997875	296729	308113
5	201604	257228	117195	130350	37686
6	30270	117943	154763	68591	73798
7	26023	16657	60759	71367	29501
8	47141	11660	7820	25965	25614
9	6776	23290	4777	3738	11517
10	1735	2802	12105	1986	1415
11	1163	857	1064	4880	823
12	5216	482	421	522	1766
13	480	2399	262	246	243
14	506	308	1015	61	160
15	426	361	119	398	12
	3447800	1318096	1722506	985316	852450

AGE	1970	1971	1972	1973	1974
3	201727	498231	72678	116786	197918
4	295620	165116	407672	59490	95498
5	37875	39144	21562	52058	7341
6	23026	21722	22911	8912	27930
7	35853	13047	9486	8049	4550
8	10279	15757	5608	3843	3997
9	9196	4214	4378	2155	1769
10	4812	4710	1483	1120	640
11	655	2629	2066	613	394
12	434	380	1218	782	333
13	763	264	228	337	402
14	154	419	161	65	182
15	70	96	209	75	19
	620464	765729	549660	254285	340973

AGE	1975	1976
3	182933	377762
4	161732	149524
5	12588	20772
6	3872	7899
7	16633	1560
8	2551	7853
9	1546	788
10	684	666
11	329	280
12	154	183
13	128	86
14	80	91
15	17	52
	383247	567516

RUN: 770404 / 1350

RUN NO. : ~~NS76 1~~

NS 76 A

VIRTUAL POPULATION ANALYSIS COD

1A-1D + 1E-1F

FISHING MORTALITIES BY YEAR AND BY AGE

AGE	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
3	0.08	0.01	0.03	0.06	0.01	0.00	0.00	0.00	0.01	0.01
4	0.18	0.06	0.10	0.17	0.26	0.06	0.10	0.16	0.25	0.09
5	0.34	0.31	0.34	0.37	0.29	0.36	0.34	0.68	0.42	0.44
6	0.40	0.46	0.57	0.64	0.52	0.37	0.63	0.85	0.47	0.32
7	0.55	0.51	0.60	0.77	0.80	0.57	0.59	0.65	0.45	0.33
8	0.46	0.64	0.49	0.56	0.77	0.64	1.03	0.71	0.53	0.70
9	0.63	0.40	0.63	0.72	0.62	0.42	0.79	1.11	0.96	0.70
10	0.45	0.72	0.66	0.63	0.52	0.35	0.57	0.63	0.79	0.41
11	0.63	0.46	0.46	0.77	0.39	0.29	0.52	0.72	0.36	0.69
12	0.53	0.36	0.29	0.51	0.59	0.25	0.26	1.03	0.41	0.71
13	0.19	0.61	1.20	0.19	0.21	0.35	0.25	1.00	0.37	1.36
14	0.09	0.70	0.69	1.41	0.57	0.22	0.44	0.51	0.99	2.11
15	0.46	0.54	0.62	0.80	0.55	0.35	0.35	0.35	0.35	0.35
MEAN-F A>= 6	0.47	0.48	0.58	0.69	0.63	0.49	0.72	0.81	0.52	0.40

AGE	1975	1976
3	0.01	0.10
4	0.21	0.15
5	0.32	0.20
6	0.71	0.25
7	0.50	0.25
8	0.92	0.25
9	0.59	0.25
10	0.64	0.25
11	0.34	0.25
12	0.33	0.25
13	0.08	0.25
14	0.18	0.25
15	0.35	0.25
MEAN-F A>= 6	0.58	0.25

THE LAST AGEGROUP IS A PLUS GROUP

RUN. 770405 / 1205
RUN NO. ~~N676-3~~
NI 76 B

VIRTUAL POPULATION ANALYSIS COD

1A-1D + 1E-1F
STOCK IN NUMBERS AT BEGINNING OF YEAR

AGE	1965	1966	1967	1968	1969
3	201038	216450	68842	77290	62853
4	376799	151819	175832	54804	59882
5	201604	257228	117195	130350	37686
6	30270	117943	154763	68591	73798
7	26023	16657	60759	71367	29501
8	47141	11660	7820	25965	25614
9	6776	23290	4777	3738	11517
10	1735	2802	12105	1986	1415
11	1163	857	1064	4880	823
12	5216	482	421	522	1766
13	480	2399	262	246	243
14	506	308	1015	61	160
15	426	361	119	398	12
	899177	802256	604974	440198	305270

AGE	1970	1971	1972	1973	1974
3	35610	91454	14057	17764	26022
4	50862	29110	74631	11495	14426
5	37875	39144	21562	52058	7341
6	23026	21722	22911	8912	27930
7	35853	13047	9486	8049	4550
8	10279	15757	5608	3843	3997
9	9196	4214	4378	2155	1769
10	4812	4710	1483	1120	640
11	655	2629	2066	613	394
12	434	380	1218	782	333
13	763	264	228	337	402
14	154	419	161	65	182
15	70	96	209	75	19
	209589	222946	157998	167268	88005

AGE	1975	1976
3	36976	117184
4	20995	30025
5	10837	13953
6	3872	6467
7	16633	1560
8	2551	7853
9	1546	788
10	684	666
11	329	280
12	154	183
13	128	86
14	80	91
15	17	52
	94802	179188

RUN: 770405 / 1205
RUN NO. : ~~NS76-6~~

NS 76 B

VIRTUAL POPULATION ANALYSIS COD

1A-1D + 1E-1F

FISHING MORTALITIES BY YEAR AND BY AGE

AGE	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
3	0.08	0.01	0.03	0.06	0.01	0.00	0.00	0.00	0.01	0.02
4	0.18	0.06	0.10	0.17	0.26	0.06	0.10	0.16	0.25	0.09
5	0.34	0.31	0.34	0.37	0.29	0.36	0.34	0.68	0.42	0.44
6	0.40	0.46	0.57	0.64	0.52	0.37	0.63	0.85	0.47	0.32
7	0.55	0.51	0.60	0.77	0.80	0.57	0.59	0.65	0.45	0.33
8	0.46	0.64	0.49	0.56	0.77	0.64	1.03	0.71	0.53	0.70
9	0.63	0.40	0.63	0.72	0.62	0.42	0.79	1.11	0.96	0.70
10	0.45	0.72	0.66	0.63	0.52	0.35	0.57	0.63	0.79	0.41
11	0.63	0.46	0.46	0.77	0.39	0.29	0.52	0.72	0.36	0.69
12	0.53	0.36	0.29	0.51	0.59	0.25	0.26	1.03	0.41	0.71
13	0.19	0.61	1.20	0.19	0.21	0.35	0.25	1.00	0.37	1.36
14	0.09	0.70	0.69	1.41	0.57	0.22	0.44	0.51	0.99	2.11
15	0.46	0.54	0.62	0.80	0.55	0.35	0.35	0.35	0.35	0.35
MEAN-F A>= 6	0.47	0.48	0.58	0.69	0.63	0.49	0.72	0.81	0.52	0.40

AGE	1975	1976
3	0.01	0.15
4	0.23	0.18
5	0.32	0.22
6	0.71	0.25
7	0.50	0.25
8	0.92	0.25
9	0.59	0.25
10	0.64	0.25
11	0.34	0.25
12	0.33	0.25
13	0.08	0.25
14	0.18	0.25
15	0.35	0.25
MEAN-F A>= 6	0.58	0.25

THE LAST AGEGROUP IS A PLUS GROUP

RUN: 770405 / 1201

RUN NO. ~~NS76 2~~

NS 76 C

VIRTUAL POPULATION ANALYSIS COD

1A-1D + 1E-1F

STOCK IN NUMBERS AT BEGINNING OF YEAR

AGE	1965	1966	1967	1968	1969
3	201038	216450	68842	77290	62853
4	376799	151819	175832	54804	59882
5	201604	257228	117195	130350	37686
6	30270	117943	154763	68591	73798
7	26023	16657	60759	71367	29501
8	47141	11660	7820	25965	25614
9	6776	23290	4777	3738	11517
10	1735	2802	12105	1986	1415
11	1163	857	1064	4880	823
12	5216	482	421	522	1766
13	480	2399	262	246	243
14	506	308	1015	61	160
15	426	361	119	398	12
	899177	802256	604974	440198	305270

AGE	1970	1971	1972	1973	1974
3	35610	91454	14057	17764	24305
4	50862	29110	74631	11495	14426
5	37875	39144	21562	52058	7341
6	23026	21722	22911	8912	27930
7	35853	13047	9486	8049	4550
8	10279	15757	5608	3843	3997
9	9196	4214	4378	2155	1769
10	4812	4710	1483	1120	640
11	655	2629	2066	613	394
12	434	380	1218	782	333
13	763	264	228	337	402
14	154	419	161	65	182
15	70	96	209	75	19
	209589	222946	157998	107268	86288

AGE	1975	1976
3	31297	79992
4	19590	25376
5	10837	12803
6	3872	6467
7	16633	1560
8	2551	7853
9	1546	788
10	684	666
11	329	280
12	154	183
13	128	86
14	80	91
15	17	52
	87718	136197

RUN: 770405 / 1202

RUN NO. : ~~N076-2~~

NS 76 C

VIRTUAL POPULATION ANALYSIS COD

1A-1D + 1E-1F
STOCK IN NUMBERS AT BEGINNING OF YEAR

AGE	1965	1966	1967	1968	1969
3	201314	216658	69172	77680	63572
4	376895	152045	176003	55074	60202
5	201604	257306	117380	130489	37906
6	30270	117943	154827	68743	73912
7	26023	16657	60759	71419	29624
8	47141	11660	7820	25965	25654
9	6776	23290	4777	3738	11517
10	1735	2802	12105	1986	1415
11	1163	857	1064	4880	823
12	5216	482	421	522	1766
13	480	2399	262	246	243
14	506	308	1015	61	160
15	426	361	119	398	12
	899549	802768	605724	441201	306806

AGE	1970	1971	1972	1973	1974
3	36269	96471	14835	23643	30745
4	51450	29650	78738	12132	19239
5	38136	39626	22004	55420	7862
6	23206	21936	23305	9271	30675
7	35946	13195	9659	8368	4843
8	10374	15829	5722	3977	4244
9	9227	4287	4432	2243	1873
10	4812	4734	1539	1162	707
11	655	2629	2085	656	426
12	434	380	1218	796	367
13	763	264	228	337	413
14	154	419	161	65	182
15	70	96	209	75	19
	211496	229516	164135	118145	101595

AGE	1975	1976
3	34846	61417
4	24862	28281
5	14778	17117
6	4298	9690
7	18877	1906
8	2779	9592
9	1737	962
10	764	813
11	381	341
12	178	224
13	154	106
14	89	112
15	17	58
	103760	130620

RUN: 770413 / 1533
RUN NO. : NS76D

NS 76 D

VIRTUAL POPULATION ANALYSIS COD

1A-1D + 1E-1F

FISHING MORTALITIES BY YEAR AND BY AGE

AGE	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
3	0.08	0.01	0.03	0.05	0.01	0.00	0.00	0.00	0.01	0.01
4	0.18	0.06	0.10	0.17	0.26	0.06	0.10	0.15	0.23	0.06
5	0.34	0.31	0.34	0.37	0.29	0.35	0.33	0.66	0.39	0.40
6	0.40	0.46	0.57	0.64	0.52	0.36	0.62	0.82	0.45	0.29
7	0.55	0.51	0.60	0.77	0.80	0.57	0.59	0.64	0.43	0.31
8	0.46	0.64	0.49	0.56	0.77	0.63	1.02	0.69	0.50	0.64
9	0.63	0.40	0.63	0.72	0.62	0.42	0.77	1.09	0.90	0.65
10	0.45	0.72	0.66	0.63	0.52	0.35	0.57	0.60	0.75	0.37
11	0.63	0.46	0.46	0.77	0.39	0.29	0.52	0.71	0.33	0.62
12	0.53	0.36	0.29	0.51	0.59	0.25	0.26	1.03	0.41	0.62
13	0.19	0.61	1.20	0.19	0.21	0.35	0.25	1.00	0.37	1.29
14	0.09	0.70	0.69	1.41	0.57	0.22	0.44	0.51	0.99	2.11
15	0.46	0.54	0.62	0.80	0.55	0.35	0.35	0.35	0.35	0.35
MEAN-F A>= 6	0.47	0.48	0.58	0.69	0.63	0.49	0.71	0.79	0.50	0.36

AGE	1975	1976
3	0.01	0.20
4	0.17	0.16
5	0.22	0.16
6	0.61	0.16
7	0.43	0.20
8	0.81	0.20
9	0.51	0.20
10	0.55	0.20
11	0.28	0.20
12	0.27	0.20
13	0.07	0.20
14	0.17	0.20
15	0.35	0.20
MEAN-F A>= 6	0.49	0.18

THE LAST AGEGROUP IS A PLUS GROUP

RUN: 770413 / 1532
RUN NO NS76D

NS 76 D

TABLE 1. Nominal catch (metric tons x 10^{-3}) of cod in Subarea 1, 1975 according to ICNAF Stat.Bull.Vol.25.

Catches reported as taken by unknown gear by Denmark (total 5355 tons) in Divs. 1B-1E have been assumed to be mainly gill-net catches (4000 tons) but may include some long-line catches, the rest (1355 tons) is assumed to be trawl catches. Faroese trawl catches have been assumed to constitute the total Faroese catch in Divs. 1B and 1C. The remainder of the assumed Faroese trawl catches (1329 tons) have been allocated to Divs. 1D and 1E in the same proportion as the Greenland trawl catches for these two divisions. Catches under unknown gear are Greenland small boat catches, the main gear being pound net.

Div.	Otter trawl	Set gill net	Long line	Unknown	TOTAL
1A	-	-	-	216	216
1B	70	26	3	1 036	1 135
1C	15 935	1 882	772	1 930	20 519
1D	6 370	5 982	214	1 269	13 835
1E	4 275	1 528	1 171	964	7 938
1F	2 696	-	430	1 140	4 266
TOTAL	29 346	9 418	2 590	6 555	47 909

TABLE 2. Preliminary nominal catch (metric tons x 10^{-3}) of cod in Subarea 1, 1976. Catches taken as reported for the Assessment Meeting, April 1977 or estimated by the author on the basis of monthly quota reports and/or on the national quotas (see footnote).

Div.	Otter trawl	Set gill net	Long line	Unknown	TOTAL
1A	5	-	-	161	166
1B	9	2	28	683	722
1C	3 691	1 550	567	1 131	6 939
1D	7 251	701	126	919	8 997
1E	6 516	2 462	901	1 357	11 236
1F	1 527	1 250	845	928	4 550
TOTAL	18 999	5 965	2 467	5 179	32 610

Footnote:	Fully reported catches (by gear and divisions) apply for	20 244 tons
	Catches reported by gear but not by divisions " "	4 514 "
	" " by divisions but not by gear " "	4 352 "
	Catches estimated or guessed " "	3 500 "

TABLE 3. Effort (hours fished), catch of cod and catch per unit effort for the Greenland trawlers (500-999 tonnage class) in 1975 and 1976.

	1975			1976		
Div.	hours	tons cod	kg/hr	hours	tons cod	kg/hr
1B	1263	67	53	127	6	47
1C	7857	9659	1229	5004	2995	599
1D	5124	1430	279	5494	3167	576
1E	3246	1309	403	6319	4834	765
1F	299	82	274	3	4	(1333)
TOTAL	17789	12547	705	16947	11006	649

TABLE 4. Subarea 1 cod, 1976. Danish samples. Only fish which were aged and weighted are given here and since these were sampled stratified the table does not give the length nor the age frequency. Overall mean lengths and weights are, however, calculated on basis of the total (random) length sample.
cm = uncorrected mean total length in cm (below) ± standard deviation.
kg = mean weight in kg round, fresh weight ± standard deviation. Most fish from commercial samples were actually weighted as gutted iced fish and were converted to round, fresh weight by a conversion factor of 1.22.
Information on discard obtained through vessels' logbooks is indicated by x) whereas information obtained through direct observation is indicated by xx).
Samples are from offshore areas unless otherwise indicated.

Age group	Divs. Month Gear	1C+1D January OTB comm.		1C+1D+1E March OTB comm.		1D+1E June-July OTB comm.		1D September OTB comm.		1D December OTB comm.	
III	Nos.	4		26		85		97		122	
	cm	40.8	1.8	39.9	0.9	45.5	2.97	44.1	2.6	45.2	3.0
	kg	0.76	0.11	0.57	0.02	0.89	0.14	0.92	0.13	0.95	0.15
IV	Nos.	32		112		65		71		59	
	cm	46.4	2.7	45.2	3.4	50.2	4.27	48.5	2.7	50.6	3.0
	kg	1.03	0.15	0.85	0.16	1.18	0.23	1.21	0.17	1.30	0.19
V	Nos.	164		155		73		7		25	
	cm	60.2	5.0	58.0	5.6	59.5	3.75	62.9	5.8	57.7	2.6
	kg	2.22	0.43	1.80	0.41	1.85	0.26	2.65	0.63	1.94	0.22
VI	Nos.	77		31		75		4		7	
	cm	67.9	3.7	65.4	5.0	66.2	4.30	73.0	2.2	61.4	3.9
	kg	3.05	0.45	2.50	0.45	2.52	0.44	3.99	0.51	2.30	0.33
VII	Nos.	30		8		27		-		3	
	cm	75.9	4.9	70.9	6.3	72.4	5.04			66.7	0.6
	kg	4.33	0.79	2.80	0.82	3.32	0.56			3.07	0.33
VIII	Nos.	34		7		129		3		-	
	cm	72.8	10.1	78.8	8.3	77.9	6.48	84.7	0.6		
	kg	4.07	1.58	4.26	0.97	4.21	0.86	5.69	0.12		
IX	Nos.	10		2		15		-		-	
	cm	74.1	7.5	74.8	10.1	80.6	4.66				
	kg	4.22	1.30	3.65	1.13	4.59	0.75				
X	Nos.	5		2		18		-		-	
	cm	91.6	12.9	73.1	9.2	87.4	5.92				
	kg	8.28	2.88	3.34	0.93	5.95	0.97				
XI	Nos.	4		1		7		-		-	
	cm	82.9	9.5	85.0	-	91.7	11.41				
	kg	6.22	2.44	5.49	-	6.99	2.07				
XII	Nos.	-		-		-		-		1	
	cm									85.0	-
	kg									5.37	-
XIII	Nos.	-		1		2		-		-	
	cm			83.0	-	87.5	4.95				
	kg			4.76	-	6.03	0.72				
XIV	Nos.	-		-		2		-		1	
	cm					83.9	4.52			106.0	-
	kg					5.11	0.72			12.20	-
XV+	Nos.	-		-		-		-		-	
	cm										
	kg										
Overall mean length		63.8		50.1		61.9		45.9		46.9	
Overall mean weight		2.52		1.25		2.39		1.05		1.08	
Discard of cod		none x)		none x)		none x)		none x)		none x)	
Nos. aged and weighted		360		345		498		182		218	
Ref.no.		2586		2588		2603		2616		2647	cont.

TABLE 4 cont.

Age group	Divs. Month Gear	1E August OTB comm.		1E October OTB comm.		SE Greenland June OTB comm		1D inshore June FPN (catch)		1D inshore July FPN (landing)	
III	Nos.	212		122		22		450		27	
	cm	45.4	2.5	44.2	4.0	42.9	1.9	39.7	4.8	44.3	0.9
	kg	0.83	0.12	0.90	0.18	0.76	0.08	-		-	
IV	Nos.	128		59		120		94		42	
	cm	50.7	3.8	52.4	3.0	50.6	3.0	44.7	3.9	46.7	2.0
	kg	1.16	0.21	1.44	0.20	1.18	0.24	-		-	
V	Nos.	95		25		83		51		92	
	cm	60.8	4.1	57.9	2.7	57.8	5.6	48.4	6.0	50.8	3.6
	kg	1.95	0.30	1.95	0.23	1.73	0.38	-		-	
VI	Nos.	81		7		108		29		50	
	cm	70.4	6.6	61.6	3.8	68.2	5.0	59.5	7.6	56.0	7.2
	kg	2.99	0.71	2.31	0.33	2.73	0.46	-		-	
VII	Nos.	15		3		35		3		6	
	cm	78.3	10.1	66.7	0.6	76.8	4.3	81.0	-	62.6	7.2
	kg	4.19	1.30	3.07	0.33	3.85	0.51	-		-	
VIII	Nos.	118		-		81				1	
	cm	82.5	7.1			80.7	5.0	-		68.0	-
	kg	4.64	0.90			4.43	0.65			-	
IX	Nos.	9		-		20					
	cm	85.5	8.7			87.5	4.9	-		-	
	kg	5.13	1.18			5.64	0.76				
X	Nos.	8		-		4					
	cm	90.3	5.5			91.8	2.4	-		-	
	kg	5.91	0.78			6.50	0.47				
XI	Nos.	3		-		1					
	cm	101.0	6.4			94.0	-	-		-	
	kg	8.59	1.53			5.98	-				
XII	Nos.	1		1		3					
	cm	100.0	-	85.0	-	92.4	7.6	-		-	
	kg	7.81		5.37		6.71	1.31				
XIII	Nos.	1		-		-				1	
	cm	83.0	-					-		103.0	-
	kg	4.76								-	
XIV	Nos.	-		1		1					
	cm			106.0	-	87.0	-	-		-	
	kg			12.2		5.04					
XV+	Nos.	2		-		1					
	cm	108.0	-			94.0		-		-	
	kg	12.87				5.98					
Overall mean length		54.4		47.1		60.9		40.7		48.5	
Overall mean weight		1.67		1.06		2.20		no weights given		no weights given	
Discard, cod		10-25% by number xx)		none x)		none x)		about 50% xx) by number		about 50% xx) by number	
Nos. aged and weighted		673		218		479		627		219	
Ref.no.		2611		2628		2599		2598		5233	

TABLE 5. Nominal catch of Subarea 1 cod by quarter of the year. Only catches specified by month are used for the percentages.

Quarter		1	2	3	4	Total specified catch in % of total nominal catch
1975	tons	9919	12521	7880	5333	35653
	%	27.8	35.1	22.1	15.0	74.4
1976	tons	5996	4167	4814	11105	26082
	%	23.0	16.0	18.4	42.6	80.0

TABLE 6. Mean weight (kg round, fresh) by age as obtained from Table 4, offshore samples and as weighted by quarterly mean catch index for 1976 as given in Table 5. The weighted mean figures obtained by the 1975 samples as presented in Res.Doc. 76/VI/17 are shown for comparison. The sample from SE Greenland is not included. Figures in brackets are those based on less than five fish.

Age group	Unweighted mean by quarter			Weighted annual mean	Res.Doc. 76/VI/17
	1	2+3	4		
III	0.67	0.88	0.93	0.85	0.71
IV	0.94	1.18	1.37	1.21	1.30
V	2.01	2.15	1.95	2.03	1.85
VI	2.78	3.17	2.31	2.71	2.67
VII	3.57	3.76	3.07	3.42	3.99
VIII	4.17	4.85		4.58	4.43
IX	3.94	4.86		4.49	5.06
X	5.81	5.93		5.88	5.60
XI	5.86	7.79		7.02	7.92
XII		(7.81)	(5.37)	(6.46)	5.16
XIII	(4.76)	(5.40)		(5.14)	6.11
XIV		(5.11)	(12.20)	(9.03)	8.51
XV+		(12.87)		(12.87)	10.11

TABLE 7. Number of cod ($x\ 10^{-3}$) per age group in nominal catches 1975 and provisional figures for 1976.

Age group	1975 1A - 1D	1975 1E - 1F	1975 Subarea 1	1976 1A -1D	1976 1E - 1F	1976 Subarea 1
III	146	129	275	4472	5652	10124
IV	3324	271	3595	2262	1538	3800
V	2314	363	2677	1715	585	2300
VI	1673	130	1803	805	497	1302
VII	3529	2326	5855	168	139	307
VIII	1131	257	1388	600	945	1545
IX	533	86	619	81	74	155
X	256	35	291	49	82	131
XI	28	56	84	24	31	55
XII	26	12	38	10	26	36
XIII	0	9	9	6	11	17
XIV	12	0	12	8	10	18
XV+	10	0	10	8	18	26
TOTAL	12982	3674	16656	10208	9608	19816
Nom.catch tons	35705	12204	47909	16824	15785	32610
Calculated mean weight kg	2.75	3.32	2.88	1.65	1.64	1.65

TABLE 8. Mean length and weight of 3-years old cod caught by R/V ADOLF JENSEN on the standard stations in Divs. 1D and 1E, 1976. All hauls were made by fine meshed otter trawl (shrimp trawl, 40 mm cod-end mesh size). Only samples with more than 25 specimens of age-group 3 are given.

Month	Div.	Mean length (cm below)	Mean weight (kg, round fresh)	Nos.	Ref.no.
JAN	1D	33.6 ± 3.3	0.36 ± 0.10	135	5176
FEB	1E	30.0 ± 3.0	0.24 ± 0.08	147	5177
APR	1D	34.6 ± 3.9	0.37 ± 0.14	157	5186
JUN	1D	34.6 ± 4.1	0.37 ± 0.14	134	5206, 5209, 5214
JUN	1E	32.0 ± 4.1	0.26 ± 0.11	109	5205
SEP	1E	40.6 ± 4.6	0.65 ± 0.21	83	5322
NOV	1E	41.6 ± 4.6	0.68 ± 0.24	175	5335

Table 9. Predicted catches and spawning biomass (at the beginning of each year) by various constant levels of fishing mortality and by various assumptions of recruitment and partial recruitment (see Section 8). Figures outside brackets are thousands of tons. First figure in bracket shows the percentage which the 1973 year class makes up of the catch and spawning stock, second figure the percentage which the 1974-77 year classes account for.

Partial Recruitment B.

	F =		0.15	0.25	0.35	0.40	0.60
Recruitment by year classes 1972: 35-37 mill. 1974: 30 mill.	1977	catch	21(29/7)	33(29/7)	45(29/7)	50(29/7)	70(30/7)
		sp.stock	76(0/0)	76(0/0)	76(0/0)	76(0/0)	76(0/0)
	1978	catch	26(38/16)	39(38/17)	49(38/18)	53(38/18)	65(39/21)
		sp.stock	98(0/0)	90(0/0)	82(0/0)	78(0/0)	65(0/0)
	1979	catch	29(40/26)	41(40/28)	48(39/30)	50(39/31)	54(38/37)
		sp.stock	174(53/0)	148(55/0)	125(56/0)	116(56/0)	84(59/0)
	1980	sp.stock	182(45/19)	142(46/20)	111(46/21)	98(46/22)	61(46/25)
1972: 25 mill. 1974: 20 mill	1977	catch	19(31/5)	30(32/5)	41(32/5)	46(32/5)	64(33/5)
		sp.stock	76(0/0)	76(0/0)	76(0/0)	76(0/0)	76(0/0)
	1978	catch	24(41/14)	36(41/15)	45(42/16)	49(42/16)	60(43/19)
		sp.stock	87(0/0)	79(0/0)	72(0/0)	68(0/0)	57(0/0)
	1979	catch	27(44/23)	37(44/26)	44(43/28)	46(43/29)	50(41/35)
		sp.stock	164(57/0)	139(58/0)	118(59/0)	109(60/0)	79(63/0)
	1980	sp.stock	160(51/14)	125(52/15)	98(52/16)	86(52/17)	53(53/19)

Table 9. Cont'd.

Partial Recruitment C.

		F =	0.15	0.25	0.35	0.40	0.60
Recruitment by year classes 1972: 30 mill 1974: 30 mill	1977	catch	21(32/10)	34(32/10)	45(32/10)	51(32/10)	71(33/10)
		sp.stock	73(0/0)	73(0/0)	73(0/0)	73(0/0)	73(0/0)
	1978	catch	26(38/20)	39(38/22)	49(38/23)	53(38/23)	64(38/26)
		sp.stock	86(0/0)	78(0/0)	71(0/0)	68(0/0)	56(0/0)
	1979	catch	28(39/30)	39(38/33)	45(37/35)	47(37/36)	50(35/42)
		sp.stock	156(55/0)	131(56/0)	110(57/0)	100(57/0)	71(59/0)
	1980	sp.stock	164(47/20)	126(47/20)	97(47/21)	85(47/22)	50(47/24)
1972: 25 mill 1974: 20 mill	1977	catch	20(34/7)	32(34/7)	43(34/7)	48(34/7)	67(35/7)
		sp.stock	73(0/0)	73(0/0)	73(0/0)	73(0/0)	73(0/0)
	1978	catch	25(41/18)	37(41/19)	46(41/21)	50(41/21)	60(40/24)
		sp.stock	82(0/0)	74(0/0)	67(0/0)	64(0/0)	53(0/0)
	1979	catch	26(41/27)	36(40/30)	42(40/33)	44(39/34)	47(37/39)
		sp.stock	152(56/0)	128(57/0)	107(58/0)	98(58/0)	69(60/0)
	1980	sp.stock	149(51/14)	115(51/15)	88(52/16	77(52/16)	45(52/18)

APPENDIX I.

CONSTRUCTION OF AGE COMPOSITION OF GILL NET AND LONG LINE CATCHES OF SUBAREA 1 COD, 1975 AND 1976

I. Portuguese gill-net (SGN) samples for Div.1C, 1972 and Div.1D, 1973 are compared to Danish otter-trawl (OT) samples for the same divisions and years.

Age group	SGN(o/oo) 1C 1972	SGN(o/oo) 1D 1973	OT(o/oo) 1C 1972	OT(o/oo) 1D 1973	Relation SGN/OT 1972	Relation SGN/OT 1973	Mean conversion factor OT to SGN
III	-	-	-	-	0	0	0
IV	-	-	122	14	0	0	0
V	10	17	458	830	0.02	0.02	0.02
VI	104	84	308	80	0.33	1.05	0.69
VII	245	296	83	52	2.95	5.69	4.32
VIII	94	311	5	9	18.8	34.6	rounded figure of 24
IX	55	92	9	6	6.1	15.3	
X	73	45	1	4	73.0	11.3	
XI	180	18	10	2	18.0	9.0	
XII	172	79	5	1	34.4	79.0	
XIII	39	28	2	1	19.5	14.0	
XIV	14	16	1	-	14.0	16+	
XV+	14	14	2	-	7.0	14+	

Conversion factors are then applied to proper OT samples which are then taken as samples of SGN catches.

II. i) A Faroese submission (Hoydal, pers.comm.) gives the following size distribution for 1330 tons (round, fresh weight) SGN-caught cod in 1976 according to market categories:

Wet salted size category (Danish inches)	Corresponding total length of fish (cm)	Percentage by weight
22+	81+	69.4
19-22	70-80	24.2
16-19	59-69	2.0
12-16	44-58	0.9
not known	-	3.6

ii) Using a length-weight table supplied by A.Meyer (pers.comm.) the following mean weight is obtained for each of the above mentioned groups provided all cm groups are evenly represented inside each size category. For the 81+ group calculations have been carried out for the interval 81-90 cm. Weights are round, fresh fish

81-90 cm	5.50 kg
70-80	3.77
59-69	2.42
44-58	1.27

iii) Dividing the above given percentages by weight by the mean weight gives the following ratio between size groups in terms of numbers

81-90 cm	12.62	= 61.3%
70-80	6.42	= 31.2
59-69	0.83	= 4.0
44-58	0.71	= 3.5

iv) Danish OT-samples for Divs.1D-1E (Ref.nos. 2611, 2616 and 2647 in Table 4) have the following combined age composition when each of the four size categories are considered separately and given a weight index as in iii) above. The combined composition would thus represent a SGN-sample

Age group	44-58	59-69	70-80	81+	TOTAL ‰
III	15.3	-	-	-	15.3
IV	16.3	2.5	-	-	18.8
V	3.1	21.4	14.5	-	39.0
VI	0.2	13.2	127.0	37.6	178.0
VII	-	1.7	25.4	26.9	54.0
VIII	0.1	0.8	137.9	424.8	563.6
IX		0.3	7.3	32.3	39.9
X				43.0	43.0
XI				16.1	16.1
XII				10.8	10.8
XIII				5.4	5.4
XIV				5.4	5.4
XV+				10.8	10.8
TOTAL	35.0	39.9	312.1	613.1	1000.1

III. If the conversion factors in I. above had been used on the same samples as used in II. iv) the following figures would have been achieved for the constructed SGN-sample. Figures in II. iv) are given again for quick comparison

Age group	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV+
Method I.	0	0	1	20	25	794	61	53	15	8	8	0	15
" II.	15	19	39	178	54	564	40	43	16	11	5	5	11

Although the two methods give somewhat different results they could, nevertheless, both be regarded as an improvement in a situation where no samples at all are existing from the gill-netters and long-liners. Method II. has been applied for the 1976 fisheries since it is based on some direct observations on the 1976 catches by gill-netters.

LIST OF CODES OF VPA AND FORECAST RUNS

All runs are coded by

i) N or S or NS, indicating the area for which the run is made:

N : Divs. 1A-1D (Northern divisions)

S : Divs. 1E-1F (Southern divisions)

NS : Subarea 1 (Divs. 1A-1F)

ii) Basis year (last year of data) by 75 or 76.

iii) The assumption made for partial recruitment (A, B or C).

	Age group:	3	4	5	6	7+
A	Divs. 1A-1D	0.09	0.27	0.64	1.0	1.0
	" 1E-1F	0.01	0.08	0.41	0.67	1.0
	Subarea 1	0.1	0.25	0.5	0.8	1.0
B	Subarea 1	0.4	0.6	0.8	1.0	1.0
C	Subarea 1	0.6	0.72	0.88	1.0	1.0

iv) Forecast runs are further coded by a serial number according to the tabulation given below.

In the VPA runs the B and C values of partial recruitment were applied only to the basis year 1976.

Tabulation of codes for forecast runs:

Partial recruitment (see Section 16)	Recruitment of year class 1974 (mill fish)	Recruitment of year class 1972 (mill fish)	F-values 1977-79: 0.15	0.25	0.35	0.40	0.60
A	30	25	- NS75A - 7 NS76A - 7	- NS75A - 1/5 NS76A - 1/5	NS75A - 2$^{x)}$ NS75A - 6 NS76A - 2/6	NS75A - 4$^{x)}$ NS75A - 8 NS76A - 4/8	NS75A - 3$^{x)}$ NS75A - 9 NS76A - 3/9
A	20	25	NS75A - 12 NS76A - 12	NS75A - 10 NS76A - 10	NS75A - 11 NS76A - 11	NS75A - 13 NS76A - 13	NS75A - 14 NS76A - 14
A	20	20	- -	N75A - 1 N76A - 1	N75A - 2$^{x)}$ N76A - 2	N75A - 4$^{x)}$ N76A 4	N75A - 3$^{x)}$ N76A - 3
A	10	5	- -	S75A - 1 S76A - 1	S75A - 2$^{x)}$ S76A - 2	S75A - 4$^{x)}$ S76A - 4	S75A - 3$^{x)}$ S76A - 3
B	30	25 25 37	NS75B - 7 NS76B - 7 NS76B - 20	NS75B - 5 NS76B - 5 NS76B - 21	NS75B - 6 NS76B - 6 NS76B - 22	NS75B - 8 NS76B - 8 NS76B - 23	NS75B - 9 NS76B - 9 NS76B - 24
B	20	25 25 35	NS75B - 12 NS76B - 12 NS76B - 15	NS75B - 10 NS76B - 10 NS76B - 16	NS75B - 11 NS76B - 11 NS76B - 17	NS75B - 13 NS76B - 13 NS76B - 18	NS75B - 14 NS76B - 14 NS76B - 19
C	30	25 25 30	NS75C - 7 NS76C - 7 NS76C - 20	NS75C - 5 NS76C - 5 NS76C - 21	NS75C - 6 NS76C - 6 NS76C - 22	NS75C - 8 NS76C - 8 NS76C - 23	NS75C - 9 NS76C - 9 NS76C - 24
C	20	25 25 30	NS75C - 12 NS76C - 12 NS76C - 15	NS75C - 10 NS76C - 10 NS76C - 16	NS75C - 11 NS76C - 11 NS76C - 17	NS75C - 13 NS76C - 13 NS76C - 18	NS75C - 14 NS76C - 14 NS76C - 19

Footnotes

Runs 1-4: F 1976 = 0.35

Runs 5-14: F 1976 = 0.25

$^{x)}$F 1977 = 0.25