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REPORT OF THE ARCTIC FISHERIES WORKING GROUP

Copenhagen, 25 September - 2 October 1985

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REPORT OF THE ARCTIC FISHERIES WORKING GROUP

1. PARTICIPANTS

The Working Group met in Copenhagen with the following participants:

A Hylen	Norway
T Jakobsen	Norway
E Luckmanov	USSR
O Nakken (Chairman)	Norway
N Pzusova	USSR
K Sunnanå	Norway
V Tretiak	USSR
A Vazguez	Spain.

2. TERMS OF REFERENCE

At the 72nd Statutory Meeting in Copenhagen, it was decided (C.Res.1984/2:4:20) that the Arctic Fisheries Working Group (Chairman: Mr O Nakken) will meet at ICES headquarters from 25 September to 2 October 1985 to assess catch options for 1986 inside safe biological limits for cod and haddock in Sub-areas I and II.

3. NORTH-EAST ARCTIC COD

3.1 Status of the Fisheries

3.1.1 Landings prior to 1985 (Tables 1-3 and Figure 4A)

The landings in 1983, 289,992 tonnes, are the same as used by the Working Group in 1984 (Anon., 1985a) and close to the TAC of 300,000 tonnes. Provisional figures for 1984 indicate a slight decline in landings (Table 1), and the total catch amounts to 278,000 tonnes, which is very close to the 279,000 tonnes anticipated by the Working Group and 58,000 tonnes in excess of the TAC of 220,000 tonnes. From 1983 to 1984, trawl catches showed a decline in all areas except Division IIb, whereas catches by other gears increased (Table 2). Landings decreased for all countries except the German Democratic Republic (Table 3).

Spanish data from 1984 in Division IIb indicated that about 75% (in numbers) of the 2-year olds and 20% of the 3-year old fish in the catches were discarded at sea. No other data on discards were available.

3.1.2 Expected landings in 1985 (Tables 1 and 2)

The total landings for 1985 were estimated at 326,000 tonnes, based on catch statistics for the first half of the year from USSR, Norway, Faroes, Federal Republic of Germany, and on information on catch quotas for other countries. The increase of about 50,000 tonnes from 1984 was due to greater availability of fish in Sub-area I and Division IIb. In Division IIa, the declining trend will continue in 1985. The main reason for these changes in the distribution of the fishery is the recruitment, the fisheries in 1985 (as well as in succeeding years) being directed towards the relatively abundant year classes of young fish which are distributed in the central, eastern and northern parts of the Barents Sea. The main consequences of these changes will be that a larger proportion of the total landings will be taken by trawls than in the preceding years.

3.1.3 Catch per unit effort (Tables 4-6)

The total trawl catches of cod and haddock combined continued to decline in 1984, and a minor increase was observed in the total effort (Norwegian units, Table 4). The catch per unit effort was slightly reduced from 1983 to 1984 in Sub-area I and Division IIb. For cod, the catch-per-unit-effort figures (Table 5) tended to decrease in all areas from 1983 to 1984, except for the USSR fleet in Sub-area I. Catch-per-unit-effort data for the fishery on spawning cod in the Lofoten area show a declining trend in the past 3 years for gill-nets, for long-lines and hand-lines (Table 6).

3.2 Catch in Numbers at Age

The age compositions for 1983 were not changed. For 1984, the data available for calculating catch in numbers were:

a) landings by areas from each country for the whole year, and

b) age compositions from the catches by Norway, USSR, Spain and the Federal Republic of Germany. Catch in numbers at age for other countries was determined by combining catches and age compositions as follows:

Sub-area I:	Faroe Island catch - USSR age composition UK + others' catch - Norwegian trawler age composition
Division IIa:	All other catches - Norwegian trawler age composition
Division IIb:	All other catches - USSR age composition

Catch in numbers for 1985 was calculated from the expected landings and age composition from the first half of the year from Norway, USSR and the Federal Republic of Germany. Figures for other countries were determined as follows:

Sub-area I:	As for 1984 (see above)
Division IIa:	" " " " "
Division IIb:	A USSR age/length key was applied to the length distribution from the Federal Republic of Germany. The resulting age composition was applied to calculate catch in numbers from all other countries.

3.3 Weight at Age (Tables 7, 8 and 9)

Data for weight at age in the catches in 1984 were available from Norwegian and USSR catches representing the whole year. Values for 1985 were available from Norway and USSR based on data for the first half of 1985. These data are given in Table 7. The average of Norwegian and USSR data weighted by their respective catches was used for the total catch for age groups 7 and younger. For ages 8 and older, it was decided to use the values that had been used previously (Table 9).

The figures show a decrease in mean weight at age from 1984 to 1985 for age groups 4-6. The expected weights in 1985 are at the same level as observed in 1983, but still the weights of the young fish are above the level used for 1982 and earlier.

In the years 1982-85 mean-length-at-age data from the Norwegian survey indicate a substantial increase in the growth of these age groups (Table 8). This would also be reflected in the mean-weight at age in the catches.

The increase in weight at age for the young fish in the 1983 and 1984 catches may also be explained by a shift in the fishing pattern. Because of poor year classes and increased mesh size in trawls in recent years, the heavy fishing of younger age groups no longer persisted.

It is expected that the catches of age 3-4 fish will increase in 1985, particularly since the 3-year olds are a relatively strong year class. This is then reflected in a decrease in the mean weight at age in the catches.

New data were not available on the weight-at-age in the stock, and the weights for 1984, given at the last meeting of the Working Group, were used for 1985 (Table 9).

3.4 Age at Maturity (Table 9)

The Working Group decided to calculate spawning stock biomasses for the period 1982-85 using the respective majority ogives given by Hylen and Nakken (1982, 1983, 1984 and 1985) (Table 10). It appears that a considerably higher proportion of age 6 and 7 fish were mature in 1985 than in the preceding years. These observations were supported by investigations made by Ponomarenko and Yaragina (pers.com.).

New information on maturity ogives was not available for the years prior to 1982, and it was, therefore, decided to use a knife-edge maturity ogive (with maturity at age 8 and older) for all these years (as in the 1984 Working Group meeting).

3.5 Survey Results

Survey results which had become available since the 1984 Working Group meeting were:

- The Joint Norwegian-USSR O-group Survey in August-September 1985 (Anon., 1984b)
- The Barents Sea Acoustic and Bottom Trawl Surveys in February 1985 (Hylen *et al.*,1985)
- The Spawning Ground Acoustic Surveys in March-April 1985 (Godø *et al.*, 1985b)
- The Svalbard Bottom Trawl Survey in September 1984 (Godø *et al.*, 1985a)
- The USSR Bottom Trawl Survey in April-May 1983 (Shevelev 1986 in press)

- The USSR Young Fish Surveys in October-December 1980-82

In addition, members of the Working Group provided information on the preliminary results of the USSR surveys in 1983-85.

3.5.1 O-group surveys (Table 11)

The abundance indices for the 1982-85 year classes are all larger than any of those from the period 1976-81, and the three most recent years' figures are only exceeded by that of the 1970 year class.

3.5.2 The bottom trawl surveys (Tables 12-14)

In the Norwegian surveys, the indices for the 1978-81 year classes show an increasing trend during their first 3-5 years of life. The index for the 1982 year class increased from age 1 to age 2 (Table 12), but was somewhat reduced from age 2 to age 3. The figure for the 1983 year class was reduced by about 50% from age 1 to age 2 (1984 survey to 1985 survey). This reduction of the abundance indices from 1984 to 1985 for the 1982 and 1983 year classes, which also caused a considerable drop in the total abundance index in the Barents Sea surveys (Table 12), is not in conformity with the tendency which has been observed for the preceding year classes.

In the Svalbard surveys (Table 13), the total abundance index increased from 1983 to 1984 due to large contributions from the 1982 and 1983 year classes.

Although the results of the bottom trawl surveys in 1985 differed, to some extent, from the results one would expect from previous years' experience, the surveys supported previous years' indications that the 1982 and 1983 year classes are far more abundant than the 1978-81 year classes.

The 1984 year class, which was observed to be similar in strength to the 1983 year class at the O-group stage (Table 11), was caught only in small quantities in the 1985 bottom trawl survey. Hence, the abundance indices of all the three youngest age groups (1982-84 year classes) were lower than expected in the 1985 survey in the Barents Sea. During the winter of 1985, young cod were distributed in midwater to a much greater extent than in previous years when they were found mainly in the near-bottom layers. It is believed that this change in the vertical distribution of fish led to a significant downward 'bias' in the bottom trawl indices for the youngest age groups in 1985 (Hylen et al., 1985). If so, this probably had the same effect on the USSR survey indices.

3.5.3 Acoustic surveys (Table 15)

Details of the acoustic surveys are given in the respective survey reports and in Hylen and Nakken (1985), where the survey results are also evaluated. For the Barents Sea survey, two sets of acoustic estimates were determined by combining the acoustic and biological data in two different ways. As in previous years, biological data (length and species distributions) from all trawl stations (bottom or pelagic) within a statistical area were combined and applied to mean values of echo abundance within the same area. The basic assumption is then that the combined length and species compositions represent the actual compositions for the entire water column. In the other method used, the values of echo abundance were split into a midwater layer and a bottom layer and samples from pelagic and bottom trawl hauls were applied, respectively.

The two alternative ways of treating the data resulted in estimates which differed greatly. Hylen et al. (1985) concluded that the most reliable estimates were those generated by the second method.

Only 14% of the total echo abundance of cod and haddock was recorded in the near-bottom layer (bottom - 10 m above); 40-45% was recorded in the layer estaurine bottom and 50 m above the bottom, while the remaining 55-60% was recorded higher up in the water column.

The acoustic abundance estimates from the 1985 survey supported the findings from earlier years indicating a vast improvement in the recruitment to the stock, while the number of older fish was considerably reduced as compared with previous years.

3.5.4 Evaluation of the surveys

Hylen *et al.* (1985) and Hylen and Nakken (1985) have evaluated the Norwegian survey results for 1985 and previous years. They were particularly concerned with the high acoustic estimate of the 1981 year class in 1985, 664 million individuals. According to all previous observations, this year class should be relatively weak. Therefore, Hylen and Nakken (1985) adjusted the 1985 Barents Sea survey figure for this year class to 140 million individuals, with the following justification: "According to previous observations that year class was estimated to be very poor in abundance both as 0-group and as 1- and 2-group. It thus seems reasonable to assume that the 1985 estimate is heavily biased upwards because of inadequate sampling, wrong ageing or incorrect establishing and/or application of age/length keys". Hylen and Nakken (1985) used the corrected acoustic estimates for the Barents Sea, together with estimates from the other surveys and the landings in 1985, to assess the total and spawning stock on 1 January 1985. Their results are presented in Table 15, together with the results from preceding years. The estimates of the 1982 and 1983 year classes are considerably higher than in 1984, but the relative increments are comparable to those observed for the preceding year classes over the first 3-5 years of life.

3.6 Recruitment (Tables 18 and 19, Figures 3 and 4B

A summary of the information available from the surveys for the 1982-85 year classes is given in the text table below:

Age	1982				1983				1984				1985
	O-gr	A	B-N	B-U	O-gr	A	B-N	B-U	O-gr	A	B-N	B-U	O-gr
0	0.6	-	-	-	1.7	-	-	-	1.6	-	-	-	2.5
1	↓	-	45	4	↓	2400	355	6	↓	185	7	1	↓
2	↓	500	127	10	↓	3400	170	9	↓	-	-	-	↓
3	400	1200	90	9	1100	-	-	-	1000	-	-	-	>1500

O-gr: O-group survey indices
A: Acoustic survey estimates (numbers in millions)
B-N: Norwegian bottom trawl indices (number in millions)
B-U: USSR bottom trawl indices (no. per hour trawlings)

The vertical arrows indicate the abundance at age 3 estimated from the regression line in Figure 3.

The O-group indices indicate that the 1983, 1984 and 1985 year classes are about 3, 3 and 4 times, respectively, as abundant as the 1982 year class. The acoustic estimates indicate that the 1983 year class is between 2 and 4 times as abundant as the 1982 year class, taking into account a reasonable natural mortality coefficient. The Norwegian bottom trawl indices give ratios between the abundance indices of these two year classes of about 8 and 1.5 at ages 1 and 2, respectively. The USSR bottom trawl surveys indicate that the 1982 and 1983 year classes are of similar abundance. Bearing in mind the information presented in section 3.5, it is reasonable to believe that both the Norwegian and the USSR bottom trawl indices in the winter of 1984-85 were influenced by the vertical distribution of the fish. In the winter of 1985, the proportion of young cod recorded acoustically in midwater well above the bottom was higher than in previous years, and this would probably lead to lower availability of fish to bottom trawls and reduced bottom trawl indices. Therefore, it is believed that the bottom trawl surveys from both countries underestimated the abundance of young fish in 1985 in relation to 1984.

The Working Group considered the 1983 year class to be about twice as abundant as the 1982 year class, the 1984 year class to be more abundant than the 1982 year class but less abundant than the 1983 year class, and the 1985 year class to be more abundant than the 1983 year class.

The 1982 year class was estimated to be about 400 million individuals at age 3 from the relationship in Figure 3. This figure corresponds to the acoustic estimate of that year class at age 2, but is considerably below the acoustic estimate of about 1200 million at age 3 obtained in the winter of 1985. However, the increment in abundance from age 2 to age 3 is in line with that observed for the preceding year classes (Table 15). The way in which the acoustic and biological data were combined in 1985 also lead to a large transfer of haddock to cod in the estimates in 1985 compared to previous years (Tables 11 and 27), which is the main reason behind the large increase for the 1982 and 1983 year classes of cod from 1984 to 1985. However, since there is little previous experience in acoustic estimation of such large year classes of age 1-3 cod, the Working Group decided not to accept the actual acoustic estimates of the 1982 and 1983 year classes, but rather to use these estimates as indices. The figure of 1200 million for the 1982 year class was, therefore, regarded as a strong indication that this year class is above the long-term average level of 650 million for the stock. The USSR survey index indicates that the 1982 year class is of average abundance, when grouping year classes in three groups: rich, average and poor. On this basis, the Working Group agreed on the following year-class sizes in millions of individuals at age 3, for prediction purposes.

1982	1983	1984	1985
800	1500	1000	>1500

Compared with estimates made in 1984, the figure for the 1982 year class has been increased by 400 million, the 1983 year class remains unaltered, and the 1984 year class is decreased by 500 million. The 0-group index for the 1985 year class indicated an abundance equal to that of the 1970 year class (1800 million).

3.7 Fishing Mortalities - VPA Runs

The Working Group's intention was to follow the same procedure as used in 1984.

a) to start the VPA in the current year,

b) to estimate input fishing mortalities so that deviations between VPA stock numbers and stock numbers from the Norwegian surveys in 1982-85 would be minimised.

A trial VPA was run with input F values in 1985 equal to those used for 1984 in last year's assessment. The run estimated stock numbers in 1984 and 1985 which were significantly higher than the survey estimates. In order to obtain stock numbers similar to the survey estimates for these two years, input F values for some age groups would have to be unrealistically high. Although landings in 1984 assumed at last year's meeting were accurately estimated on the basis of data from the first half of the year, a closer examination indicated that there were large changes in the age composition of the catches. There were considerably more young fish in the final age composition than in the one which had been based on data from only the first half of the year because young fish had been recruited to the fishery in the autumn. With the relatively abundant 1982 year class entering the fishery in 1985, the effect would likely be even greater on the 1985 age compostion. The Working Group, therefore, decided that the estimated age composition for 1985 was unreliable and that the available data from 1985 were not adequate for making a reliable estimate of the 1985 age composition. The assessment would, therefore, have to be based on a VPA starting in 1984, using only the estimated total landings in 1985 as a restraint in the predictions.

To obtain a reasonable fit between the stock numbers from the VPA and those from the surveys, the ratios between catch in numbers in the landings and stock in numbers from the surveys were calculated for each age group in 1982-84 and are shown in the text table below:

Age	C/N ratios			Adjusted 1984 ratio	F value
	1982	1983	1984		
3	.103	.107	.063	.071	.08
4	.199	.242	.264	.267	.35
5	.188	.207	.329	.311	.41
6	.296	.304	.375	.365	.50
7	.276	.395	.502	.504	.79
8	.365	.366	.425	.415	.62
9	.240	.196	.493	.436	.65

It can be seen from the table that there is a change in the C/N ratios from 1982 to 1984. There seems to be a trend in this change, and it was decided not to use the average values, but to correct the 1984 values by assuming that the trend of the change is linear. A linear regression was calculated for each age and the 1984 value was taken to be the expected value from the regression and is given in the table as the "adjusted 1984 ratio". The corresponding F values were then calculated and are given in the table.

For ages 3 and 4, the numbers estimated by the surveys tend to be underestimates, about 20% for age 4 and somewhat greater for age 3. This indicated that the F values for ages 3 and 4 should be lowered, and it was decided to use the values of 0.06 and 0.25, respectively, the same as used by the 1984 Working Group.

For ages 10 and older, the survey results indicate that fishing mortality should be somewhat lower than for ages 8 and 9, and an F value of 0.55 was chosen for ages 10 and older.

The F values for the ages 5-9 were rounded, and input fishing mortalities and F values resulting from the VPA run are shown in Table 17. VPA stock numbers are shown in Table 18.
VPA stock numbers are shown in Table 18. The text table below shows stock numbers (in millions) from the surveys and from the VPA for 1982-85.

Age	1982		1983		1984		1985	
	Survey	VPA	Survey	VPA	Survey	VPA	Survey	VPA
3	87	133	29	96	121	144	1212	-
4	105	135	81	101	58	76	167	111
5	103	89	99	91	59	65	56	49
6	.95	81	58	56	54	56	35	36
7	154	91	43	41	30	30	26	28
8	23	15	50	35	19	18	7	11
9	12	5	13	5	12	14	6	8
10	1	2	5	1	4	2	2	6

The average F for ages 5-10 in 1984 was 0.59 which is a little higher than the expected value given by the 1984 Working Group.

The text table indicates a generally good fit of the VPA results to the survey results. The evaluation of the fit given in the 1984 Working Group report is still valid and the addition of the 1985 survey results gives four years of good agreement between the surveys and the VPA assessment for the ages 5-7. Ages 8 and older seem to be overestimated in the surveys compared to the VPA in 1982 and 1983, but the correspondence seems to be better in 1984 and 1985.

The trend in the fishing mortalities is a decrease from 1978 to 1983 with a stabilisation in 1984 at about the same level as in 1983 (Table 17, Figure 4A).

To illustrate the relationship between F and effort, a series of plots are given based upon a VPA run splitting the F values into various categories of fishing gear (split-VPA). Plots of fishing mortalities generated by the Norwegian trawlers versus effort by the same fleet are presented for ages 5-6 combined in Sub-area I (Figure 1), and ages 5-8 combined in Division IIa (Figure 2). Plots of the catchability (Q = F/Effort) are given in both figures. The general trend is an increase in catchability in both areas. This is not unreasonable considering that Norwegian trawlers have been severely restricted by quotas in the 1980s and, therefore, may have chosen the grounds and seasons giving the highest catch rates. The very rapid increase in catchability in Sub-area I in the most recent years may be related also to the low effort exerted in this area.

3.8 Projection of Stock Biomass and Catch

The input data for catch and stock biomass projections are given in Table 19. In the 1984 Working Group report, reasons (recruitment indices, increased growth) were given for increasing the fishing mortalities on ages 3 and 4 in 1985, and this is done on the same basis in the current assessment. Otherwise, the F values for 1985 are the same as for 1984. The 1985 exploitation pattern was also used for 1986-88, except for a 50% reduction at age 3. This was done because the individual growth in recent years has increased to a level above normal, and the Working Group anticipated that this trend will be reversed for the strong recruiting 1983-85 year classes, for which the values 1500 million, 1000 million and 1500 million, respectively,(see Section 3.6), have been used in the projection. With reduced growth, these year classes will recruit to the fishing somewhat later than the 1982 year class. Weights at age and maturity ogives were also adjusted to take into account the reduction in the growth rate for these year classes.

3.8.1 Short-term projection

Using the same level of fishing mortalities in 1985 as in 1984 ($\bar{F}_{(5-10)} = 0.59$), the projected landings in 1985 were 327 000 tonnes which is close to that estimated by the Working Group (326 000 tonnes) on the basis of preliminary data (see Section 3.1.2). The Working Group, therefore, agreed to accept this as a basis for projections for 1986 and onwards.

Yield and spawning stock biomass per recruit were calculated using the relevant figures for 1986 (Table 19), and the results are shown in Figure 4C. $F_{0.1} = 0.15$ and $F_{max} = 0.30$, the latter being approximately half the current level of $\bar{F}_{5-10} = 0.59$. Projected catches in 1986 and spawning stock biomass levels in 1987 are shown graphically in Figure 4D. Management options for 1986 are given in the text table below:

SHORT-TERM PROJECTION
Species: COD
Area: ICES Sub-areas I and II

1985				Management option 1986	1986			1987	
Stock biom. (3+)	Spawn. stock biom.	$\bar{F}_{(5-10)}$	Catch (3+)		Stock biom. (3+)	Spawn. stock biom.	Catch (3+)	Stock biom. (3+)	Spawn stock biom.
1,024	346	0.59	327	$F_{0.1}=0.15$	1,837	268	131	2,803	444
				$F_{max}=0.30$			244	2,673	392
				$F_{max}=0.45$			354	2,547	344
				$\bar{F}_{86} = \bar{F}_{85}$			446	2,442	305

Weight is in thousands of tonnes

3.8.2 Medium-term projection

The text table below shows the pattern of catch, stock biomass, and spawning stock biomass for four levels of fishing mortality for 1986-88. For 1989, only projections of spawning stock biomass are given because catch and stock biomass projections, to some extent, will depend on the size of the 1986 year class. $\bar{F}_{5-10} = 0.45$ is introduced as an alternative simply because it is intermediate between F_{max} and the current F.

MEDIUM-TERM PROJECTION
Species: COD Area: ICES Sub-areas I and II

Management strategy	$F_{0.1} = 0.15$			$F_{max} = 0.30$			$\bar{F} = 0.45$			$\bar{F}_{85} = 0.59$		
Year	STB	SSB	Catch	STB	SSB	Catch	STB	SSB	Catch	STB	SSB	Catch
1986	1,837	268	131	1,837	268	244	1,837	268	354	1,837	268	446
1987	2,803	444	233	2,673	392	409	2,547	344	557	2,442	305	664
1988	4,156	957	355	3,773	772	582	3,430	616	743	3,162	502	838
1989		2,430			1,871			1,424			1,115	

TSB = Total stock biomass

For $F_{0.1}$ and F_{max}, catches will be reduced in 1986, but all the alternatives result in rapidly increasing catches from 1986 to 1988. Spawning stock biomass will, for all alternatives, reach its lowest level in 1985 and will increase to more than 1 million tonnes in 1989.

4. NORTH-EAST ARCTIC HADDOCK

4.1 Status of the Fisheries (Tables 20-22, Figure 7A)

4.1.1 Landings prior to 1985

The landings in 1983, 21,607 tonnes, are the same as used by the Working Group in 1984 (Anon., 1985). Provisional figures for 1984 showed a further decline in landings in Division IIa, and the total catch amounted to about 18,000 tonnes which is 3 000 tonnes below the level (21,000 tonnes) estimated by the 1984 Working Group.

4.1.2 Expected landings in 1985 (Table 20)

Based on information concerning landings in the first half of the year from Norway, Federal Republic of Germany and the USSR and reports for the first 8 months of the year to Norwegian authorities from German Democratic Republic, Faroe Islands, Portugal, Spain and the UK, the Working Group estimated the landings in 1985 to be 21,000 tonnes. This is an increase of about 5,500 tonnes from 1984, due to greater availability of young fish in Sub-area I, but is considerably below the agreed TAC of 50,000 tonnes. The fishery in 1985 has been directed towards these young fish, specially the strong 1982 year class which is distributed in the central and eastern part of the Barents Sea. This is resulting in a larger proportion of the landings being taken by trawlers than in the preceding years. This change in exploitation is expected to be pronounced in the second half of the year. However, since the 3-year olds (1982 year class) occur together with the 2-year olds (1983 year class) in most of the fishing areas, it is difficult to both obtain catches of legally sized haddock and to estimate the total landings for 1985.

4.1.3 Catch per unit effort (Table 22)

CPUE in the Norwegian trawl fisheries exhibited a sharp decline from 1983 to 1984, both in Sub-area I and Division IIa, the 1984 figures being 50% and 75% of the 1983 figures, respectively.

4.2 Catch in Numbers at Age (Table 28)

Age compositions for 1983 were the same as used by the 1984 Working Group. For 1984, the data available for calculating catch in numbers were:

a) landings by areas from each country for the whole year, and

b) age compositions from the catches of Norway, USSR, and Federal Republic of Germany.

The catch in numbers at age for the landings of other countries was determined by using age compositions from Norwegian trawl catches outside the 12 nautical mile limit in Sub-area I and Division IIa. In Division IIb, an age composition from Norwegian trawlers in Sub-area I was used.

The catch in numbers for 1985 was calculated from the expected landings and age compositions from the first half of the year from USSR, Norway and Federal Republic of Germany. Figures for other countries were determined by combining the expected landings with age compositions from Norwegian trawl catches as described above.

4.3 Weight at Age (Table 23)

Weight data for haddock were available both from Norwegian and USSR catches in 1984 and 1985 (Table 7). The weight at age in the catches was calculated as the mean value weighted by the respective catches (Table 23). For 1983, the data given by the 1984 Working Group were used.

New data for the weight at age in the stock were not available and the old values were used for 1984 and 1985.

For the prediction, it was decided to use the weight-at-age values for 1982 and earlier, which are the same for the catch and the stock. These values were used because of the decline in the catch weights from 1984 to 1985. It was expected that the size at age will continue to decline in 1986 and it was felt that the best values available were the values for 1982 and earlier.

4.4. Age at Maturity (Table 31)

Only two maturity ogives are published for haddock (Sonina 1981, Saetersdal 1954). As in the two previous assessments, the Working Group used the ogive established by Saetersdal (1954) for the whole period as well as the predictions.

4.5 Survey Results (Table 24-27)

The survey results that were used originated from the same surveys as for cod (see Section 3.5).

4.5.1 O-group surveys (Table 24)

In the past four years, the O-group indices for haddock have been considerably higher than in the preceding 4-year period, 1978-81. The 1983 and 1984 indices were particularly high.

4.5.2 Bottom trawl surveys (Table 25 and 26)

The abundance indices from the Norwegian bottom trawl surveys (Table 25) indicate that both the 1982, 1983 and 1984 year classes are strong. However, the 1984 year class was, during the survey in the winter of 1985, less abundant than expected from the O-group survey indices (Table 24). The results from the USSR young fish surveys (Tables 24 and 26) were in agreement with the Norwegian bottom trawl results for the 1982 and 1983 year classes, but the USSR index for the 1984 year class indicated that its abundance was much lower than indicated by the Norwegian figure.

4.5.3 Acoustic surveys (Table 27)

The acoustic estimates of haddock obtained in the winter of 1984 for the 1978-80 year classes were all low at 10-20 million fish. The 1981-83 year classes were all reduced considerably in numbers from 1984 to 1985. The main cause of this discrepancy was that the data for these two years were treated differently (Hylen et. al. 1985, see also Section 3.5), leading to lower estimates of haddock and higher estimates of cod in 1985 than in previous years. The 1985 figures, which are thought to be more reliable than in previous years, indicated that the 1982 and 1983 year classes were abundant. The estimate of the 1983 year class at age 2 was on the same level as the 1969 year class, the most abundant year class in the whole series, at age 3. The acoustic estimate of the 1984 year class at age 1, about 160 000 million, was much less than the corresponding figures for the two preceding year classes, but was far above the estimates of all the year classes prior to 1982.

The estimates and indices for the year classes prior to 1982 were low and variable in all surveys. The 1978-81 year classes at age 3 probably constituted less than 20-25 million individuals each.

4.5.4 Evaluation of the surveys

The estimates and indices for the 1982 and 1983 year classes are in agreement and indicate that both of these year classes are very strong; the acoustic estimates indicating abundance figures of about 500 and 1100 million individuals at ages 3 and 4, respectively. However, since there is little provious experience in acoustic estimations of such abundant year classes, the estimates should be used with caution. The various indices for the 1984 year class are not in full agreement. All three surveys conducted during the winter of 1984-85 produced lower abundance figures than indicated by the O-group survey in August-September 1984.

4.6 Recruitment (Tables 30 and 31, Figure 7B)

A summary of the information on the size of the 1982-85 year classes is given in the text table below:

	1982				1983				1984				1985
Age	O-gr	A	B-N	B-U	O-gr	A	B-N	B-U	O-gr	A	B-N	B-U	O-gr
0	0.38	-	-	-	0.62	-	-	-	0.78	-	-	-	0.27
1	-	-	315	23	-	(2100)	663	40	-	158	168	1	-
2	-	(1000)	356	59	-	1057	616	79	-	-	-	-	-
3	-	479	380	63	-	-	-	-	-	-	-	-	-

O-gr: O-group survey indices
A: Acoustic survey estimates (numbers in millions)
B-N: Norwegian bottom trawl indices (numbers in millions)
B-U: USSR bottom trawl indices (no. per hour trawling)

The figures in brackets are the acoustic estimates from 1984 which are considered to be overestimates. The information in the text table indicates the following approximate ratios between the abundance of the year classes:

Survey	1982	1983	1984	1985
O-gr	1	1.6	2.0	0.7
Norw. surveys	1	1.5	0.5	-
USSR surveys	1	1.3	0.04	-

There are large discrepancies between the different surveys for the 1984 year class. Estimates from both the Norwegian and the USSR surveys were much less than the O-group index, with the estimate from the USSR survey being especially small. The 1984 year class was distributed further north at the O-group stage than the 1982 and 1983 year classes and may have been subjected to higher levels of natural mortality during the first winter. This may explain the decrease in abundance from age 0 to age 1, but it does not explain the large deviations in observed abundance between the Norwegian and USSR surveys during the winter of 1984-85. The USSR survey results indicated that the 1984 year class is poor and will consist of less than 50 million fish at age 3, while the Norwegian surveys indicated that this year class is approximately half the size of the 1982 year class. On the basis of these considerations and information given in the previous sections, the Working Group assumed that these year classes at age 3 were the following size (in millions of fish):

1982	1983	1984	1985
300	400	75	50

4.7 Fishing Mortalities - VPA Runs

The revised age composition of landings in 1984 indicated large discrepancies with the values estimated by the 1984 Working Group, and, as for cod (see Section 3.7), it was agreed that data were not available for a reliable estimate of the age composition of the 1985 landings.

A trial VPA was run starting in 1984 using the same input F values as in last year's Working Group report. Preliminary plots were made of $\bar{F}_{(6-7)}$ generated on cod by Norwegian trawlers in Division IIa versus $\bar{F}_{(5-7)}$ on haddock generated by the same fleet, and of the total international trawl catch ratio versus the biomass (3+) ratio (Cod/Haddock) (final plots are given in Figures 5 and 6). The plots indicated that lower input F values would move the points for the most recent years closer to the regression line.

A new VPA was then run with reduced F values for the main age groups and the resulting plots are shown in Figures 5 and 6. In the latter plot (trawl catch ratio vs. biomass ratio), the points for 1983 and 1984 are close to the regression line, whereas in Figure 5 ($\bar{F}_{6-7}$ cod vs. $\bar{F}_{5-7}$ haddock), the 1984 point is far from the line. Bearing in mind the changes in catchability of cod in this area in recent years (Figure 2), catchability was calculated for both cod and haddock for the age groups used in the plot. For cod, catchability was very stable during 1978-82, averaging 1.63×10^6, but then suddenly increased to 2.43×10^6 in 1983 and 2.68×10^6 in 1984. For haddock, catchability in the same period fluctuated between 0.32×10^6, with no apparent trend. Relative changes in catchability between cod and haddock will influence the plot in Figure 5, and the arrows attached to the points for 1983 and 1984 show where the points would have been if the catchability of cod had remained at the 1978-82 level. The 1984 point would have been close to the regression line, and the plot would be consistent with the VPA run, although it seems that little reliance should be put on it. The plot in Figure 6 appears to provide a better basis for estimating input F values, but the scattering of the points is still considerable.

The text table below shows the stock numbers from the VPA compared to the estimates from the acoustic surveys.

Age	1982		1983		1984		1985	
	Survey	VPA	Survey	VPA	Survey	VPA	Survey	VPA
3	7	11	7	9	53	10	479	-
4	10	5	9	8	15	7	14	8
5	12	12	5	3	7	5	+	5
6	29	38	4	7	2	2	+	3

4.8 Projection of Stock Biomass and Catch

The Working Group last year expected an increase in the fishing mortality at age 3 in 1985 (Anon., 1985a). However, surveys have shown that the strong 1982 year class is distributed in the same area as the strong 1983 year class. Trawl catches taken with the legal mesh size will exceed 15% by number of undersized fish. This will make it difficult to exploit the 1982 year class to a large degree in 1985. The 1984-85 fishing pattern was, therefore, accepted for 1985 (Table 31). The 1984 fishing mortality level will generate total landings in 1985 of 27,000 tonnes compared with the expected catch of 23,000 tonnes minus about 2,000 tonnes of age 2 fish. However, the expected 1985 catch in numbers at age is very close to that generated by the 1984 fishing mortalities. The expected catch for 1985 is very uncertain and the 1984 fishing mortalities were, therefore, accepted for 1985, although they generate a catch 6,000 tonnes higher than expected. This gives the stock size in 1986 presented in Table 31.

The input data used in the short- and medium- term projections are also given in Table 31. As mentioned earlier, the weights at age for the catch were revised for 1984 and 1985 (Table 23). In the absence of stock weight-at-age data, the old series of weights at age was used for both the stock and catch weight in the short- and medium- term projections.

A modified 1985 fishing pattern was used for the projections. In 1986 the strong 1982 year class will be fished heavily by the fishing fleets, and the fishing mortality at age 4 will increase. This will simultaneously result in a higher fishing mortality at age 5. These changes in the fishing pattern in 1986 are indicated in Table 31.

The maturity ogive is the same as used in earlier assessments.

The input data for the projections give $F_{0.1}$ and F_{max} values on the yield-per-recruit curve as shown in Figure 7C.

4.8.1 Short-term projection

The short-term projections are given for three alternatives: $F_{0.1}$, F_{max} and $F_{86} = F_{85}$. The F_{max} alternative involves an increase in the present F by a factor of 1.84.

SHORT-TERM PROJECTION
Species: HADDOCK
Area: ICES Sub-area I and II

1985				Management option 1986	1986			1987	
Stock biom. (3+)	Spawn. stock biom.	$\bar{F}_{(4-7)}$	Catch (3+)		Stock biom. (3+)	Spawn. stock biom.	Catch (3+)	Stock biom. (3+)	Spawn stock biom.
290	73	0.19	27	$F_{0.1}$=0.17	581	76	55	725	141
				F_{max}=0.35			103	656	122
				$\bar{F}_{86}=\bar{F}_{85}$			50	719	140

The consistency of the data is poor and the stock number estimates from the surveys are clearly of little value for estimation of input F values for the VPA. However, the largest discrepancy between the survey and the VPA (age 3 in 1984) is probably caused by some cod being included in the survey estimate. If this problem is solved and with more abundant year classes entering the stock, the consistency between survey and VPA results may improve in the future.

Since the survey data were not useful, the only available basis for estimating input F values was provided by the plots in Figures 5 and 6, with the most reliance probably being placed on the latter. The Working Group, therefore, agreed to make no further changes in the input F values (Table 29). Fishing mortalities and stock numbers from the VPA are given in Tables 29 and 30. The historic trend in fishing mortalities is shown in Figure 7A.

4.8.2 Medium-term projection

For the medium-term projection, the same alternatives are given as for the short-term projection. The Working Group assumed that the strong 1982 and 1983 year classes will be more heavily exploited than the previous ones and the 1986 fishing pattern was used for the period 1986-1989.

MEDIUM-TERM PROJECTION
Species: HADDOCK
Area: ICES Sub-areas I and II

Management strategy	$F_{0.1}$ = 0.17			F_{max} = 0.35			$\overline{F}_{85}$ = 0.19		
Year	SB	SSB	Catch	SB	SSB	Catch	SB	SSB	Catch
1986	581	76	55	581	76	103	581	76	59
1987	725	141	110	656	122	180	719	140	117
1988	783	277	117	609	202	166	767	270	123
1989		427			266			411	

The stock and catch projections for 1989 are not given because the estimates are considered to be very uncertain.

The spawning stock biomass of haddock is currently at a low level, but a significant increase will occur after 1987, when about 25% of the 1982 year class is expected to reach maturity. The total stock biomass will increase until 1987, while its level in 1988-89 depends largely on recruitment from the 1984-86 year classes and the exploitation in 1985-87.

5. DEFICIENCIES IN THE DATA BASE

a) Lack of age compositions from countries other than Norway, USSR, Spain and Federal Republic of Germany.

b) Lack of weight-at-age data for years prior to 1982. Such data should always be given together with the age compositions.

c) Insufficient knowledge of the rate of maturation in years prior to 1982. The use of published information produces time series of the spawning stocks which do not seem reasonable. Reliable information on maturation rates in the past is essential both for stock and recruitment relationships and for the prediction of the spawning stock.

d) Lack of catch and effort data for estimating input F values for the VPA.

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Table 1. North-East Arctic COD
Total nominal catch (tonnes) by fishing areas
(landings of Norwegian coastal cod not included).
(Data provided by Working Group members)

Year	Sub-area I	Division IIa	Division IIb	Total catch
1960	357,327	115,116	91,599	622,042
1961	409,694	153,019	220,508	783,221
1962	548,621	139,848	220,797	909,266
1963	547,469	117,100	111,768	776,337
1964	206,883	104,698	126,114	437,695
1965	241,489	100,011	103,430	444,983
1966	292,253	134,805	56,653	483,711
1967	322,798	128,747	121,060	572,605
1968	642,452	162,472	269,254	1,074,084
1969	679,373	255,599	262,254	1,197,226
1970	603,855	243,835	85,556	933,246
1971	312,505	319,623	56,920	689,048
1972	197,015	335,257	32,982	565,254
1973	492,716	211,762	88,207	792,685
1974	723,489	124,214	254,730	1,102,433
1975	561,701	120,276	147,400	829,377
1976	526,685	237,245	103,533	867,463
1977	538,231	257,073	109,997	905,301
1978	418,265	263,157	17,293	698,715
1979	195,166	235,449	9,923	440,538
1980	168,671	199,313	12,450	380,434
1981	137,033	245,167	16,837	399,037
1982	96,576	236,125	31,029	363,730
1983	64,803	200,279	24,910	289,992
1984*	58,197	194,205	25,854	278,256

*Provisional figures

Expected Catches

1985	111,000	166,000	49,000	326,000

Table 2. Total nominal catches (thousand tonnes) by trawl and other gear for each area.

Year	Sub-Area I				Division IIa				Division IIb	
	Cod		Haddock		Cod		Haddock		Cod	Haddock
	Trawl	Others	Trawl	Others	Trawl	Others	Trawl	Others	Trawl	Trawl
1967	238.0	84.8	73.8	34.3	38.7	90.0	20.5	7.5	121.1	0.4
1968	588.1	54.4	98.1	42.9	44.2	118.3	31.4	8.6	269.2	0.7
1969	633.5	45.9	41.3	47.7	119.7	135.9	33.1	7.1	262.3	1.3
1970	524.5	79.4	36.7	22.8	90.5	153.3	20.2	6.4	85.6	0.5
1971	253.1	59.4	27.3	29.0	74.5	245.1	15.0	6.6	56.9	0.4
1972	158.1	38.9	193.4	27.8	49.9	285.4	34.4	7.6	33.0	2.2
1973	459.0	33.7	241.2	42.5	39.4	172.4	13.9	9.4	88.2	13.0
1974	677.0	46.5	133.1	25.9	41.0	83.2	39.9	7.1	254.7	15.1
1975	526.3	35.4	103.5	18.2	33.7	86.6	34.6	9.7	147.4	9.7
1976	466.5	60.2	77.7	16.4	112.3	124.9	28.1	9.5	103.5	5.6
1977	471.5	66.7	57.6	14.6	100.9	156.2	19.9	8.6	110.0	9.5
1978	360.4	57.9	53.9	10.1	117.0	146.2	15.7	14.8	17.3	1.0
1979	161.5	33.7	47.8	16.0	114.9	120.5	20.3	18.9	8.1	0.6
1980	133.3	35.4	30.5	23.7	83.7	115.6	14.8	18.9	12.5	0.1
1981	91.5	45.1	19.0	17.9	77.2	167.9	21.8	18.7	17.2	0.5
1982	44.8	51.8	9.0	8.9	65.1	171.0	18.5	10.5	21.0	-
1983	36.6	28.2	3.7	3.8	56.6	143.7	7.6	6.3	24.9	0.2
1984*	28.2	30.0	1.7	2.4	44.6	149.6	6.5	6.9	25.8	0.1
1985*	65.0	45.8	6.6	4.1	46.9	119.0	4.5	7.5	49.2	0.2

*Provisional

Table 3. North-East Arctic COD.
Nominal catch (tonnes, whole weight) by countries (landings of Norwegian coastal cod not included, landings of Murman cod included). (Sub-area I and Divisions IIa and IIb combined). (Data provided by Working Group members).

Year	Faroe Islands	France	German Dem.Rep.	Germany, Fed.Rep.	Norway	Poland	United Kingdom	U.S.S.R.	Others	Total all countries
1960	3,306	22,321	-	9,472	231,997	20	141,175	213,400	351	622,042
1961	3,934	13,755	3,921	8,129	268,377	-	158,113	325,780	1,212	783,221
1962	3,109	20,482	1,532	6,503	225,615	-	175,020	476,760	245	909,266
1963	-	18,318	129	4,223	205,056	108	129,779	417,964	-	775,577
1964	-	8,634	297	3,202	149,878	-	94,549	180,550	585	437,695
1965	-	526	91	3,670	197,085	-	89,962	152,780	816	444,930
1966	-	2,967	228	4,284	203,792	-	103,012	169,300	121	483,704
1967	-	664	45	3,632	218,910	-	87,008	262,340	6	572,605
1968	-	-	225	1,073	255,611	-	140,387	676,758	-	1,074,084
1969	29,374	-	5,907	5,543	305,241	7,856	231,066	612,215	133	1,197,226
1970	26,265	44,245	12,413	9,451	377,606	5,153	181,481	276,632	-	933,246
1971	5,877	34,772	4,998	9,726	407,044	1,512	80,102	144,802	215	689,048
1972	1,393	8,915	1,300	3,405	394,181	892	58,382	96,653	166	565,287
1973	1,916	17,028	4,684	16,751	285,184	843	78,808	387,196	276	792,686
1974	5,717	46,028	4,860	78,507	287,276	9,898	90,894	540,801	38,453	1,102,434
1975	11,309	28,734	9,981	30,037	277,099	7,435	101,843	343,580	19,368	829,377
1976	11,511	20,941	8,946	24,369	344,502	6,986	89,061	343,057	18,090	867,463
1977	9,167	15,414	3,463	12,763	388,982	1,084	86,781	369,876	17,771	905,301
1978	9,092	9,394	3,029	5,434	363,088	566	35,449	267,138	5,525	698,715
1979	6,320	3,046	547	2,513	294,821	15	17,991	105,846	9,439	440,538
1980	9,981	1,705	233	1,921	232,242	3	10,366	115,194	8,789	380,434
						Spain				
1981	12,825	3,106	298	2,228	277,818	14,500	5,262	83,000	-	399,037
1982	11,998	761	302	1,717	287,525	14,515	6,601	40,311	-	363,730
1983	11,106	126	473	1,243	234,000	14,229	5,840	22,975	-	289,992
1984*	10,674	100	686	1,010	231,330	8,608	3,592	22,256	-	278,256

*Provisional figures

Table 4. North-East Arctic COD and HADDOCK catches ('000 tonnes) and total trawl effort in Norwegian units.

Year	SUB-AREA I			DIVISION IIa			DIVISION IIb	Total
	CPUE $\times 10^{-3}$	Ct $\times 10^{-3}$	Trawl effort $\times 10^{-3}$	CPUE $\times 10^{-3}$	Ct $\times 10^{-3}$	Trawl effort $\times 10^{-3}$	Ct $\times 10^{-3}$	Trawl effort $\times 10^{-3}$
1972	0.96	351.5	366.1	1.17	84.3	72.0	35.2	473.5
1973	1.40	700.2	500.1	1.09	53.3	48.9	101.2	622.7
1974	2.02	810.1	401.0	1.70	80.9	47.5	269.8	584.4
1975	2.08	629.8	302.7	1.80	68.3	37.9	130.8	404.5
1976	1.96	544.2	277.6	1.93	140.4	72.7	109.1	406.2
1977	1.65	529.1	320.6	1.30	120.8	92.9	119.5	489.6
1978	1.50	414.3	276.2	1.26	132.7	105.3	18.3	394.2
1979	1.21	209.3	172.9	1.24	135.2	109.0	8.7	289.1
1980	1.92	163.8	85.3	1.49	98.5	66.1	12.6	158.6
1981	2.06	110.5	53.6	1.39	98.4	70.7	17.7	134.9
1982	1.82	53.8	29.5	1.39	83.6	60.1	31.0	109.9
1983	1.85	40.3	21.7	1.22	63.0	51.6	25.1	91.2
1984	1.59	29.9	18.8	0.90	51.1	56.8	25.9	99.8
1985*	–	71.6	–	–	51.4	–	49.4	–

*Projected figures

Table 5. North-East Arctic COD.
Catch per unit effort (tonnes, round fresh)

	Sub-area 1			Division IIb			Division IIa		
Year	Norway[1]	U.K.[2]	USSR[3]	Norway[1]	U.K.[2]	USSR[3]	Norway[1]	U.K.[2]	Norway[4]
1960	-	0.075	0.42	-	0.105	0.31	-	0.067	3.0
1961	-	0.079	0.38	-	0.129	0.44	-	0.058	3.7
1962	-	0.092	0.59	-	0.133	0.74	-	0.066	4.0
1963	-	0.085	0.60	-	0.098	0.55	-	0.066	3.1
1964	-	0.056	0.37	-	0.092	0.39	-	0.070	4.8
1965	-	0.066	0.39	-	0.109	0.49	-	0.066	2.9
1966	-	0.074	0.42	-	0.078	0.19	-	0.067	4.0
1967	-	0.081	0.53	-	0.106	0.87	-	0.052	3.5
1968	-	0.110	1.09	-	0.173	1.21	-	0.056	5.1
1969	-	0.113	1.00	-	0.135	1.17	-	0.094	5.9
1970	-	0.100	0.80	-	0.100	0.80	-	0.066	6.4
1971	-	0.056	0.43	-	0.071	0.16	-	0.062	10.6
1972	0.90	0.047	0.34	0.59	0.051	0.18	1.08	0.055	11.5
1973	1.05	0.057	0.56	0.43	0.054	0.57	0.71	0.043	6.8
1974	1.75	0.079	0.90	1.94	0.106	0.77	1.19	0.028	3.4
1975	1.82	0.077	0.85	1.67	0.100	0.43	1.36	0.033	3.4
1976	1.69	0.060	0.66	1.20	0.081	0.30	1.69	0.035	3.8
1977	1.54	0.052	0.50	0.91	0.056	0.25	1.16	0.044	5.0
1978	1.37	0.062	0.37	0.56	0.044	0.08	1.12	0.037	7.1
1979	0.85	0.046	0.36	0.62	-	0.06	1.06	0.042	6.4
1980	1.47	-	0.36	0.41	-	0.16	1.27	USSR	5.0
					Spain[5]				
1981	1.42	-	0.41	(0.96)	-	0.07	1.02	0.35	6.2
1982	1.30	-	0.35	-	0.86	0.26	1.01	0.34	6.4
1983	1.58	-	0.31	(1.31)	0.90	0.36	1.05	0.38	7.6
1984	1.46	-	0.45	(1.23)	0.78	0.35	0.77	0.27	7.0
1985*	2.49	-	1.03	-	1.13	-	1.37	0.42	-

*Figures for January-June. For Spain: July-August

[1] Norwegian data - tonnes per 1,000 tonne-hours fishing

[2] United Kingdom data - tonnes per 100 tonne-hours fishing

[3] USSR data - tonnes per hour fishing

[4] Norwegian data - tonnes per gill-net boat week in Lofoten

[5] Spanish Data - tonnes per hour fishing

Table 6. North-East Arctic COD.
Catch per unit effort. Data from the Lofoten fishery are given in gutted weight with head off.

Year	Norwegian vessels		
	Catch (kg per man per day worked in the Lofoten fishery (Division IIa))		
	Gill-net	Long-line	Hand-line
1960	77.8	148.3	56.7
1961	101.5	141.1	75.5
1962	94.9	134.4	57.8
1963	80.8	116.3	56.2
1964	104.5	62.1	51.5
1965	81.8	78.3	68.4
1966	121.8	131.9	72.6
1967	107.9	245.4	120.7
1968	158.0	184.6	61.5
1969	170.6	200.4	142.8
1970	180.3	304.3	127.6
1971	334.3	510.7	192.7
1972	318.7	400.1	110.2
1973	189.7	366.5	112.1
1974	96.3	146.4	63.9
1975	122.0	188.3	96.1
1976	131.4	258.4	134.8
1977	173.2	279.6	143.5
1978	237.6	381.7	134.6
1979	201.3	306.0	125.1
1980	169.9	207.8	100.9
1981	217.0	327.9	109.6
1982	199.1	753.4	252.0
1983	308.0	348.8	134.0
1984	301.0	208.4	95.6
1985	204.7	178.3	75.6

Table 7. Weights in Norwegian and USSR catches.

Age	COD				HADDOCK			
	1984		1985		1984		1985	
	Norway	USSR	Norway	USSR	Norway	USSR	Norway	USSR
2	1.16	0.22	0.56	0.32	1.17	0.66	0.53	0.24
3	1.47	0.76	1.36	0.66	1.58	1.35	1.23	0.56
4	1.97	1.30	1.74	1.07	1.99	1.90	1.70	1.25
5	2.53	2.04	2.27	1.70	2.42	2.48	2.29	2.16
6	3.13	2.90	3.19	2.50	2.64	3.13	2.61	2.66
7	3.82	4.12	4.15	3.80	2.89	3.12	2.69	3.12
8	4.81	5.56	4.97	5.13	3.16	3.57	3.13	3.10
9	5.95	8.76	5.89	6.62	3.41	3.86	3.40	3.40
10	7.19	13.55	7.21	9.52	3.51	3.98	3.69	3.70
11	7.85	14.95	7.82	9.00	4.04	4.77	3.54	4.60
12	8.46	14.85	9.61	9.00	4.04	-	3.01	-
13	7.99	19.52	10.08	15.10	3.84	-	3.51	-
14	9.78	19.31	11.04	15.30	4.19	-	4.26	-
15+	10.64	22.37	9.21	19.25	4.36	5.37	4.06	4.75

Table 8. Length at age from the Norwegian surveys in 1978-84 in cm. The 1975 year class is indicated. The values for ages 7 and 8 are uncertain.

Age	1978	1979	1980	1981	1982	1983	1984	1985
3	32.13	33.10	34.15	35.50	37.55	34.85	35.79	40.26
4	45.86	42.02	42.50	44.65	46.32	46.77	49.23	50.78
5	54.19	53.27	52.45	52.96	54.71	56.02	57.89	62.22
6	64.63	64.37	63.46	61.28	63.09	64.45	67.39	71.11
7	67.56	74.73	73.58	69.59	70.84	73.30	79.60	81.82
8	76.87	82.97	83.61	77.90	82.87	80.38	82.20	88.70

Table 9. Input data to the assessment of COD.
Weight in catches and weight in stock versus age

Age	Weight in stock and catches 1982 and earlier	Weight in stock			Weight in catches		
		1983	1984	1985	1983	1984	1985
3	0.65	0.36	0.53		0.90	1.04	1.29
4	1.00	1.01	1.20		1.46	1.68	1.51
5	1.55	1.63	1.90		2.19	2.52	2.06
6	2.35	2.53	2.91		2.78	3.20	2.99
7	3.45	3.45	3.97		3.45	3.97	4.08
8	4.70	4.70	4.70		4.70	4.70	4.70
9	6.17	6.17	6.17		6.17	6.17	6.17
10	7.70	7.70	7.70		7.70	7.70	7.70
11	9.25	9.25	9.25		9.25	9.25	9.25
12	10.85	10.85	10.85		10.85	10.85	10.85
13	12.50	12.50	12.50		12.50	12.50	12.50
14	13.90	13.90	13.90		13.90	13.90	13.90
15+	15.00	15.00	15.00		15.00	15.00	15.00

Table 10. North-East Arctic COD.
Maturity ogives used in the assessment, Alternative 1, for the estimate of the spawning stock biomass

Age	Percentage mature				
	1982[1]	1983[2]	1984[3]	1984[4]	1985[5]
3	-	1	-	-	-
4	5	8	1	4	+
5	10	10	18	18	13
6	34	30	32	31	63
7	65	73	69	56	96
8	82	88	100	89	100
9	92	97	100	99	100
10	100	100	100	100	100
11	100	100	100	100	100
12	100	100	100	100	100
13	100	100	100	100	100
14	100	100	100	100	100
15+	100	100	100	100	100

[1]Hylen and Nakken (1982)

[2]Hylen and Nakken (1983)

[3]Hylen and Nakken (1984)

[4]Ponomarenko and Yaragina (1985)

[5]Hylen and Nakken (1985)

Table 11. North-East Arctic COD.
Year class strength. Number per hour trawling for
USSR Young Fish Surveys is for age 3

Year class	USSR Survey No. per hour trawling: Sub-area I	Division IIb	Mean	USSR assessment	O-group survey index (Logarithmic) All areas	Virtual Population No.at age 3 ($x 10^{-6}$) M = 0.2
1957	12	16	13	- Average	-	791
1958	16	24	19	+ Average	-	919
1959	18	14	16	+ Average	-	731
1960	9	19	13	Poor	-	474
1961	2	2	2	Poor	-	339
1962	7	4	6	Poor	-	778
1963	21	120	76	Rich	-	1,584
1964	49	45	46	Rich	-	1,293
1965	<1	<1	<1	Very Poor	+	170
1966	2	<1	1	Very Poor	0.02	112
1967	1	<1	1	Very Poor	0.04	197
1968	7	1	5	Poor	0.02	405
1969	11	6	9	Poor	0.25	1,016
1970	74	86	76	Rich	2.51	1,819
1971	37	24	32	Average	0.77	524
1972	53	17	40	Average	0.52	622
1973	74	5	46	Rich	1.48	615
1974	6	1	4	Poor	0.29	350
1975	93	4	62	Rich	0.90	654
1976	4	<1	3	Poor	0.13	214
1977	2	1	1	Poor	0.49	150
1978	1	3	2	Poor	0.22	168
1979	<1	8	3	Poor	0.40	(133)
1980	1	8	4	Poor	0.13	(96)
1981	4	4	4	Poor	0.10	(144)
1982	8	10	9	Average	0.59	-
1983	-	-	-	-	1.69	-
1984	-	-	-	-	1.55	-
1985	-	-	-	-	2.46	-

( ) = estimated

Table 12. North-East Arctic COD. Results from the Norwegian bottom trawl survey in the Barents Sea. Index of number of fish in each year class

Year	Year class												Total
	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973+	
1981	-	-	-	-	0.7	11.0	8.6	16.9	34.1	37.9	4.8	1.3	115.3
1982	-	-	-	0.1	0.9	16.1	20.4	21.4	16.0	15.8	1.4	0.2	92.3
1983	-	-	44.6	5.9	10.8	28.0	31.9	14.3	4.7	3.0	0.6	-	143.8
1984	-	355.3	126.6	60.2	19.2	15.6	9.4	3.0	0.4	0.2	-	-	589.9
1985	7.3	168.9	90.3	78.1	15.7	6.3	2.5	0.2	+	0.1	-	-	369.4

Table 13. North-East Arctic COD. Results from the Norwegian bottom trawl survey in the Svalbard area. Index of number of fish in each year class

Year	Year class												Total
	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972+	
1981	-	-	-	0.1	22.2	9.0	5.5	1.6	6.1	3.8	0.7	0.9	49.8
1982	-	-	1.5	4.0	22.3	9.6	2.8	1.9	2.9	0.4	0.1	0.1	45.6
1983	-	14.6	5.1	6.2	9.5	3.0	2.5	1.3	1.6	0.4	0.2	-	44.4
1984	52.2	42.7	5.6	4.2	5.3	2.2	0.5	0.5	0.4	0.2	-	-	113.8

Table 14. North-East Arctic COD. Results from the USSR bottom trawl survey in the Barents Sea and the Norwegian Sea. Mean catch in numbers caught per hour of trawling

Year	Age										Total
	1	2	3	4	5	6	7	8	9	10+	
1979	-	0.9	5.0	33.8	9.8	4.3	2.9	1.1	0.6	0.4	58.8
1980	-	0.4	4.6	3.8	10.6	2.9	1.0	0.8	0.2	0.1	24.5
1981	-	2.5	2.8	3.9	2.2	4.8	0.8	0.3	0.1	+	17.5
1982	-	0.1	3.0	2.9	1.6	0.4	1.1	0.4	+	+	9.7
1983	0.1	0.1	0.2	1.8	1.4	0.5	0.1	0.2	0.1	+	4.5

SHEVELEV (1983, 1984, 1985, 1986)

Table 15. North-East Arctic COD. Stock numbers in millions at 1 January 1982 and 1983 from Hylen and Nakken (1982) (1983)

Year	Age												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1982	1	4	81	105	103	95	154	23	12	6	3	2	1
1983	-	27	29	81	99	58	43	50	13	5	2	+	+
1984	2,382	506	121	58	59	54	30	19	12	4	-	-	-
1985	(185)	3,442	1,212	167	56	35	26	7	6	2	-	-	-

Table 16   VIRTUAL POPULATION ANALYSIS

NORTH-EAST ARCTIC COD

CATCH IN NUMBERS   UNIT: thousands

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	42416	13196	5298	15725	55937	34467	3709	2307	7164	7754	35536	294262
4	170566	106984	45912	25999	55644	160048	174585	24545	10792	13739	45431	131493
5	167241	205549	97950	78299	54676	69235	267961	238511	25813	11831	26832	61000
6	89460	95498	58575	68511	42539	22061	107051	181239	137329	9527	12089	20569
7	28297	35518	19642	25444	37169	26295	26701	79353	96420	59290	7918	7248
8	21996	16221	9162	8438	13500	25139	16399	26989	31920	52003	34885	8328
9	7956	11894	6196	3569	5077	11323	11597	13463	8753	12093	22515	19130
10	2728	3884	3553	1467	1495	2329	3657	5092	3249	2434	4572	4499
11	2603	1021	733	1161	580	627	657	1913	1232	762	1215	677
12	1647	1025	172	131	403	316	122	414	260	418	353	195
13	392	498	387	67	77	225	124	121	106	149	315	81
14	280	129	264	91	9	40	70	23	39	42	121	59
15+	103	157	131	179	70	14	46	46	55	25	40	55
TOTAL	535685	491574	248025	229081	251976	352179	612679	574026	323792	170067	191622	547596

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
3	91855	45282	85337	39594	78822	8600	3911	5407	8948	5108	7630
4	437377	59798	114341	168609	45400	77484	17086	9466	20933	19594	15324
5	203772	226646	79993	136335	88495	43677	81986	20803	19345	20473	19458
6	47006	118567	118236	52925	56823	31943	40061	63433	28084	17656	20259
7	12630	29522	47672	61821	25407	16815	17664	21788	42496	17004	15067
8	4370	9353	13962	23338	31821	3274	7442	9933	8395	18329	8075
9	2523	2617	4051	5659	9408	10974	5508	4267	2678	2545	5922
10	5607	1555	936	1521	1227	1785	3196	1311	708	646	742
11	2127	1928	558	610	913	427	678	882	271	229	218
12	322	575	442	271	446	103	79	109	260	74	149
13	151	231	139	122	748	59	24	37	27	58	52
14	83	15	26	92	48	38	26	3	5	20	11
15+	62	37	53	54	51	45	8	1	5	5	11
TOTAL	807885	496126	465946	490951	339609	200224	175669	135440	132355	99741	92918

Table 17 VIRTUAL POPULATION ANALYSIS

NORTH-EAST ARCTIC COD

FISHING MORTALITY COEFFICIENT UNIT: Year-1 NATURAL MORTALITY COEFFICIENT = .20

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	.066	.031	.017	.023	.040	.030	.024	.023	.041	.021	.039	.196
4	.305	.236	.144	.111	.104	.152	.207	.221	.142	.103	.167	.199
5	.648	.738	.352	.389	.212	.181	.408	.481	.382	.228	.298	.353
6	.823	.999	.481	.445	.379	.202	.467	.537	.571	.236	.384	.392
7	.607	.962	.569	.397	.465	.427	.401	.768	.619	.518	.314	.419
8	.654	.873	.716	.515	.566	.668	.526	.927	.337	.328	.667	.638
9	.800	.935	1.047	.690	.680	.835	.764	1.132	.959	.930	1.117	1.001
10	.963	1.293	.833	.770	.709	.788	.725	.949	.970	.771	1.222	.713
11	.808	1.333	1.059	.734	.460	.862	.535	1.128	.536	.639	1.216	.576
12	.810	.910	.864	.491	.616	.889	.355	.782	.432	.461	.704	.635
13	.673	.621	1.145	1.052	.606	.864	1.151	.721	.466	.474	.768	.340
14	.500	.490	.810	.960	.370	.750	.740	.680	.540	.340	.910	.310
15+	.500	.490	.810	.960	.370	.750	.740	.680	.540	.340	.910	.310
(5-10)U	.749	.967	.666	.534	.502	.517	.548	.799	.723	.585	.667	.586

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
3	.214	.084	.166	.133	.142	.045	.029	.023	.077	.036	.060
4	.496	.210	.312	.566	.222	.203	.119	.091	.188	.241	.250
5	.537	.521	.479	.752	.667	.344	.342	.208	.272	.283	.400
6	.507	.701	.572	.683	.844	.543	.611	.486	.479	.426	.500
7	.445	.703	.695	.678	.851	.655	.666	.817	.713	.601	.800
8	.483	.703	.886	.906	.935	.764	.694	1.040	.901	.792	.650
9	.403	.604	.774	1.209	1.280	1.052	.698	1.190	1.042	.781	.650
10	.957	.466	.451	.768	.981	.929	1.086	1.033	.630	.705	.550
11	.913	1.115	.303	.603	1.792	1.222	1.228	1.085	.687	.427	.550
12	.601	.681	.859	.236	1.312	1.189	.787	.651	1.212	.402	.550
13	1.739	1.255	.342	.618	2.049	.586	1.055	1.142	.527	1.034	.550
14	.700	.860	.430	.400	.530	.560	.560	.340	.440	.430	.550
15+	.700	.860	.430	.400	.530	.560	.560	.340	.440	.430	.550
(5-10)U	.555	.616	.643	.833	.926	.714	.716	.804	.673	.598	.592

Table 18 VIRTUAL POPULATION ANALYSIS

NORTH-EAST ARCTIC COD

STOCK SIZE IN NUMBERS UNIT: thousands

BIOMASS TOTALS UNIT: tonnes

ALL VALUES ARE GIVEN FOR 1 JANUARY

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	731055	473635	338964	778291	1533555	1293326	170105	112218	197120	405032	1015799	1818325
4	711521	560263	375865	272730	623011	1246009	1027765	135921	89793	154921	324610	799586
5	383005	429248	362440	266359	199855	459916	875935	684293	89192	63790	114449	224844
6	173642	164106	168004	208775	147802	132414	314181	476750	346500	49853	41580	69584
7	67910	62438	49488	85057	109495	82824	88550	161272	228043	160350	32244	23192
8	49998	30293	19535	22940	40805	56320	44226	48559	61247	100492	78181	19284
9	15730	21279	10357	7815	11224	21765	23657	21522	15728	21734	35934	32841
10	4792	5785	6840	2977	3211	4654	7730	9074	5681	4933	7011	9624
11	5112	1498	1300	2434	1129	1294	1734	3065	2859	1762	1868	1691
12	3230	1865	325	369	957	584	447	831	812	1239	762	453
13	873	1176	615	112	185	423	196	257	311	432	640	309
14	779	364	518	160	32	83	146	51	102	160	220	243
15+	236	444	257	315	248	29	96	102	92	95	73	226
TOTAL NO	2147935	1752396	1334505	1648337	2727509	3299634	2554769	1653825	1037480	964765	1653570	3000202
SPS NO	80300	62704	39745	37122	63790	85159	78232	83591	86853	130818	124688	64671
TOT.BIOM	2900018	2513249	1966173	2189373	3028450	3856473	3980019	3419442	2427784	1870441	2052069	2972094
SPS BIOM	477306	378723	242659	213829	341260	460038	440162	473220	470594	683010	680838	398554

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
3	524534	622444	614918	350337	653814	214071	150303	168078	132664	96398	144414	800 000
4	1223769	346771	468767	426577	251144	464264	167504	119526	134535	100544	76118	111351
5	536257	610081	230082	281040	198558	164759	310548	121737	89322	91297	64689	48535
6	129306	256606	296517	116686	108455	83336	95663	180450	80943	55734	56340	35502
7	38510	63760	104216	136967	48260	38171	39633	42497	90898	41101	29795	27978
8	12486	20204	25842	42573	56916	16878	16226	16666	15374	30481	18442	10961
9	8344	6306	8190	8727	14085	18290	6438	6636	4823	5114	13525	7882
10	9836	4568	2823	3093	2132	3207	5230	2148	1654	1393	1918	5781
11	3863	3108	2346	1472	1175	655	1037	1445	595	721	563	906
12	778	1270	834	1419	659	160	158	249	401	245	385	266
13	197	349	526	289	918	145	40	59	106	98	134	182
14	180	28	81	306	128	97	66	11	15	63	28	63
15+	134	70	166	180	136	115	20	4	15	16	28	27
TOTAL NO	2488247	1935565	1755308	1369664	1336179	1004148	792665	659510	551345	429205	406381	
SPS NO	35869	35903	40606	58058	76146	39547	29215	27221	122093	104460	86017	
TOT.BIOM	3070089	2737354	2516123	2153975	1809073	1415866	1277067	1140995	989403	793272	769809	
SPS BIOM	237443	217372	234672	317320	404130	229550	169287	152850	400071	373045	353901	

Table 19 North-East Arctic COD
Input data for the catch and stock projections.
Input variables by age group.

Age	1985 Fishing mortal-ities	1986 Stock size	Fishing pattern 1986-88	Maturity ogive		Weight in the catch			Weight in the stock		
				1986-87	1988-89	1986	1987	1988	1986	1987	1988
3	0.10	1,500,000	0.05	0.00	0.00	0.65	0.65	0.65	0.48	0.48	0.48
4	0.35	592,654	0.35	0.00	0.00	1.51	1.00	1.00	1.20	0.90	0.90
5	0.40	64,243	0.40	0.13	0.01	2.06	2.06	1.55	1.90	1.90	1.55
6	0.50	26,636	0.50	0.63	0.63	2.99	2.99	2.99	2.91	2.91	2.91
7	0.80	17,629	0.80	0.96	0.96	4.08	4.08	4.08	3.97	3.97	3.97
8	0.65	10,292	0.65	1.00	1.00	4.70	4.70	4.70	4.70	4.70	4.70
9	0.65	4,684	0.65	1.00	1.00	6.17	6.17	6.17	6.17	6.17	6.17
10	0.55	3,368	0.55	1.00	1.00	7.70	7.70	7.70	7.70	7.70	7.70
11	0.55	2,730	0.55	1.00	1.00	9.25	9.25	9.25	9.25	9.25	9.25
12	0.55	427	0.55	1.00	1.00	10.85	10.85	10.85	10.85	10.85	10.85
13	0.55	125	0.55	1.00	1.00	12.50	12.50	12.50	12.50	12.50	12.50
14	0.55	85	0.55	1.00	1.00	13.90	13.90	13.90	13.90	13.90	13.90
15+	0.55	42	0.55	1.00	1.00	15.00	15.00	15.00	15.00	15.00	15.00
Units	-	1,000 individuals	-	-	-	kg	kg	kg	kg	kg	kg

Natural mortality is 0.20 for all ages and all years

Recruitment : 1986 1,500 million
(age 3) 1987 1,600 million
1988 1,500 million

Table 20 North-East Arctic HADDOCK.
Total nominal catch (tonnes) by fishing areas.
(Data provided by Working Group members).

Year	Sub-area I	Division IIa	Division IIb	Total
1960	125,657	27,925	1,854	155,434
1961	165,165	25,642	2,427	193,234
1962	160,972	25,189	1,727	187,888
1963	124,774	21,031	939	146,744
1964	79,056	18,735	1,109	98,900
1965	98,505	18,640	939	118,079
1966	124,115	34,892	1,614	160,621
1967	108,066	27,980	440	136,486
1968	140,970	40,031	725	181,726
1969	88,960	40,208	1,341	130,509
1970	59,493	26,611	497	86,601
1971	56,300	21,567	435	78,302
1972	221,183	41,979	2,155	265,317
1973	283,728	23,348	2,989	320,065
1974	159,037	47,033	5,068	221,138
1975	121,686	44,330	9,726	175,742
1976	94,065	37,566	5,649	137,279
1977	72,159	28,452	9,547	110,158
1978	63,965	30,478	979	95,422
1979	63,841	39,167	615	103,623
1980	54,205	33,616	68	87,889
1981	36,834	39,864	455	77,153
1982	17,948	29,005	2	46,955
1983	7,550	13,872	185	21,607
1984*	4,118	13,469	74	17,661

*Provisional figures.

Expected catches

1985	11,000	12,000	+	23,000

Tabel 21. North-East Arctic HADDOCK.
Nominal catches (tonnes) by countries. (Norwegian coastal haddock not included, Murman haddock included). (Sub-area I and Divisions IIa and IIb combined). (Data provided by Working Group members).

Year	Faroe Islands	France	German Dem.Rep.	Germany, Fed.Rep.	Norway	Poland	United Kingdom	U.S.S.R	Others	Total
1960	172	-	-	5,597	46,263	-	45,469	57,025	125	155,651
1961	285	220	-	6,304	60,862	-	39,650	85,345	558	193,234
1962	83	409	-	2,895	54,567	-	37,486	91,910	58	187,438
1963	17	363	-	2,554	59,955	-	19,809	63,526	-	146,224
1964	-	208	-	1,482	38,695	-	14,653	43,870	250	99,158
1965	-	226	-	1,568	60,447	-	14,345	41,750	242	118,578
1966	-	1,072	11	2,098	82,090	-	27,723	48,710	74	161,778
1967	-	1,208	3	1,705	51,954	-	24,158	57,346	23	136,397
1968	-	-	-	1,867	64,076	-	40,129	75,654	-	101,726
1969	2	-	309	1,490	67,549	-	37,234	24,211	25	130,820
1970	541	-	656	2,119	37,716	-	20,423	26,802	-	87,257
1971	81	-	16	896	45,715	43	16,373	15,778	3	78,905
1972	137	-	829	1,433	46,700	1,433	17,166	196,224	2,231	266,153
1973	1,212	3,214	22	9,534	86,767	34	32,408	186,534	2,501	322,626
1974	925	3,601	454	23,409	66,164	3,045	37,663	78,548	7,348	221,157
1975	299	5,191	437	15,930	55,966	1,080	28,677	65,015	3,163	175,758
1976	536	4,459	348	16,660	49,492	986	16,940	42,485	5,358	137,265
1977	213	1,510	144	4,798	40,118	-	10,878	52,210	287	110,158
1978	466	1,411	369	1,521	39,955	1	5,766	45,895	38	95,422
1979	343	1,198	10	1,948	66,849	2	6,454	26,365	454	103,623
1980	497	226	15	1,365	61,886	-	2,948	20,706	246	87,889
1981	381	414	22	2,398	58,856	-	1,682	13,400	-	77,153
1982	496	53	-	1,258	41,421	-	827	2,900	-	46,955
1983	428	-	1	729	19,371	-	259	680	139	21,607
1984*	297	-	4	400	15,586	-	234	1,103	37	17,661

*Provisional figures.

Table 22 North-East Arctic HADDOCK.
Catch per unit effort

Year	Sub-area I		Division IIb		Division IIa	
	Norway[1]	United Kingdom[2]	Norway[1]	United Kingdom[2]	Norway[1]	United Kingdom[2]
1960	-	33	-	2.8	-	34
1961	-	29	-	3.3	-	36
1962	-	23	-	2.5	-	42
1963	-	13	-	0.9	-	33
1964	-	18	-	1.6	-	18
1965	-	18	-	2.0	-	18
1966	-	17	-	2.8	-	34
1967	-	18	-	2.4	-	25
1968	-	19	-	1.0	-	50
1969	-	13	-	2.0	-	42
1970	-	7	-	1.0	-	31
1971	-	8	-	3.0	-	25
1972	0.06	14	0.02	23.0	0.09	18
1973	0.35	22	0.18	20.0	0.39	20
1974	0.27	20	0.09	15.0	0.51	74
1975	0.26	15	0.06	4.0	0.44	60
1976	0.27	10	+	3.0	0.24	38
1977	0.11	4	+	0.2	0.14	16
1978	0.13	5	+	4.0	0.14	15
1979	0.36	-	0.07	-	0.18	-
1980	0.45	-	+	-	0.22	-
1981	0.64	-	-	-	0.37	-
1982	0.51	-	-	-	0.38	-
1983	0.27	-	(0.04)	-	0.17	-
1984*	0.13	-	(0.01)	-	0.13	-

*Preliminary figures

[1] Norwegian data - tonnes per 1,000 tonne-hours fishing

[2] United Kingdom data - tonnes per 100 tonne-hours fishing

Table 23 Input weight-at-age data (kg) to the assessment of HADDOCK

Year	3	4	5	6	7	8	9	10	11	12	13	14+
1982	0.66	1.03	1.79	2.38	2.86	3.33	3.70	4.41	5.40	6.40	7.40	8.00
1983	1.52	1.86	2.10	2.38	2.86	3.33	3.70	4.41	5.40	6.40	7.40	8.00
1984	1.57	1.991	2.42	2.68	2.93	3.33	3.70	4.41	5.40	6.40	7.40	8.00
1985	0.87	1.60	2.28	2.61	2.71	3.33	3.70	4.41	5.40	6.40	7.40	8.00

Table 24 North-East Arctic HADDOCK.
Year class strength.

Year class	USSR Survey No. per hour trawling Age 1	Age 2	Age 3	0-group survey index (Logarithmic) All areas	Virtual Population No. at age 3 ($x 10^{-6}$)
1957	38	9	14	-	242
1958	2	4	5	-	109
1959	7	14	33	-	241
1960	30	40	72	-	274
1961	32	50	34	-	320
1962	5	3	4	-	100
1963	16	9	12	-	243
1964	11	12	15	-	291
1965	<1	<1	<1	0.01	20
1966	<1	<1	<1	0.01	17
1967	3	13	8	0.08	164
1968	<1	<1	3	+	97
1969	31	69	120	0.29	1,025
1970	10	33	31	0.64	270
1971	3	3	9	0.26	54
1972	2	9	3	0.16	49
1973	13	8	5	0.26	56
1974	15	35	14	0.51	115
1975	163	96	59	0.60	175
1976	6	13	4	0.38	156
1977	1	1	<1	0.33	23
1978	<1	<1	<1	0.12	7
1979	<1	<1	<1	0.20	(11)
1980	<1	<1	-	0.15	(9)
1981	<1	(<1)	8	0.03	(10)
1982	23	59	63	0.38	-
1983	40	79	-	0.62	-
1984	1	-	-	0.78	-
1985	-	-	-	0.27	-

( ) = Estimated

Table 25 North-East Arctic HADDOCK.
Results from the Norwegian bottom trawl survey in the Barents Sea in February. Index of number of fish in each year class.

Year	Year class											Total
	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	
1981					0.3	4.8	2.3	9.5	2.0	6.1	0.5	25.7
1982				0.5	0.0	1.8	2.1	2.2	5.5	2.7	0.2	15.9
1983			314.5	5.7	4.1	3.8	1.9	2.3	3.9	1.6	-	379.0
1984		663.2	355.8	152	1.6	0.7	0.2	0.3	0.4	1.8	-	1,037.4
1985	167.8	616.2	380.2	7.2	0.4	0.2	0.3	0.3	-	-	-	1,172.6

Table 26 North-East Arctic HADDOCK.
Results from the USSR bottom trawl survey in the Barents Sea and the Norwegian Sea. Mean catch in numbers caught per hour of trawling.

Year	Age										Total
	1	2	3	4	5	6	7	8	9	10+	
1979	-	1.2	19.3	18.8	2.3	0.3	0.1	0.1	0.1	0.3	42.5
1980	+	1.1	1.0	13.1	10.6	1.0	+	+	-	0.1	27.0
1981	0.2	0.7	1.2	0.9	7.6	7.1	0.2	+	-	-	18.0
1982	-	0.4	0.9	0.5	0.9	3.7	1.2	+	+	+	7.7
1983	2.2	0.2	0.3	0.3	0.1	0.1	0.6	0.4	+	+	4.3

Shevelev (1983, 1984, 1985, 1986)

Table 27 North-East Arctic HADDOCK.
Results from Norwegian acoustic survey in the Barents Sea. Stock numbers in millions.

Year	Year class												Total
	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	
1981	-	-	-	-	2	25	14	66	160	50	2	1	320
1982	-	-	-	3	4	7	10	12	29	14	1	-	80
1983	-	-	-	10	7	9	5	4	10	5	-	-	50
1984	-	2,148	1,002	53	15	7	2	2	2	-	-	-	3,231
1985	158	1,057	479	14	+	+	+	+	+	-	-	-	1,708

Table 28 SUM OF PRODUCTS CHECK

NORTH-EAST ARCTIC HADDOCK
CATEGORY: TOTAL

CATCH IN NUMBERS UNIT: thousands

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	39604	28567	22305	5911	26157	15918	657	1520	23004	1979	230229	70204
4	30947	72995	49162	46161	22469	41373	67632	1963	2408	24359	22246	258773
5	49028	19035	30592	40032	62724	13505	41267	44526	1870	1258	42849	24018
6	33922	13627	5800	12578	28840	25736	7748	18956	21995	918	3196	6872
7	3209	9290	3519	1672	5711	8878	15599	3611	7948	9279	1606	418
8	1344	1243	2709	970	578	1617	5292	4925	1974	3056	6736	422
9	1778	561	832	893	435	218	655	1624	1978	826	2630	1680
10	243	409	104	122	188	176	182	515	726	1043	896	525
11	247	79	206	204	186	155	101	43	166	369	988	146
12	482	84	234	123	25	76	115	43	26	130	538	340
13	20	169	121	14	8	27	18	14	52	27	53	68
14+	8	41	67	205	7	7	19	2	19	4	42	13
TOTAL	160832	146100	115651	108885	147328	107686	139285	77542	62136	43248	312009	363479

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
3	9684	10037	13989	55967	47311	17540	627	486	883	704	456
4	41701	14089	13449	22043	18812	35290	22878	2561	900	1930	841
5	88111	33871	6808	7368	4076	10645	21794	22124	3372	384	836
6	5827	49712	20789	2586	1389	1429	2971	10685	12203	1374	307
7	4138	2135	40044	7781	1626	812	250	1034	2625	3282	765
8	382	1236	1247	11043	2596	546	504	162	344	906	2250
9	617	92	1349	311	6215	1466	230	162	75	52	499
10	2043	131	193	388	162	2310	842	72	80	37	70
11	935	500	279	96	258	181	1299	330	91	29	25
12	276	147	652	101	3	87	111	564	320	21	36
13	458	53	331	84	74	2	35	27	204	21	44
14+	143	92	46	98	65	53	15	42	34	91	185
TOTAL	154315	112095	99176	107866	82587	70361	51556	38249	21131	9331	6314

Table 29 VIRTUAL POPULATION ANALYSIS

NORTH-EAST ARCTIC HADDOCK

FISHING MORTALITY COEFFICIENT UNIT: Year-1 NATURAL MORTALITY COEFFICIENT = .20

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	.200	.122	.080	.067	.126	.062	.037	.102	.168	.023	.283	.336
4	.595	.680	.317	.235	.338	.360	.402	.149	.233	.268	.378	.593
5	1.048	.935	.690	.462	.575	.427	.554	.506	.207	.134	1.059	.918
6	1.043	.992	.859	.690	.722	.494	.467	.536	.506	.148	.962	.466
7	.620	.956	.770	.655	.309	.510	.639	.415	.452	.416	.416	.302
8	.663	.523	.848	.497	.497	.554	.660	.425	.429	.314	.609	.182
9	.978	.652	.820	.772	.436	.353	.457	.433	.302	.311	.488	.297
10	.400	.633	.235	.261	.359	.315	.562	.417	.351	.258	.656	.167
11	.400	.218	.780	.970	.798	.568	.301	.247	.405	.303	.414	.206
12	.719	.230	1.953	1.883	.295	.937	1.160	.202	.232	.645	.979	.244
13	.600	.600	.600	.600	.600	.600	.600	.400	.400	.400	.600	.300
14+	.600	.600	.600	.600	.600	.600	.600	.400	.400	.400	.600	.300
(4- 7)U	.827	.891	.659	.511	.621	.433	.516	.402	.350	.254	.704	.570

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
3	.215	.251	.319	.759	.352	.132	.031	.085	.091	.091	.050
4	.342	.551	.625	1.247	.630	.484	.255	.170	.223	.294	.150
5	.412	.516	.568	.866	.830	.924	.631	.419	.352	.355	.200
6	.594	.432	.704	.439	.385	.807	.734	.746	.432	.236	.200
7	.573	.453	.752	.630	.550	.408	.311	.618	.407	.196	.200
8	.499	.333	.524	.477	.445	.359	.481	.341	.429	.238	.200
9	.457	.212	.742	.237	.545	.488	.252	.279	.261	.105	.200
10	.712	.154	.913	.491	.187	.400	.580	.116	.216	.199	.200
11	.502	.374	.564	2.207	.719	.328	.412	.473	.211	.113	.200
12	.741	.134	1.244	.409	.382	.570	.343	.316	1.231	.069	.200
13	.600	.300	.500	.500	.600	.475	.475	.130	.180	.220	.200
14+	.600	.300	.500	.500	.600	.475	.475	.130	.180	.220	.200
(4- 7)U	.480	.488	.662	.796	.599	.656	.483	.488	.353	.270	.188

Table 30 VIRTUAL POPULATION ANALYSIS

NORTH-EAST ARCTIC HADDOCK

STOCK SIZE IN NUMBERS UNIT: thousands

BIOMASS TOTALS UNIT: tonnes

ALL VALUES ARE GIVEN FOR 1 JANUARY

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	240746	274166	320365	100062	242595	291103	19735	17210	164097	96809	1025097	269943
4	75407	161449	198715	242171	76591	175041	223970	15603	12720	113629	77473	632281
5	81904	34055	66979	118517	136737	42541	106123	122683	11306	8247	71125	43460
6	56814	23518	10948	27515	61147	72261	22716	49947	60559	7328	5619	20186
7	7589	16386	7142	5796	11294	24318	36055	11653	23921	29678	5172	1759
8	3023	3337	5156	2709	1615	4155	11956	15576	6501	12458	16137	2794
9	3994	1278	1619	1208	1549	864	1934	5061	8555	3388	7454	7188
10	833	953	545	534	684	714	463	1013	2687	5046	2032	3746
11	321	443	414	353	362	391	427	216	547	1548	3193	863
12	1025	450	292	155	107	136	181	254	138	299	936	1728
13	48	409	293	54	19	65	44	47	173	90	128	288
14+	19	99	162	476	17	17	46	7	63	13	102	55
TOTAL NO	471294	516546	612650	498202	552523	611486	423719	259275	290546	276733	1214469	984291
SPS NO	68173	49694	45907	63377	36353	34463	94208	87591	74432	60348	57422	70462
TOT.BIOM	576973	540318	615713	629421	713761	713559	644138	477594	422985	385993	1027396	1031507
SPS BIOM	165052	172298	162472	130602	190291	202133	227126	220966	210695	180266	167858	151387

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
3	55076	49604	56203	114685	174954	155668	22731	6534	11127	8892	10307	[300 000]
4	157945	36376	31583	33445	43965	100751	111641	18044	4952	8513	6645	8027
5	286187	91857	17170	13834	7867	19178	50364	70825	12466	3244	5072	4683
6	14209	155258	44869	7965	4764	2809	6250	22160	38139	7178	1862	3400
7	10367	6421	82528	18172	4202	2654	1026	2449	8609	20281	4641	1248
8	1064	4785	3343	31840	7922	1965	1444	615	1080	4693	15650	3111
9	1907	529	2807	1620	16171	4158	1135	731	358	576	3027	9150
10	4375	1008	350	1095	1047	7676	2091	722	453	226	425	2029
11	2594	1758	707	115	549	711	4212	958	527	299	152	285
12	575	1286	990	330	10	219	420	2283	469	349	218	102
13	1109	224	921	234	179	6	101	244	1362	117	267	146
14+	346	390	128	273	157	153	43	379	227	507	1122	951
TOTAL NO	535755	349496	241600	223603	261790	295970	201937	125995	79790	54675	47388	
SPS NO	102324	120768	111114	59936	36108	28142	30903	37013	35379	29486	25157	
TOT.BIOM	833507	667734	434534	329422	294543	317544	283602	242702	175068	122952	112193	
SPS BIOM	228633	296602	314133	184669	118010	85600	81917	97412	100027	89175	87313	

Table 31 North-East Arctic HADDOCK. Input data for stock size and catch projections. Input variables by age groups.

Age	1985 Fishing mortalities	1986 Stock size	Fishing pattern 1986- 88	Maturity ogive 1986-.89	Weight in the catch 1986- 88	Weight in the stock 1986- 88
3	0.05	400,000	0.05	0.00	0.66	0.66
4	0.15	233,640	0.25	0.05	1.03	1.03
5	0.20	5,656	0.30	0.23	1.79	1.79
6	0.20	3,139	0.20	0.53	2.38	2.38
7	0.20	2,279	0.20	0.88	2.86	2.86
8	0.20	836	0.20	0.98	3.33	3.33
9	0.20	2,085	0.20	1.00	3.70	3.70
10	0.20	6,133	0.20	1.00	4.41	4.41
11	0.20	1,360	0.20	1.00	5.40	5.40
12	0.20	191	0.20	1.00	6.70	6.70
13	0.20	68	0.20	1.00	7.40	7.40
14+	0.20	721	0.20	1.00	8.00	8.00
Units	-	1,000 Individuals	-	-	kg	kg

Natural mortality is 0.20 for all ages and all years
Recruitment: 1986 400 million
(Age 3) 1987 75 million
1988 50 million

Figure 1. North-East Arctic COD
Fishing mortality generated by Norwegian trawlers in Sub-area I on age 5-6 cod versus effort by the same fleet (in Norwegian units) in this area. Catchability (Q) versus year calculated from the same data sets

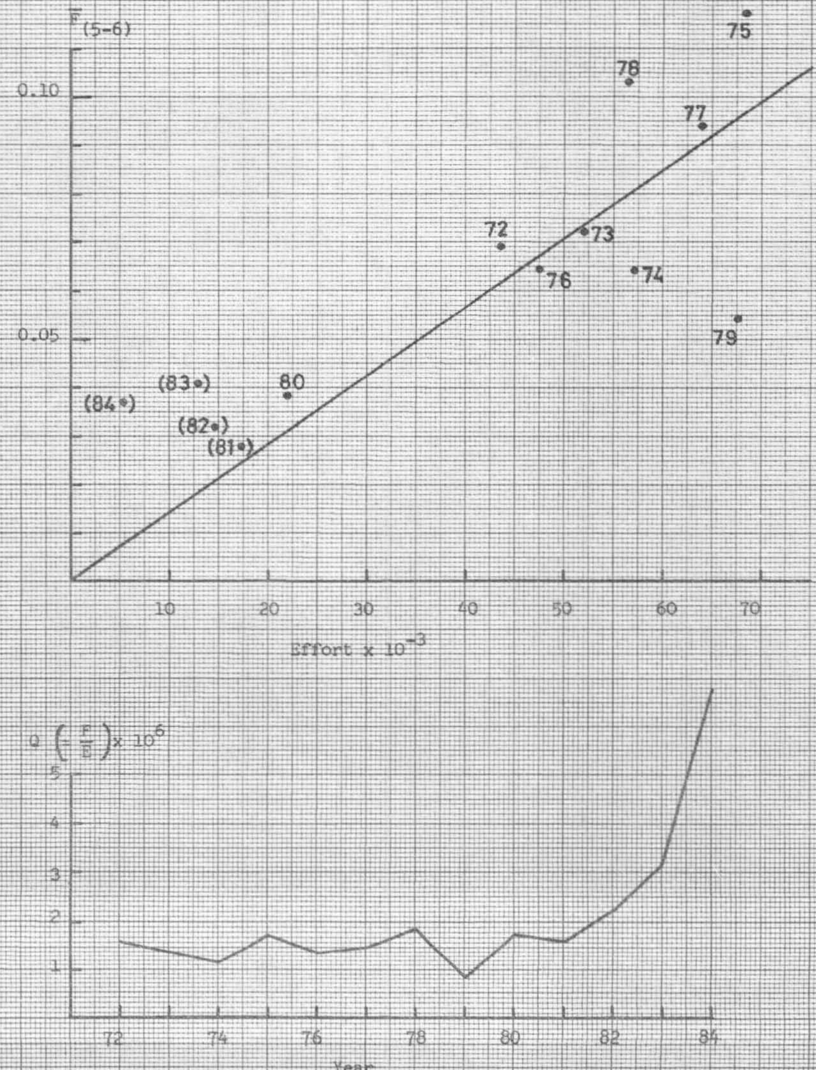


Figure 2 North-East Arctic COD.
Fishing mortality generated by Norwegian trawlers in Division IIa on age 5-8 cod versus effort by the same fleet (in Norwegian units) in this area. Catchability (Q) versus year calculated from the same data sets.

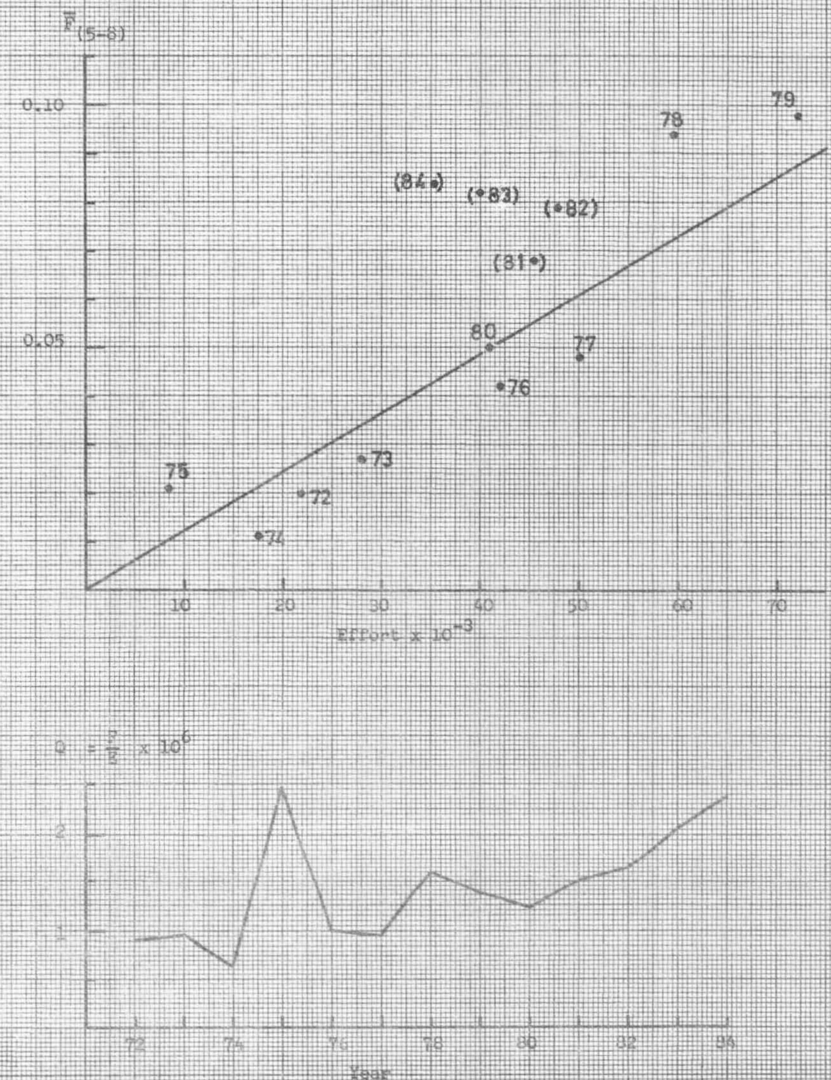


Figure 3 North-East Arctic COD
The numbers of age 3 fish from the VPA versus the logarithmic 0-group survey index.

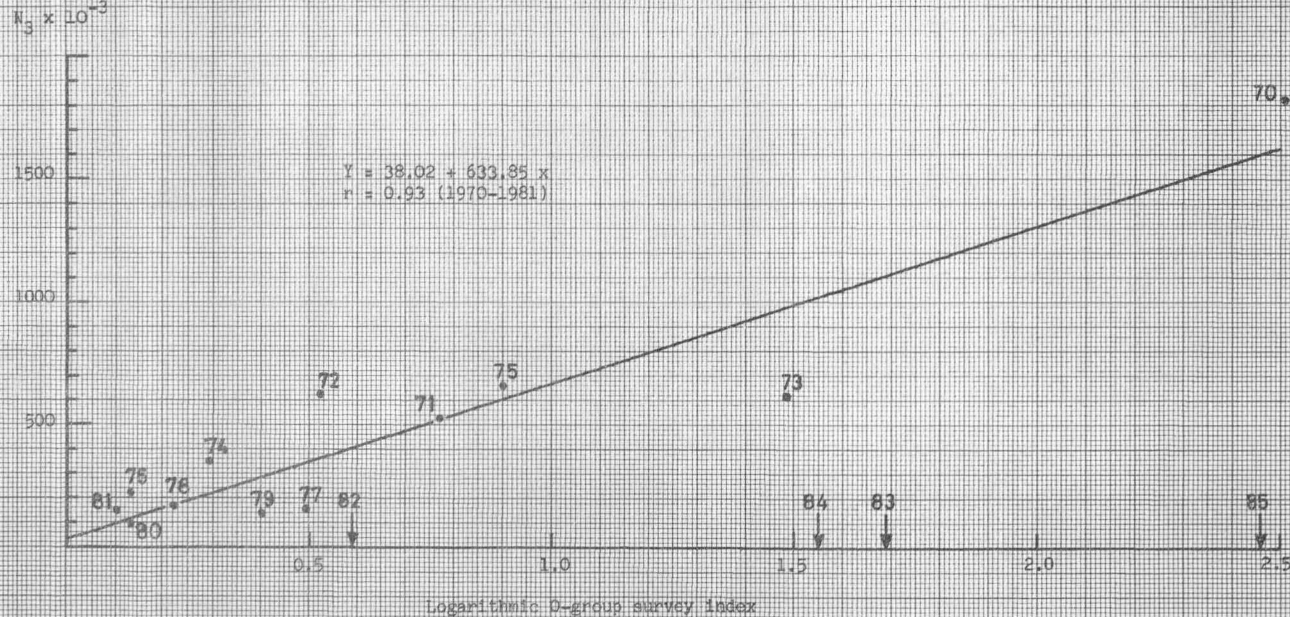
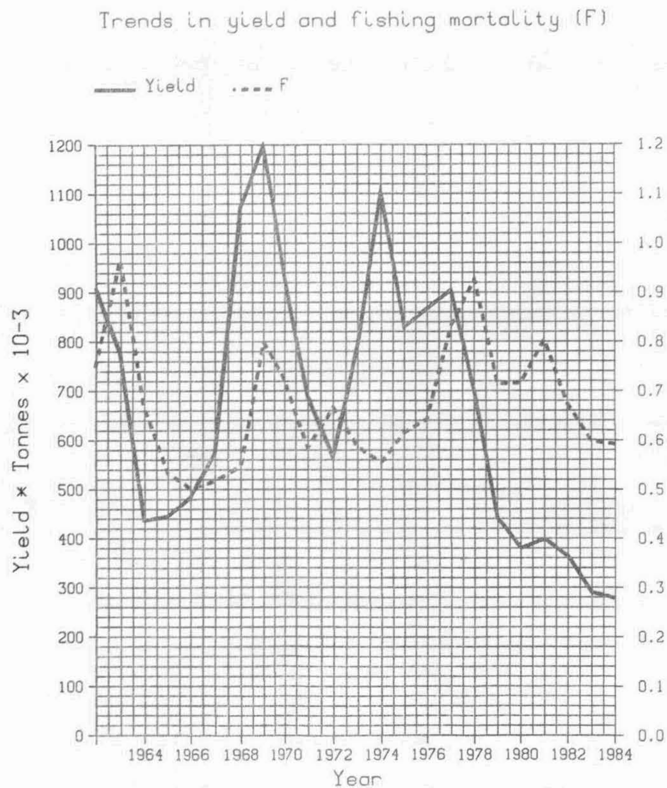
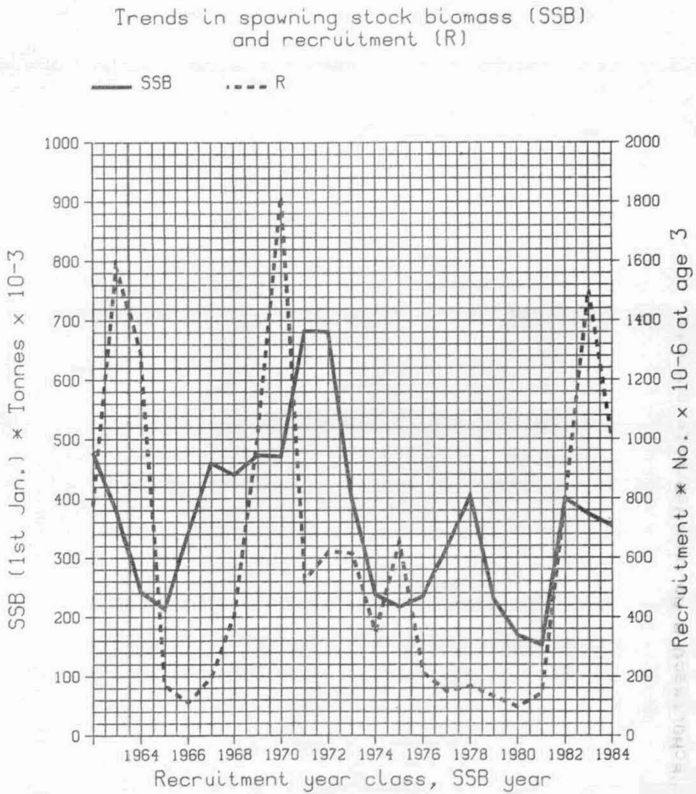


Figure 4. A-B

FISH STOCK SUMMARY
STOCK: NE Arctic Cod
20-10-1985



A



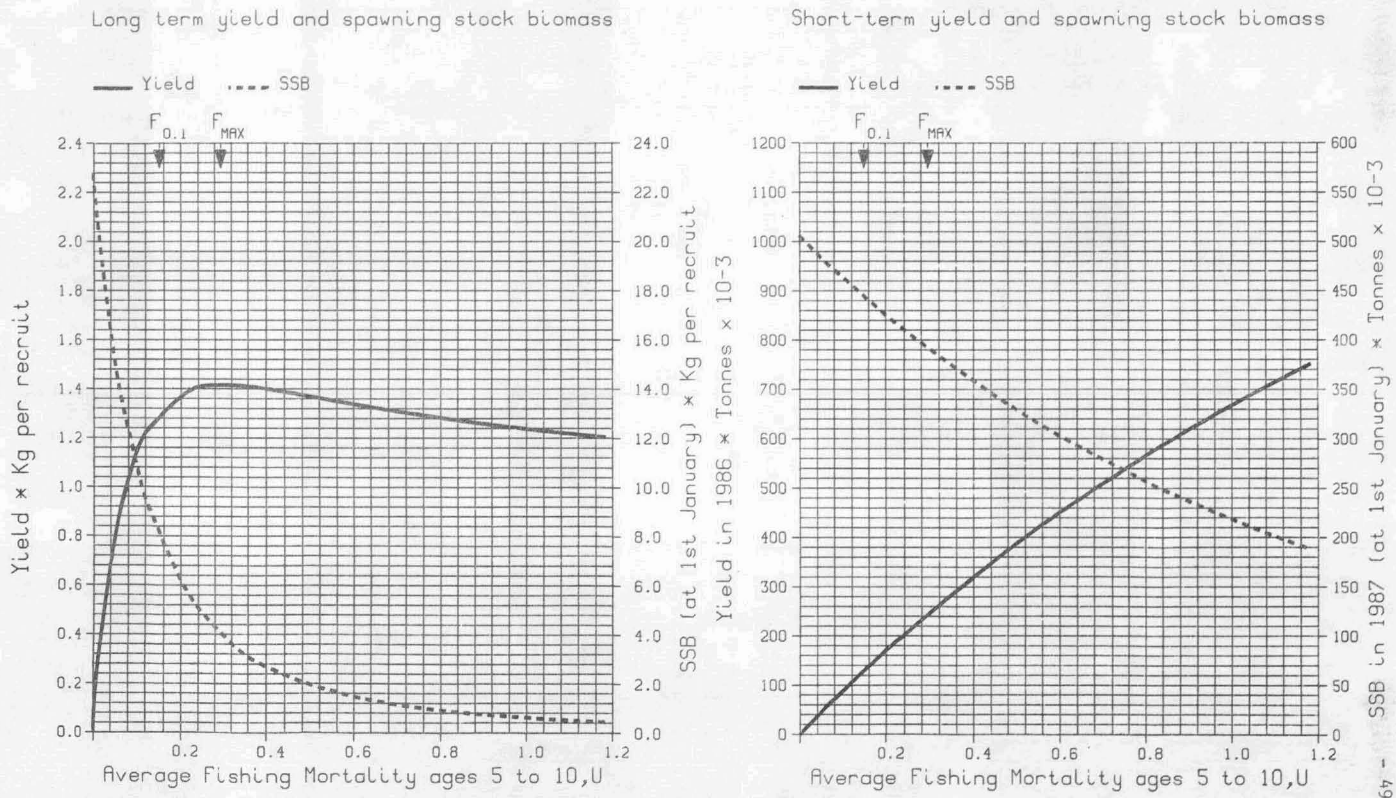
B

Figure 4. C-D

FISH STOCK SUMMARY

STOCK: NE Arctic Cod

20-10-1985



C

D

Figure 5 North-East Arctic COD and HADDOCK
The Fishing mortalities generated on cod ages (6-7) in Division IIa and haddock ages (5-7) in Sub-area II. Both sets of data refer to Norwegian trawlers for the years 1967-1984. (The arrows for 1983 and 1984 show the change if F is corrected for the increasing Q of cod in those years).

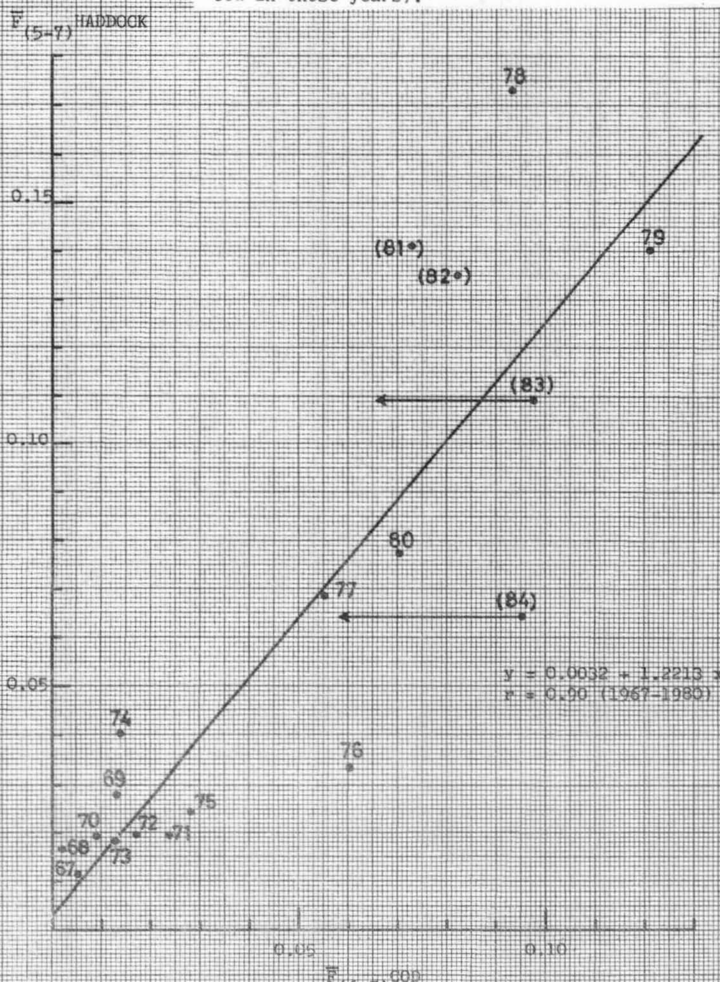


Figure 6 North-East Arctic COD and HADDOCK
Total international trawl catch ratio versus biomass (3+) ratio for the years 1967-84.

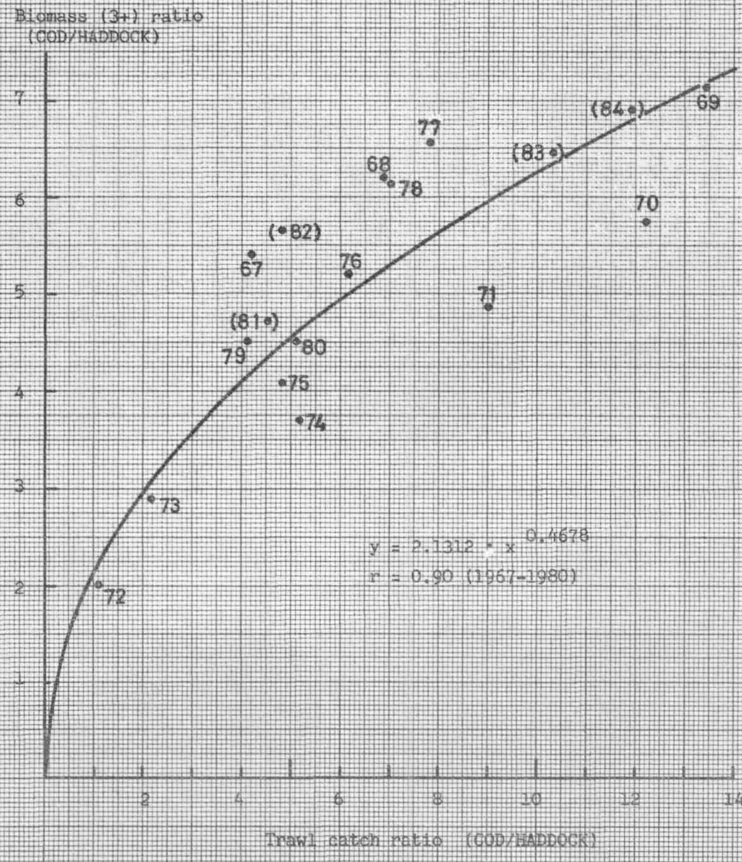


Figure 7. A-B

FISH STOCK SUMMARY

STOCK: NE Arctic Haddock

20-10-1985

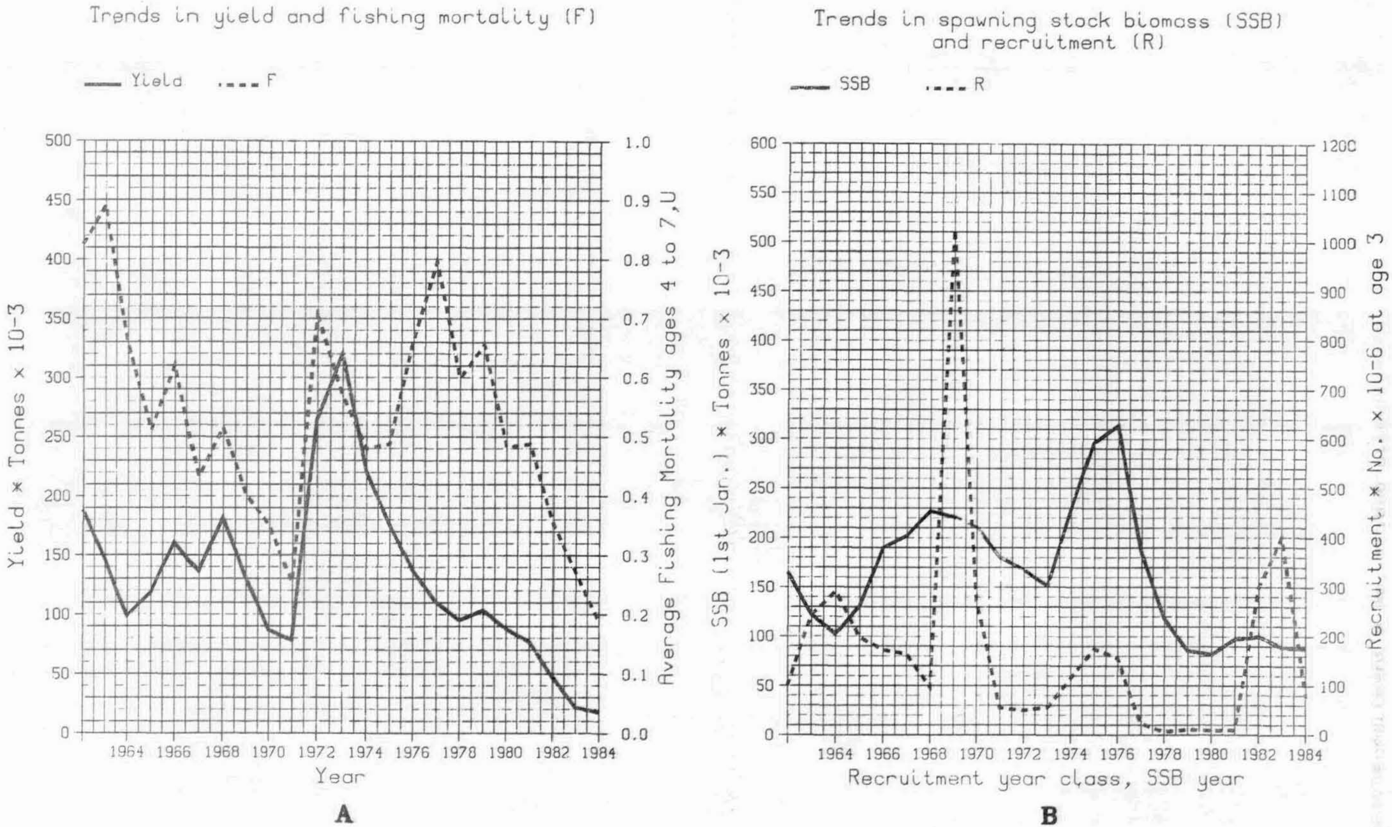


Figure 7. C-D

FISH STOCK SUMMARY
STOCK: NE Arctic Haddock
15-10-1985