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Exploration of the Sea

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REPORT OF THE ARCTIC FISHERIES WORKING GROUP

Copenhagen, 1-5 October 1980

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x) General Secretary,  
ICES.

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REPORT OF THE ARCTIC FISHERIES WORKING GROUP

1. PARTICIPANTS

V C Anthony	USA
A C Burd	United Kingdom
P Cornus	Germany, Fed.Rep. of
A Hylen	Norway
V P Ponomarenko	USSR
C J Rørvik	Norway
V M Ryzhov	USSR
A Schumacher (Chairman)	Germany, Fed.Rep. of
M Yu. Volodarski	USSR

V Nikolaev, ICES Statistician, also participated in the meeting, which was held at ICES headquarters from 1-5 October 1980.

2. TERMS OF REFERENCE

At the 67th Statutory Meeting the Council decided (C.Res.1979/2:42):

"that the Arctic Fisheries Working Group should meet at ICES headquarters 5-10 May 1980 to assess TACs for 1981 for cod and haddock".

3. INTRODUCTORY REMARKS

At its May meeting the Working Group could not produce a reliable assessment since the differences between the results of an assessment based on fisheries data and an assessment using survey data were too large to be accounted for by normal sources of error in either estimate.

The Working Group, therefore, was seeking advice from ACFM on how it should proceed on these assessments.

ACFM advised the Arctic Fisheries Working Group to take the following line:

1. In estimating fishing mortalities and stock sizes in 1979 and 1980 more weight should be given to reliable survey results, particularly if two independent surveys are in reasonable agreement, than to fishery dependent data.
2. Adjustments should be made to the estimates of total international effort given by the Working Group. The possibility of underestimation of total international effort derived from cpue data for 1978 and 1979, due to the considerable change in the distribution of cod and haddock, should be fully evaluated and corrected for if necessary.
3. In view of possible errors or biases, in the estimated age composition of commercial catches, age data reported by national laboratories should be examined by the members of the Working Group prior to its next meeting. This examination should include: (a) comparison of time and location of samples taken, in relation to season and area of the catches to which the data of these samples were to be applied; and (b) interpretation of age structures on the otoliths.
4. In evaluating the assessments, and the TACs for 1981, due consideration should be given to the mixed fishery on cod and haddock in the area.
5. The Arctic Fisheries Working Group should meet at ICES headquarters for 3 (4) days prior to the Statutory Meeting (1-3(4) October 1980) to assess TACs for North-East Arctic Cod and Haddock according to the advice given by ACFM.

In addition, at its meeting in July ACFM received a letter from Dr Zilanov, the USSR representative in ACFM, requesting some data should be acquired in view of analysing stock/recruitment relationship. He also requested data and explanation on the mixture of coastal cod and Arctic cod in Norwegian waters.

Comments on these topics are given in Sections 8 and 9 of this report.

#### 4. NORTH-EAST ARCTIC COD

##### 4.1 Status of the Fisheries

Revised figures for cod landings in 1979 amounted to 444 016 tonnes, about 17 000 tonnes higher than the preliminary figure used in the previous Working Group report (C.M.1980/G:12). This is 255 984 tonnes less than the total TAC of 700 000 tonnes, Murman cod included (Tables 1 and 2).

The estimated total landing of North-East Arctic cod by September 1980 is 332 000 tonnes (Table 3). The estimated total catch for the whole year is 401 000 tonnes. For assessment purposes the estimated catch was split by regions and by countries in order to apply the appropriate age compositions. This catch is some 20% below that projected by the Working Group in 1979 assuming no change in exploitation level from that in 1978 (C.M.1979/G:20).

##### 4.2 Stock Size in 1979

Both in the ACFM report and that of the Working Group (C.M.1980/G:12) difficulties were reported in assessing and interpreting the level of total international effort and stock abundances derived from cpue data. Despite total revision of the United Kingdom data base and a careful re-examination of other countries' cpue data, it would appear that the 1979 cpue overestimates the abundance of the stock in 1979, and as a result fishing mortalities and effective fishing effort are underestimated.

The age composition of the commercial catches in 1979 indicated that the fishery was concentrated on the 1975 year class which dominated the age compositions in the trawl fisheries. Extreme hydrographic conditions in the autumn of 1978 and the spring of 1979 are believed to have had the effect of concentrating the stock, thus rendering it more vulnerable to the fishery.

The trawl fisheries in Sub-areas I and IIb concentrate on the 4-7 year old fish, but there appeared no way in which the magnitude of the likely overestimate of abundance from cpue could be assessed. In consequence, the international effort as estimated from these cpue data is underestimated in 1978 and 1979.

The Working Group, therefore, followed the line indicated by ACFM in basing an estimation of fishing mortality and stock size in 1979 and 1980 on "reliable survey results".

Two series of data were available, the Norwegian acoustic surveys for 1978, 1979 and 1980 and the USSR groundfish surveys in 1979 and 1980. The results of both these surveys are also affected by the environmental factors mentioned above. The Norwegian acoustic surveys in February and March each year do not cover the full distributional range of the cod stock. While the younger fish may more fully occur in the surveyed area, the older fish are distributed more to the west and outside the surveyed area. The stock estimates must be regarded as underestimates, but, as with the cpue data, it is not possible to assess the magnitude of this. Difficulties in the acoustic equipment during the 1980 survey may have introduced an additional bias into the survey estimate, the

magnitude of which cannot be quantified at present.

The stock estimates from the 1979 survey are given below:

(Table 7 C.M.1980/G:12)

<u>Age</u>	<u>Year class</u>	<u>Stock in millions</u>
3	1976	112
4	1975	522
5	1974	77
6	1973	44

In the absence of any other estimate the Working Group accepted this stock size estimate of the 1975 year class.

The USSR ground fish survey takes place in April-May and covers a wide area. The Working Group examined these data (Table 4) to assess whether they could give valid estimates of the numbers of fish older than age 4 and whether they could provide estimates of total mortality. Compared with the commercial fishery data, the rates of the abundance of the older fish to that of the 1975 year class in the USSR were higher. This was interpreted as further evidence of concentration by the commercial fishery and it was agreed to use the ratios in the USSR data to calculate stock sizes of older fish on the basis of  $522 \times 10^6$  fish of the 1975 year class.

Total mortality estimates were calculated from the Norwegian acoustic data, the USSR data, and the Norwegian catch data from the acoustic surveys but used as a ground fish survey, Table 5. It was concluded from the comparison of the Norwegian acoustic data and the USSR data that the latter probably was more representative of the abundances of older fish, and confirmed the procedure adopted.

In assessing the stock sizes of age groups 8-12, which are mainly taken in the fisheries in IIA, a regression was calculated relating mean fishing mortality in 1971-78 to total effort on fish older than 8 in gill net units (Figure 1, Table 6). From an estimate of gill net effort in 1979 a mean F of 0.55 was derived. In accordance with the previous exploitation pattern F values were computed which produced this mean. The fishing mortalities were applied to the catches in a number of these age groups in 1979 to arrive at stock estimates.

It is believed that the trend in increasing catchability in the gill net fishery has continued (C.M.1979/G:12, Figure 2). This would result in an underestimation of fishing mortality.

From the catches in number in 1979 the stock at 1 Jan. 1980 was computed. Taking into consideration that the 1980 total is limited by quota regulation, an estimated annual catch in number was derived. When applied to the computed 1980 stock the fishing mortalities were in general absurdly low, particularly on ages 8-12 (.43 compared to the level of .73 in the 1971-77 period). It was concluded that the procedure adopted in relying on the survey data was not acceptable and that these data did not offer a reliable base.

#### 4.3 Virtual Population Analysis (VPA)

The age compositions used for the 1979 landings were adjusted for the revised catch figures. Preliminary age compositions were derived for

the estimated 1980 landings by applying age distributions for the first half of 1980, submitted by the Federal Republic of Germany, Norway and USSR (Table 7).

These catch at age data were used as input data for the VPA. Natural mortality was set at 0.2, as customary.

Because of the lack of any independent method of assessing fishing mortality in 1980 and not accepting the apparent reduction in effort as calculated from the cpue data for 1979, the Working Group decided that there was no reason to suppose that the level of exploitation or its pattern was different from that in recent years. It calculated the mean fishing mortality on each age group for the period 1971-77 taken from the VPA in the previous Working Group report (C.M.1980/G:12) as input  $F$  for starting the VPA. The results are given in Tables 8, 9 and 10.

Figure 2 illustrates the decline in the Arctic cod stock from 1950 in biomass. The lower part of the histogram gives the biomass of fish older than 7 years, while the upper part shows the biomass of the juvenile stock of 4-7 year olds. Even supposing that the input  $F$  values are too high in 1980 no major adjustment would reverse the obvious trend in declining spawning stock and declining recruitment.

#### 4.4 Recruitment

The number of recruits at age 3 as calculated from the virtual population analysis (C.M.1980/G:12) were plotted against an index of abundance from the USSR young fish survey (Figure 3). A curvilinear regression ( $r=0.84$ ) was fitted to the data for the purpose of estimating the abundance of the 1976, 1977, 1978 and 1979 year classes at age 3. The USSR Young fish survey indices for these year classes are given in Table 13 of the Report of the Arctic Fisheries Working Group (C.M.1980/G:12). A straight line was fitted to these points in the previous report which produced an intercept on the y-axis of 293 million fish. This means that even when no fish were caught in the USSR survey the recruitment estimate would still be 293 million fish. This level is greater than that determined for the 1965, 1966, 1967 and 1974 year classes from the virtual population analysis. The new curve, shown in Figure 3, has an intercept of 75 million fish and represents the poor year classes much better than the previously used straight line. The estimate of recruitment for the 1976, 1977, 1978 and 1979 year classes are 325, 195, 100 and 100 million cod, respectively.

#### 4.5 Catch Prediction

The parameters used for calculating catches in 1981 and the resulting stock sizes in 1982 are given in Table 11. No change has been made on the pattern of exploitation and on the average weight per age group from the previous assessments.

Recruitment has been estimated on the basis of the USSR Young fish survey index and a predictive regression (s. section 4.4 of this report).

#### 4.5.1 Management Options

Species: COD

Area: ICES SA I and II

1980				MANAGEMENT OPTION FOR 1981	1981				1982	
STOCK BIOM. (3+)	SPAWNING STOCK BIOMASS (8+)	$\bar{F}$ (8-12)	CATCH (3+)		STOCK BIOM. (3+)	SPAWNING STOCK BIOMASS (8+)	$\bar{F}$ (8-12)	CATCH (3+)	STOCK BIOM. (3+)	SPAWNING STOCK BIOMASS (8+)
1 560	222	.7	401	Doubling 1980-81 SSB	1 380	244	.06	50	1 620	430
				$F_{0.1}$			.15	137	1 516	418
				$F_{(MAX)}$			.25	220	1 411	380
				Maintaining TAC 1980			.50	400	1 181	298
				Maintaining 1980 level of exploi- tation			.70	521	1 028	246

Weights in thousands of tonnes

The results of the catch projection are given in Figure 4. In the table above, management options related to the reference points on the yield per recruit curve as suggested by ACFM are given.

In addition, other options which are related to certain levels of spawning stock biomass and catch are also considered.

#### 4.5.2 Effects of 1981 TACs on spawning stock biomass

In the 1979 report of the Arctic Fisheries Working Group (C.M.1979/G:20) it was pointed out that, based on a Ricker stock/recruitment relation, the optimum level of spawning stock biomass ranges from 500 000 tonnes to 1 000 000 tonnes. Only by ceasing to fish would the spawning stock reach the level of 500 000 tonnes at the beginning of 1982. This level is considered by the Working Group as a minimum requirement to reduce the probability of recruitment failure due to low spawning stock levels.

The exploitation of the stock in 1981 at a level of  $F_{0.1}$  would increase the spawning stock by 70% at the beginning of 1982. The 1981 TAC would then be about 140 000 tonnes. If this management strategy would be continued up to the mid-1980s there would be a continuous increase in spawning stock biomass up to about 1 000 000 tonnes in 1984 (see table on p.7 ) which was the level between 1950 and 1960 (see Figure 2).

The TAC levels associated with this management policy are expected to be very low in the next few years unless extremely abundant year classes will recruit to the fishery.

Fishing at  $F_{max}$  in 1981 would increase the spawning stock in 1982 by about 55% from the 1981 level to 380 000 tonnes. This level of  $F$  in 1981 would require a reduction in TAC from the present level to 220 000 tonnes in 1981. Continuation of this management policy would increase the spawning stock further in 1983 and 1984 to about 650 000 and 800 000 tonnes respectively. This estimated increase is mainly due to the expected contribution to the spawning stock of the 1975 year class which is entering the spawning stock in 1983. Since the following year classes are estimated to be poor, no further increase in spawning stock size can be expected in the later 1980s. However, it might be possible to keep the spawning stock biomass above the dangerously low level if this long-term management strategy will be followed (see text table, p.7 ). Maintaining the level of fishing mortality (0.5) which is associated with a TAC in 1981 equal to that of 1980 would increase the spawning stock biomass to about 300 000 tonnes in 1982 followed by a further increase to about 400 000 tonnes in 1983 and 1984. Under this management option the spawning stock is not expected to reach even the lower level of its optimal range. The estimated catch in 1982 associated with this management policy is 362 000 tonnes.



Estimated spawning stock biomass 1981-85 and estimated catch 1981-82 at different levels of exploitation (catch figures for 1983-85 are dependent on recruitment estimates and are therefore not given in the table).

Year	.15( $F_{0.1}$ )		.25( $F_{max}$ )		.5		.7	
	SSB	Catch	SSB	Catch	SSB	Catch	SSB	Catch
1981	244	137	244	220	244	400	244	521
1982	418	164	380	243	298	362	246	405
33	780		647		405		279	
1984	1 048		797		404		235	
1985	1 136		794		328		163	

Maintaining the present level of exploitation ( $F = 0.7$ ) into the mid-1980s would, after a marginal increase in 1983 reduce the spawning stock further below the present level which is already dangerously low.

In general the spawning stock biomass in the mid-1980s is expected to be very low unless a drastic reduction in the overall level of exploitation will occur. This is due to the heavy overexploitation of the rich 1973 and 1975 year classes. Their contribution to the spawning stock in coming years is less than it could have been if they were only moderately exploited.

When the poor 1976-80 year classes enter the spawning stock in the mid-1980s, there is a possibility of a further reduction in spawning stock biomass as can be appreciated from the table above.

#### 4.6 Comments on Assessment

An evaluation of the size of the 1975 year class is difficult because it is hard to explain an apparent large decline of the 1975 year class from the age composition of the catches unless there is a very low fishing mortality on this year class in 1978, 1979 and 1980. Independent information of the 1975 year class at age 3 comes from the acoustic survey, cpue data and the USSR youngfish survey.

The VPA which is based on the 1980 catches and average fishing mortalities 1971-77 (Table 9) gives an estimate of the 1975 year class at age 4 of 476 million, while that from the acoustic survey is 522 million (table in Section 4.2). Recognising that the acoustic survey tends to underestimate the stock, the present assessment of the 1975 year class seems to be somewhat low.

The concentration phenomena of the stock renders the interpretation of cpue data in 1979 and 1980 difficult.

In view of the uncertainties in interpreting the data, a conservative approach should be taken in managing this stock despite a possible under-estimation of the present size of the 1975 year class.

#### 5. HADDOCK

##### 5.1 Status of the Fisheries

The revised figures for haddock landings in 1979 (Tables 12 and 13) amounted to 102 172 tonnes, about 750 tonnes higher than the preliminary

figure used in the previous Working Group report (C.M.1980/G:12).

Estimated total landings of haddock are 49 000 tonnes for the period January-September 1980 (Table 14). The estimate for the whole year is 71 000 tonnes. As for cod, the total catch is split by regions and by countries.

## 5.2 Virtual Population Analysis (VPA)

The age compositions used for the 1979 landings were adjusted for the revised catch figures. Preliminary age compositions were derived for the estimated 1980 landings by applying age compositions for the first half of 1980, submitted by the Federal Republic of Germany, Norway and USSR (Table 15).

### 5.2.1 Fishing mortalities

The average fishing mortality on 3-6 years old haddock in 1979 was calculated using the results from the USSR bottom trawl survey (Table 20). Taking the cpue of the 7 year olds in 1980 to be 0.1, and the cpue of  $\leq 3$  year olds in 1979 to be representative for the 3 year olds in 1979, the cpue ratios give an average total mortality of 0.74 on the 3 to 6 year olds. Attributing this to 1979 and subtracting a natural mortality of 0.20,  $F_{3-6} = 0.54$  in 1979. Using the relative fishing pattern given in Doc. C.M.1980/G:12 (Table 20) one arrives at the input fishing mortalities for 1979 (Table 17). However, the fishing mortality on the 3 year olds were revised to give a recruitment of the 1976 year class of 225 million in 1979 in accordance with Figure 5 (see Section 5.2.2).

### 5.2.2 Recruitment

The number of recruits at age 3 as estimated in the previous Working Group Report (C.M.1980/G:12) are used together with the USSR young fish survey indices to fit two regression lines to the data as shown in Figure 5 for the purpose of estimating recruitment levels from the USSR surveys. In last year's report, a straight line was fitted to the same data which produced a correlation coefficient of 0.58 and an intercept on the Y-axis of 99 million fish. A USSR survey which caught few or no haddock would indicate a recruitment level of, at least, 99 million fish if that regression line were used to estimate recruitment. With the present time series, 5 year classes have been less than 100 million fish at the time of recruitment. Both regression lines given in Figure 5 have correlation coefficients greater than 0.7 but the root type of regression has a negative Y-intercept. The straight line regression was therefore calculated for survey values less than thirteen fish per hour. The root equation is intended to be used for predicting recruitment for large survey values and the straight line regression is intended to be used for low survey catches. On this basis recruitment levels of 225, 50 and 50 million fish were estimated for the 1976, 1977 and 1978 year classes, respectively.

### 5.3 Catch Prediction

The parameters used for calculating catches in 1981 and resulting stock sizes in 1982 are given in Table 21. No changes have been made on the pattern of exploitation compared to the 1979 assessment. The average weight per age group has been revised at the last meeting of the Working Group on the basis of more recent data in order to account for the large discrepancies between the reported landings and the sum of products from catch in numbers and average weights per age group.

Recruitment has been estimated from the USSR young fish survey index and a regression (see Section 5.2.2 of this report). It has to be noted that the recruitment of the 1977 and 1978 year classes is rather low.

### 5.3.1 Management Options

Species: HADDOCK

Area: ICES SA I and II

1980				MANAGEMENT OPTION FOR 1981	1981				1982	
STOCK BIOM. (3+)	SPAWNING STOCK BIOMASS (6+)	$\bar{F}$ (7-14)	CATCH (3+)		STOCK BIOM. (3+)	SPAWNING STOCK BIOMASS (6+)	$\bar{F}$ (7-14)	CATCH (3+)	STOCK BIOM. (3+)	SPAWNING STOCK BIOMASS (6+)
372	71	.53	71	Doubling SSB= $F^{(MAX)}$ = present level of $F$	398	114	.27	107	345	231
				$F_{0.1}$			.14	60	401	277

Weights in thousands of tonnes

The results of the catch projection are given in Figure 6. In the table on p. 9 the two options are listed which have been considered by the Working Group and which are related to reference points on the yield per recruit curve.

### 5.3.2 Effects of 1981 TACs on spawning stock biomass

The size of the spawning stock is very low at present (1980) and at about the same level as in 1964 and 1965 which was the lowest on record. The 1969 year class which increased the spawning stock to the level of 400 000 tonnes in 1975 and 1976 has been fished down since then and is now of minor importance to the spawning biomass.

Under the two management options considered by the Working Group the spawning stock is expected to increase above the 1971-80 average of about 190 000 tonnes by 1982, due to the contribution of the relative abundant 1975 year class.

Fishing at  $F_{0.1}$  would result in a spawning stock biomass of 277 000 tonnes in 1982 and would allow a catch of 60 000 tonnes in 1981 which is about 15% below the estimated 1980 catch. Fishing at  $F_{max}$  would result in a spawning stock biomass of 231 000 tonnes in 1982 and is associated with a TAC of 107 000 tonnes for 1981 which is of the same order as the catch level in the preceeding years. Since the 1977 and 1978 year classes are expected to be poor a cautionary approach in long-term management policy is advisable.

The stock situation at present offers the possibility to reduce the level of exploitation to  $F_{max}$  without reductions in the level of catch in 1981.

## 6. MIXED FISHERY

Figure 7 shows the ratio between the total stock biomass (3+) of cod and haddock versus the ratio of the total international catch of the same two species. The broken line in Figure 7 shows the 1:1 relation which would be implied by a complete mixed fishery.

The deviation from this 1:1 relation tends to be more systematic for high and low biomass ratios. This may be because the main distributions of cod and haddock do not completely overlap.

For a high abundance of haddock relative to cod (for example in 1972 and 1973 when the rich 1969 year class of haddock entered the fishery) one would expect some concentration of effort (particularly from trawlers) in the areas where haddock is abundant. This could explain that the catch ratio of cod to haddock in 1972 and 1973 are below the 1:1 relation. The opposite effect, when the haddock stock is low compared to cod stock, would tend to increase the catches of cod relative to haddock above the 1:1 relation (Figure 7).

These considerations are supported by the data, as also shown by the line fitted by linear regression (Figure 7) which has a slope of 1.33 (>1).

The total stock biomass ratio in 1981 is estimated to be 3.47 which would imply a by-catch of haddock in the cod fishery of 29% taking the 1:1 relation (Fig.7), or 27% using the fitted line.

There are consequences for management if haddock is considered to be only a by-catch in the cod fishery. Supposing a haddock TAC were set at 107 000 tonnes then from the by-catch relation the expected cod

catch would be of the order of 380 000 tonnes. This approximates to an F of about 0.5 on cod and would result in simply maintaining the spawning stock biomass in 1982 at about the level in 1980.

Should the management decision be to further protect the cod stock then a lower TAC would have to be set for haddock.

# 7. AGE COMPOSITION

The Working Group was advised by ACFM as follows:

"In view of possible errors or biases in the estimated age composition of commercial catches, age data reported by national laboratories should be examined by the members of the Working Group prior to its next meeting. This examination should include: (a) comparison of time and location of samples taken, in relation to season and area of the catches to which the data of these samples were to be applied; and (b) interpretation of age structures on the otoliths".

At the time of the Working Group meeting no documentation was available to consider point (a).

For the interpretation of age structures on the otoliths (b), results of comparative age readings from USSR and Norwegian scientists on 1980 samples have been presented (see text table below).

## NORWEGIAN INTERPRETATION

Age	3	4	5	6	7	8	9	10	Total	%
4		3	1						4	2.0
5			82						82	41.0
6			35	42	1				78	39.0
7				4	18	3			25	12.5
8					3	5	1		9	4.5
9							1		1	0.5
10								1	1	0.5
total	-	3	118	46	22	8	2	1	200	
%	-	1.5	59.0	23.0	11.0	4.0	1.0	0.5		100

The number of the 6 and 7 year old fish from the USSR interpretation was higher and the number of 5 year old fish was lower compared to the interpretation done by Norwegian age readers. One explanation of these differences might be the frequent occurrence of a secondary ring in the second summer zone. Therefore, age validation studies are recommended in order to resolve this problem.

# 8. THE MIXTURE OF NORTH-EAST ARCTIC COD AND COASTAL COD IN NORWEGIAN WATERS

The assessment carried out by the Working Group have only dealt with the North-East Arctic. This cod stock visit Norwegian waters at different times during the course of their annual migratory movements. However, a second cod population is living in Norwegian coastal waters throughout

their lives.

These two cod populations were first distinguished by characteristics of their otolith structure, findings which later have been confirmed by genetic testings. These observations have been the justifications for the estimation and exclusion of coastal cod from the reported landings of cod as used for assessments in the North-East Arctic (C.M.1970/F:2). The amount of coastal cod taken by Norway can be assessed from the differences between the catches reported in Bulletin Statistique and those in the Working Group reports.

9. STOCK/RECRUITMENT RELATIONSHIP

The problem of stock/recruitment relationship has not been considered by the Arctic Working Group at this meeting. However, in the report of the Working Group from its 1979 meeting (C.M.1979/G:20) a Ricker stock/recruitment relation for cod has been presented indicating an optimum level of spawning stock biomass for the range of 500 000 tonnes to 1 000 000 tonnes. In its comments on the management options presented in this report, this range has been considered.

Table 1. COD. Total nominal catch (tonnes) by fishing areas (landings of Norwegian coastal cod not included).

Year	Sub-area I	Division IIb	Division IIa	Total catch
1960	375 327	91 599	155 116	622 042
1961	409 694	220 508	153 019	783 221
1962	548 621	220 797	139 848	909 266
1963	547 469	111 768	117 100	776 337
1964	206 883	126 114	104 698	437 695
1965	241 489	103 430	100 011	444 930
1966	292 253	56 653	134 805	483 711
1967	322 798	121 060	128 747	572 605
1968	642 452	269 160	162 472	1 074 084
1969	679 373	262 254	255 599	1 197 226
1970	603 855	85 556	243 835	933 246
1971	312 505	56 920	319 623	689 048
1972	197 015	32 982	335 257	565 254
1973	492 716	88 207	211 762	792 685
1974	723 489	254 730	124 214	1 102 433
1975	561 701	147 400	120 276	829 377
1976	526 685	103 533	237 245	867 463
1977	538 231	109 997	257 073	905 301
1978	418 265	17 293	263 157	698 715
1979 <sup>x)</sup>	193 517	10 044	240 455	444 016

x) Provisional figures, revised 2 October 1980.

**Table 2.** COD. Nominal catch (tonnes, whole weight) by countries (landings of Norwegian coastal cod not 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	USSR	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	-	-	255	1 073	255 611	-	140 387	676 758	-	1 074 084
1969	29 374	-	5 907	5 343	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 <sup>1)</sup>	38 453	1 102 434
1975	11 309	28 734	9 981	30 037	277 099	7 435	101 834	343 580 <sup>1)</sup>	19 368	829 377
1976	11 511	20 941	8 946	24 369	344 502	6 986	89 061	343 057 <sup>1)</sup>	18 090	867 463
1977	9 167	15 414	3 463	12 763	388 982	1 084	86 781	369 876 <sup>1)</sup>	17 771	905 301
1978	9 092	9 394	3 029	5 434	363 088	566	35 449	267 138 <sup>1)</sup>	5 525	698 715
1979 <sup>x)</sup>	6 320	3 046	547	2 515	284 779	15	17 991	119 364 <sup>1)</sup>	9 439	444 016

x) Provisional figures, revised 2 October 1980.

1) Murman cod included.



Table 3. COD. Estimated catch for 1980 by countries ('000 tonnes, whole weight).

	January-September <sup>x)</sup>	January-December
EEC Countries	12	17
Norway	214 <sup>1)</sup>	247 <sup>1)</sup>
Others	18	18
USSR	88 <sup>2)</sup>	119
Total	332	401

x) Provisional figures.

1) Coastal cod excluded.

2) January-August.

Table 4. COD. Age composition of catches in April and May 1979-80 in the USSR groundfish survey.

Area	Year	Mean catch per trawling hour,specimens							Mean age, years
		Age							
		≤3	4	5	6	7	≥8	Total	
B Norwegian Sea	1979	0.7	20.5	16.7	11.4	8.4	6.2	64	5.5
	1980	0.7	1.0	16.1	6.2	2.6	3.5	30	5.7
A <sub>I</sub> West.areas of south. Barents Sea	1979	10.4	54.2	9.8	1.8	0.8	0.4	77	4.1
	1980	8.5	6.9	12.1	2.1	0.4	0.2	30	4.3
Coast. <sup>2</sup> areas of south.Barents Sea	1979	3.5	11.2	1.0	0.2	0.1	0.1	16	3.9
	1980	5.3	2.3	1.5	0.2	+	-	9	3.6
A South.Barents Sea	1979	8.0	39.6	6.8	1.2	0.5	0.3	56	4.1
	1980	6.9	5.1	8.2	1.4	0.3	0.1	22	4.2
A+B Norwegian Sea and south.Barents Sea	1979	5.9	33.8	9.8	4.3	2.9	2.1	59	4.5
	1980	5.0	3.8	10.6	2.9	1.0	1.2	25	4.8

Table 5. North-east Arctic COD. Total mortality rates for 1979/80 estimated on the basis of Norwegian and USSR surveys in 1979 and 1980.

Survey	Age							
	1/2	2/3	3/4	4/5	5/6	6/7	7/8	8
Norwegian acoustic survey	-0.25	-0.62	0.34	1.01	1.51	1.73	1.95	
USSR groundfish survey			0.44	1.16	1.22	1.46		
Norwegian groundfish survey	-1.39	-1.78	-0.82	0.43	0.78	0.99	1.28	1.82

Table 6. COD. Data used to estimate total international effort in gill net units and to calculate the regression of  $\bar{F}_{(8-12)}$  to total effort (Figure 1).

Year	C8+, total fishery eff.	Lofoten cpue gill net	C.M.1980/G:12 $\bar{F}_{8-12}$	Total effort (gill net units)	q x 10 <sup>3</sup>
1971	352 175	334.3	.74	1 053	.70
1972	358 136	318.7	.96	1 124	.85
1973	202 852	189.7	.67	1 069	.63
1974	106 419	96.3	.66	1 105	.60
1975	99 803	122.0	.70	818	.86
1976	110 674	131.4	.57	842	.68
1977	159 118	173.2	.61	919	.66
1978	241 121	237.6	.72 <sup>x)</sup>	1 015	.73
1979	146 295	201.3	.55 <sup>x)</sup>	727	.55

x) From regression, see Figure 1.

Table 7. North-east Arctic COD. Input catch data.

AGE	1963	1964	1965	1966	1967	1968
1	1	103	1	1	1	1
2	4	675	2522	869	151	1
3	13196	5298	15725	55937	34467	3709
4	106904	45912	25999	55644	160048	174585
5	205549	97950	78299	34676	69235	267961
6	95498	58575	68511	42539	22061	107051
7	35518	19642	25444	37169	26295	26701
8	16221	9162	8438	18500	25139	16399
9	11894	6196	3569	5077	11323	11597
10	3884	3553	1467	1495	2329	3657
11	1021	783	1161	380	687	657
12	1025	172	131	403	316	122
13	498	387	67	77	225	124
14	129	264	91	9	40	70
+15	157	131	179	70	14	46
TOTAL						
	491579	248803	231604	252846	352331	612681
SPAWNING STOCK (AGE ≥ 8)	34829	20648	15103	26011	40073	32672

AGE	1969	1970	1971	1972	1973	1974
1	1	1	38	1	1	115
2	275	591	2210	4701	8277	21347
3	2307	7164	7754	35536	294262	91855
4	24545	10792	13739	45431	131493	437377
5	238511	25813	11831	26832	61000	203772
6	181239	137829	9527	12089	20569	47006
7	79363	96420	59290	7918	7248	12630
8	26989	31920	52003	34885	8328	4370
9	13463	8933	12093	22315	19130	2523
10	5092	3249	2434	4572	4499	5607
11	1913	1232	762	1215	677	2127
12	414	260	418	353	195	322
13	121	106	149	315	81	151
14	23	39	42	121	59	83
+15	46	35	25	40	55	62
TOTAL						
	574302	324384	172315	196324	555874	829347
SPAWNING STOCK (AGE ≥ 8)	48061	45774	67926	63816	33024	15245

AGE	1975	1976	1977	1978	1979	1980
1	1	706	1	3	0	0
2	1184	1908	11288	802	0	0
3	45282	85337	39594	78822	8277	985
4	59798	114341	168609	45400	87262	15086
5	226646	79993	136335	88495	49808	95561
6	118567	118236	52925	56823	36323	38983
7	29522	47872	61821	25407	19663	20623
8	9353	13962	23338	31821	9730	9573
9	2617	4051	5659	9408	12826	3598
10	1555	936	1521	1227	2160	3992
11	1928	558	610	913	422	481
12	575	442	271	446	139	51
13	231	139	122	748	88	21
14	15	26	92	48	59	38
+15	37	53	54	51	79	91
TOTAL						
	497311	468560	502240	340414	226836	189083
SPAWNING STOCK (AGE ≥ 8)	16311	20167	31667	44662	25503	17845

Table 8. North-East Arctic COD. Fishing mortalities.

AGE	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.000	.001	.001	.001	.001	.000	.001	.001	.002
3	.031	.017	.023	.040	.030	.024	.023	.041	.021
4	.236	.144	.111	.103	.153	.207	.220	.141	.103
5	.738	.352	.389	.211	.181	.409	.480	.378	.227
6	1.002	.480	.447	.380	.202	.466	.538	.570	.232
7	.963	.572	.397	.467	.428	.399	.767	.621	.517
8	.868	.718	.520	.564	.672	.522	.918	.834	.834
9	.934	1.031	.694	.694	.831	.775	1.141	.936	.921
10	1.260	.832	.742	.717	.820	.718	.983	.993	.728
11	1.334	.980	.731	.430	.884	.579	1.101	.686	.672
12	.833	.866	.420	.612	.783	.372	.919	.411	.527
13	.592	.912	1.060	.470	.852	.841	.782	.641	.439
14	.535	.737	.563	.375	.478	.718	.358	.630	.571
15	.490	.810	.960	.370	.750	.740	.680	.540	.340

MEAN F FOR AGES  $\geq 8$  AND  $\leq 12$  (NOT WEIGHTED BY STOCK IN NUMBERS)  
1.046 .885 .621 .603 .798 .593 1.012 .772 .736

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	.000	.000	.000	.000	.001	.000	.000	.000	.000
2	.002	.014	.030	.002	.004	.015	.008	.000	.000
3	.039	.194	.211	.081	.153	.116	.139	.101	.110
4	.167	.199	.487	.207	.299	.503	.189	.225	.270
5	.297	.354	.536	.507	.468	.703	.543	.327	.410
6	.381	.390	.508	.698	.545	.655	.731	.450	.460
7	.308	.414	.443	.705	.688	.620	.779	.609	.500
8	.665	.619	.474	.697	.890	.886	.774	.802	.690
9	1.137	.992	.383	.584	.761	1.228	1.200	.853	.810
10	1.188	.744	.937	.433	.427	.740	1.025	1.057	.720
11	1.050	.539	1.006	1.052	.272	.551	1.579	1.372	.720
12	.779	.459	.536	.855	.743	.205	1.051	1.271	.580
13	1.004	.404	.793	.960	.512	.467	1.402	.601	.650
14	.785	.509	.963	.160	.254	.774	.338	.357	.570
15	.910	.310	.700	.860	.430	.400	.530	.560	.560

MEAN F FOR AGES  $\geq 8$  AND  $\leq 12$  (NOT WEIGHTED BY STOCK IN NUMBERS)  
.964 .670 .667 .724 .619 .722 1.126 1.071 .704

M (CONSTANT) = .200

Table 9. North-east Arctic COD. Stock size in numbers.

AGE	1963	1964	1965	1966	1967	1968
1	1162873	2364139	1931373	255684	168191	294917
2	415027	951915	1935500	1581273	209335	137703
3	473312	339792	778752	1582376	1293852	171253
4	559619	375601	273414	623389	1245043	1028197
5	429397	361913	266142	200410	460209	875145
6	163820	168121	208344	147624	132867	314433
7	62390	49256	85152	109145	82679	88921
8	30410	19497	22751	46883	56043	44106
9	21287	10452	7783	11070	21828	23426
10	5862	6847	3053	3185	4529	7781
11	1497	1361	2440	1191	1273	1632
12	1974	323	418	962	634	431
13	1218	703	111	225	427	237
14	341	552	231	32	115	149
15	221	163	216	108	18	58
TOTAL						
	3329048	4650635	5515681	4563555	3677045	2988390
SPAWNING STOCK (AGE >= 8)	62810	39898	37005	63655	84867	7821

AGE	1969	1970	1971	1972	1973	1974
1	604690	1520855	2749879	803358	987496	991896
2	241456	495077	1245170	2251376	657733	808492
3	112740	197439	404801	1017462	1839025	531031
4	136861	90221	155183	324421	800948	1240704
5	684649	89961	64141	114663	224688	537372
6	476086	346795	50482	41867	69759	129178
7	161478	227518	160593	32758	23426	38653
8	48841	61413	100065	78380	19704	12677
9	21425	15971	21838	35588	33003	8686
10	8836	5603	5129	7119	9348	10017
11	3106	2708	1699	2027	1777	3639
12	749	846	1116	711	580	849
13	243	245	459	540	267	300
14	84	91	105	242	162	146
15	60	48	40	49	90	80
TOTAL						
	2501303	3054789	4960700	4710562	4668007	4313721
SPAWNING STOCK (AGE >= 8)	83344	86924	130452	124655	64931	36393

AGE	1975	1976	1977	1978	1979	1980
1	594929	1013118	142284	15539	0	0
2	811992	487085	828833	116492	12720	0
3	642664	663733	397068	668397	94651	10414
4	352087	485319	466527	289395	476199	70029
5	623881	234432	294570	230913	196054	311347
6	257512	307763	120234	118434	108830	115766
7	63655	104951	146126	51144	47068	57353
8	20321	25756	43170	64362	19214	20952
9	6462	8285	8657	14566	24313	7057
10	4847	2950	3169	2077	3591	8481
11	3213	2573	1575	1237	610	1022
12	1089	919	1605	744	209	127
13	407	379	358	1070	213	48
14	111	127	186	184	216	96
15	46	78	81	70	107	123
TOTAL						
	3383215	3337469	2454444	1575623	984994	602813
SPAWNING STOCK (AGE >= 8)	36496	41067	58802	84310	48472	37904

Table 10. North-east Arctic COD. Stock weight.

AGE	1963	1964	1965	1966	1967	1968
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	307653	220865	506189	1028544	841004	111314
4	559619	375601	273414	623389	1245043	1028197
5	665566	560965	412520	310635	713324	1356475
6	384977	395084	489608	346916	312238	738918
7	215245	169932	293775	376551	285241	306777
8	142928	91634	106930	220350	263402	207300
9	131344	64487	48023	68302	134679	144535
10	45134	52724	23510	24525	34875	59917
11	13847	12590	22570	11014	11776	15100
12	21421	3503	4538	10432	6879	4672
13	15228	8788	1590	2812	5335	2966
14	4734	7672	3214	438	1601	2072
15	3316	2450	3244	1618	266	876
TOTAL	2511012	1966297	2188925	3025527	3855665	3979121
SPAWNING STOCK (AGE ≥ 8)	377953	243849	213420	339491	458814	437440

AGE	1969	1970	1971	1972	1973	1974
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	73281	128336	263121	661351	1195366	345170
4	136861	90221	155183	324421	800948	1240704
5	1061206	139439	99418	177728	348267	832926
6	1118801	814967	118632	98387	163934	303569
7	557898	784936	554045	113015	80820	133354
8	229555	288642	470305	368386	92698	59582
9	132192	98542	134742	219580	203628	53591
10	68036	43141	39494	54815	71977	77132
11	28733	25045	15719	18748	16438	33656
12	8123	9176	12112	7709	6298	9210
13	3036	3057	5740	6746	3336	3756
14	1165	1266	1466	3368	2251	2027
15	893	719	596	732	1357	1196
TOTAL	3418982	2427488	1870572	2054986	2987229	3095873
SPAWNING STOCK (AGE ≥ 8)	471734	469589	680174	680085	397894	240150

AGE	1975	1976	1977	1978	1979	1980
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	417731	431427	258094	434458	61523	6769
4	352087	485319	468527	289395	476199	70029
5	967016	363370	456583	357915	303884	482587
6	605153	723243	282550	280671	258100	272050
7	219611	362080	504136	176446	162385	197867
8	95509	121054	202898	302500	90305	98473
9	39873	51119	53417	89873	150011	43539
10	77319	22712	24403	15990	27648	65300
11	29724	23804	14572	11446	5644	9452
12	11814	9969	17416	8070	2266	1374
13	5983	4741	4473	13578	2661	600
14	1548	1772	2586	2552	2996	1329
15	684	1165	1215	1054	1608	1852
TOTAL	2783151	2601775	2288870	1983747	1545231	1251221
SPAWNING STOCK (AGE ≥ 8)	221553	236336	320980	444863	283140	221919

1980

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Table 11. COD. Parameters used in catch predictions ( $M = 0.2$ ).

Age	Relative fishing mortality ( $\bar{F}_{8-12} = 1.00$ )	Mean weights (kg)	Stock size at the beginning of 1981 (in thousands)
3	0.28	0.65	100 000 <sup>x)</sup>
4	0.41	1.00	158 855
5	0.69	1.55	198 305
6	0.85	2.35	169 169
7	0.93	3.45	59 833
8	0.95	4.70	28 480
9	1.11	6.17	8 604
10	1.08	7.70	2 570
11	1.05	9.25	3 380
12	0.83	10.85	407
13	0.87	12.50	58
14	0.73	13.90	21
15+	0.76	15.00	65

x) Recruitment at age 3 as estimated from USSR  
youngfish survey index (see Figure 3 ).

Table 12. HADDOCK. Total nominal catch (tonnes) by fishing areas.  
(Data provided by Working Group members)

Year	Sub-area I	Division IIb	Division IIa	Total
1960	125 675	1 854	27 925	155 454
1961	165 165	2 427	25 642	193 234
1962	160 972	1 727	25 189	187 888
1963	124 774	939	21 031	146 744
1964	79 056	1 109	18 735	98 900
1965	98 505	939	18 640	118 079
1966	124 115	1 614	34 892	160 621
1967	108 066	440	27 980	136 486
1968	140 970	725	40 031	181 726
1969	88 960	1 341	40 208	130 509
1970	59 493	497	26 611	86 601
1971	56 300	435	21 567	78 302
1972	221 183	2 155	41 979	265 317
1973	283 728	12 989	23 348	320 065
1974	159 037	15 068	47 033	221 138
1975	121 686	9 726	44 330	175 742
1976	94 064	5 649	37 566	137 279
1977	72 159	9 547	28 452	110 158
1978	63 965	979	30 478	95 422
1979 <sup>x)</sup>	63 521	620	38 031	102 172

x) Provisional figures, revised 2 October 1980.



Table 13. HADDOCK. Nominal catch (tonnes) by countries.  
(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	U.K.	USSR	Others	Total
1960	172	-	-	5 597	47 263	-	45 469	57 025	125	155 651
1961	295	220	-	6 304	60 862	-	39 650	85 345	558	193 234
1962	83	409	-	2 895	54 567	-	37 486	91 940	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	-	181 726
1969	2	-	309	1 490	67 549	-	37 234	24 211	25	130 820
1970	541	-	656	2 119	36 716	-	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	434	32 408	186 534	2 501	322 626
1974	925	3 601	454	23 409	66 164	3 045	37 663	78 548 <sup>1)</sup>	7 348	221 157
1975	299	5 191	437	15 930	55 966	1 080	28 677	65 015 <sup>1)</sup>	3 163	175 758
1976	537	4 459	348	16 660	49 492	986	16 940	42 485 <sup>1)</sup>	5 358	137 265
1977	213	1 510	144	4 798	40 118	-	10 878	52 210 <sup>1)</sup>	287	110 158
1978	466	1 411	369	1 521	39 955	1	5 766	45 895 <sup>1)</sup>	38	95 422
1979 <sup>x)</sup>	343	1 198	10	1 952	65 116	2	6 454	26 643	454	102 172

x) Provisional figures, revised 2 October 1980.

1) Murman haddock included.

Table 14. HADDOCK. Estimated catch for 1980 by countries  
('000 tonnes, whole weight).

	January-September <sup>x)</sup>	January-December
EEC countries	3	3
Norway	42 <sup>1)</sup>	59 <sup>1)</sup>
Others	-	7
USSR	4 <sup>2)</sup>	2
Total	49	71

x) Provisional figures.

1) "Other haddock" excluded.

2) January-August.

Table 15. HADDOCK. Age composition and total numbers landed x 10<sup>-3</sup>  
in 1980. Preliminary figures.

(Data provided by Working Group Members, Oct.1980)

Age	Sub-area I	Division IIa	Division IIb	Σ
3	78	28	1	107
4	10 046	12 914	123	23 083
5	12 404	5 554	22	17 980
6	1 546	1 942	22	3 510
7		248	5	253
8	69	319	7	395
9	82	174		256
10	254	366	7	627
11	100	611	24	735
12	47	31	1	79
13		99	1	100
14		35		35
15+		4		4
Total	24 626	22 325	213	47 164
Weight landed (tonnes, round fresh)	36 839	34 067	315	71 221

Table 16. North-east Arctic HADDOCK. Input catch data.

AGE	1962	1963	1964	1965	1966	1967
1	1	3	149	1	1	1
2	4536	2151	831	3483	2559	53
3	39604	28567	22305	5911	26157	15918
4	30947	72995	49162	46161	22469	41373
5	49028	19035	30592	40032	62724	13505
6	33922	13627	5800	12578	28840	25736
7	3209	9290	3519	1672	5711	8878
8	1344	1243	2709	970	578	1617
9	1778	561	832	893	435	218
10	243	409	104	122	188	176
11	247	79	206	204	186	155
12	482	84	234	123	25	76
13	20	169	121	14	8	27
14	8	41	67	205	7	7
TOTAL						
	165369	148254	116631	112369	149888	107740
SPAWNING STOCK (AGE >= 6)						
	41253	25503	13592	16781	35978	36890

AGE	1968	1969	1970	1971	1972	1973
1	1	1	480	15	133	1
2	33	1058	276	3535	9369	5915
3	657	1520	23004	1979	230229	70204
4	67632	1963	2408	24359	22246	258773
5	41267	44526	1870	1258	42849	24018
6	7748	18956	21995	918	3196	6872
7	15599	3611	7948	9279	1606	418
8	5292	4925	1974	3056	6736	422
9	655	1624	1978	826	2630	1680
10	182	315	726	1043	896	525
11	101	43	166	369	988	146
12	115	43	26	130	538	340
13	18	14	52	27	53	68
14	19	2	19	4	42	13
TOTAL						
	139319	78601	62922	46798	321511	369395
SPAWNING STOCK (AGE >= 6)						
	29729	29533	34884	15652	16685	10484

AGE	1974	1975	1976	1977	1978	1979
1	281	1321	3475	184	46	0
2	3713	4355	7496	18456	2033	67
3	9684	10037	13989	55967	47311	17983
4	41701	14089	13449	22043	18812	39519
5	88111	33671	6808	7368	4076	12170
6	5827	49712	20789	2586	1389	1375
7	4138	2135	40044	7781	1626	960
8	382	1236	1247	11043	2596	576
9	617	92	1349	311	6215	1642
10	2043	131	193	388	162	2615
11	935	500	279	96	258	255
12	276	147	652	101	3	95
13	458	53	331	84	74	5
14	143	92	46	98	65	49
TOTAL						
	158309	117771	110147	126506	84666	77311
SPAWNING STOCK (AGE >= 6)						
	14819	54998	64930	22488	12388	7572

Table 17. North-east Arctic HADDOCK. Fishing mortalities.

AGE	1962	1963	1964	1965	1966	1967	1968	1969	1970
1	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.015	.006	.007	.013	.008	.002	.002	.006	.003
3	.200	.121	.080	.067	.127	.062	.036	.102	.167
4	.591	.680	.314	.236	.388	.303	.401	.144	.232
5	1.060	.920	.690	.457	.578	.428	.562	.505	.199
6	1.037	1.023	.828	.691	.707	.499	.469	.550	.504
7	.627	.941	.828	.607	.801	.491	.651	.416	.471
8	.646	.533	.816	.573	.436	.556	.618	.438	.423
9	.966	.621	.849	.711	.551	.291	.459	.388	.315
10	.398	.615	.218	.277	.312	.452	.421	.420	.300
11	.202	.216	.738	.865	.887	.459	.512	.165	.409
12	.753	.098	1.902	1.543	.233	1.235	.746	.428	.142
13	.167	.658	.198	.554	.353	.423	1.223	.182	1.493
14	.600	.600	.600	.600	.600	.600	.600	.400	.400

MEAN F FOR AGES  $\geq 3$  AND  $\leq 6$  (NOT WEIGHTED BY STOCK IN NUMBERS)  
 .722 .686 .478 .363 .450 .323 .367 .325 .276

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	.000	.002	.000	.003	.007	.013	.002	.031	.000
2	.003	.031	.094	.066	.067	.053	.087	.022	.057
3	.023	.283	.333	.220	.254	.316	.669	.331	.276
4	.268	.377	.593	.338	.569	.637	1.217	.497	.510
5	.183	1.053	.915	.412	.507	.602	.901	.778	.708
6	.142	.951	.461	.590	.433	.680	.484	.415	.666
7	.413	.392	.296	.562	.447	.755	.590	.648	.567
8	.333	.601	.168	.484	.323	.514	.481	.399	.503
9	.314	.535	.291	.394	.203	.704	.230	.551	.475
10	.273	.665	.190	.690	.134	.848	.447	.180	.475
11	.245	.449	.210	.604	.355	.466	1.615	.609	.475
12	.657	.676	.273	.765	.175	1.110	.305	.171	.475
13	.214	.621	.163	.717	.316	.734	.391	.384	.475
14	.400	.600	.300	.600	.300	.500	.500	.600	.475

MEAN F FOR AGES  $\geq 3$  AND  $\leq 6$  (NOT WEIGHTED BY STOCK IN NUMBERS)  
 .154 .666 .575 .390 .441 .559 .818 .505 .540

M (CONSTANT) = .200

Table 18. North-east Arctic HADDOCK. Stock size in numbers.

AGE	1962	1963	1964	1965	1966	1967
1	479318	150285	364191	438314	30426	25826
2	341843	392432	123040	298040	358860	24910
3	240721	275780	319353	99986	240869	291499
4	75814	161428	200036	241342	76528	173628
5	81374	34387	66962	119598	156059	42489
6	57015	23092	11216	27502	62028	71648
7	7524	16550	6800	4014	11283	25034
8	3085	3291	5286	2431	1791	4146
9	3119	1324	1582	1913	1123	948
10	812	972	583	554	769	530
11	1488	447	430	383	344	461
12	993	996	295	168	132	116
13	143	383	739	36	29	86
14	19	99	162	496	17	17
TOTAL						
	1293267	1061468	1100676	1234778	940258	661337
SPAWNING STOCK (AGE ≥ 6)	74197	47154	27093	37498	77517	102986

AGE	1968	1969	1970	1971	1972	1973
1	246763	145002	1533900	418362	88651	78220
2	21144	202031	118717	1255418	342513	72461
3	20346	17281	164454	96948	1024656	271967
4	224294	16065	12778	113921	77587	631921
5	104969	122948	11384	8295	71364	43553
6	22674	49008	60774	7637	5658	20379
7	35604	11619	23156	30054	5425	1790
8	12541	15209	6273	11834	16281	3000
9	1947	5536	8036	3366	6944	7305
10	580	1007	3075	4802	2013	3330
11	276	312	542	1865	2993	848
12	238	135	217	295	1195	1565
13	28	93	72	154	125	498
14	46	7	63	13	102	55
TOTAL						
	691450	586253	1943439	1952962	1645506	1136891
SPAWNING STOCK (AGE ≥ 6)	73935	82926	102207	60019	40736	38769

AGE	1974	1975	1976	1977	1978	1979
1	90799	198387	303313	125105	1679	0
2	64040	74086	161232	245193	102261	1333
3	53591	49081	56727	125240	184099	81888
4	159600	35488	31156	33874	52536	108225
5	285893	93210	16447	13486	8209	26158
6	14284	155018	45972	7377	4483	3086
7	10524	6482	82332	19069	3722	2425
8	1090	4913	3393	31681	8652	1594
9	2076	550	2912	1661	16042	4754
10	4471	1146	367	1179	1080	7571
11	2254	1836	820	129	618	738
12	523	1009	1054	422	21	275
13	975	214	694	284	254	14
14	346	390	128	273	157	142
TOTAL						
	690907	621811	706549	604974	383814	238204
SPAWNING STOCK (AGE ≥ 6)	36583	171558	137673	62075	35030	20539

Table 19. North-east Arctic HADDOCK. Stock weight.

AGE	1962	1963	1964	1965	1966	1967
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	158876	182015	210773	85991	150973	192389
4	78089	166271	208038	248583	78824	178837
5	145660	61554	119862	214080	279345	76056
6	135695	54959	26694	65454	147628	170523
7	21520	47333	19447	11481	32269	71598
8	10272	10961	17603	8096	5965	13866
9	11538	4900	5853	7080	4153	3508
10	3581	4287	2570	2443	3392	2336
11	8033	2412	2323	2071	1857	2489
12	6650	6670	1974	1128	886	777
13	1060	2831	5471	266	218	635
14	155	794	1298	3971	136	136
TOTAL						
SPAWNING STOCK (AGE ≥ 6)	581129	544988	619906	630642	713646	713089
	198505	135148	83233	101989	196503	265807

AGE	1968	1969	1970	1971	1972	1973
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	13429	11405	108539	63986	676273	179498
4	231023	16547	13161	117338	79915	650878
5	187894	220076	20377	14848	127741	77960
6	53985	116639	144641	18175	13466	48501
7	101827	33231	66225	85953	15516	5119
8	41763	50647	20691	39488	54216	9991
9	7265	20483	29732	12452	25692	27028
10	2559	4441	13560	21175	8878	14886
11	1490	1684	2926	10071	16163	4578
12	1597	907	1451	1975	8006	10484
13	204	685	535	1139	926	3683
14	368	53	505	106	814	441
TOTAL						
SPAWNING STOCK (AGE ≥ 6)	643323	476798	422544	386626	1027606	1032847
	210977	228770	280466	190455	143677	124511

AGE	1974	1975	1976	1977	1978	1979
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	35634	32394	37440	82658	121506	54046
4	164388	36553	32091	34890	54112	111471
5	511749	166846	29441	24141	14695	46823
6	33996	368943	109415	17557	10671	7345
7	30899	18539	235471	54537	10646	6934
8	3629	16360	11298	105499	28810	5309
9	7633	2035	10774	6145	59355	17589
10	19715	5055	1620	5201	4762	13367
11	12170	9912	4430	696	3336	3987
12	3769	6760	7060	2825	141	1843
13	7218	1587	5133	2104	1883	107
14	2773	3118	1023	2180	1259	1135
TOTAL						
SPAWNING STOCK (AGE ≥ 6)	832820	668100	485196	338434	311174	289977
	121049	432308	386224	196744	120863	77636

Table 20. HADDOCK. Age composition of catches in April and May 1979-80  
in the USSR groundfish survey.

Area	Year	Mean catch per trawling hour,specimens							Mean age, years	Mean length (cm)	Mean weight (g)	Mean catch per trawling hour(kg)
		Age						Total				
		≤3	4	5	6	7	≥8					
B Norwegian Sea	1979	33.8	20.0	6.3	1.0	0.3	1.5	63	3.7	41.2	1 033	59
	1980	1.3	22.3	12.1	3.0	0.1	0.4	39	4.5	48.6	1 300	51
A <sub>1</sub> West. areas of south.Barents Sea	1979	18.6	25.6	0.8	+	+	+	45	3.6	33.8	396	18
	1980	2.6	11.5	14.0	0.1	-	+	28	4.4	41.5	847	24
A <sub>2</sub> Coastal areas of south. Barents Sea	1979	7.6	4.2	0.1	-	-	-	12	3.3	29.5	294	3
	1980	3.0	5.2	3.1	-	-	-	11	3.8	34.8	565	7
A South.Barents Sea	1979	14.8	18.3	0.6	+	+	+	34	3.6	33.2	385	13
	1980	2.5	8.9	9.8	0.1	-	+	21	4.3	40.2	812	17
A+B Norwegian Sea and south. Barents Sea	1979	20.6	18.8	2.3	0.3	0.1	0.5	42	3.6	36.6	597	25
	1980	2.1	13.1	10.6	1.0	+	0.1	27	4.4	44.1	1 036	28

Table 21. HADDOCK. Parameters used in catch predictions ( $M = 0.2$ ).

Age	Relative fishing mortality ( $\bar{F}_{3-6} = 1.00$ )	Mean weights (kg)	Stock size (in thousands) at the beginning of:	
			1980	1981
3	0.582	0.66	50 000 <sup>x</sup> )	50 000 <sup>x</sup> )
4	1.075	1.03	167 995	40 854
5	1.493	1.79	53 208	116 748
6	1.403	2.38	10 561	27 445
7	1.194	2.86	1 298	5 502
8	1.060	3.33	1 126	835
9	1.0	3.70	790	568
10	1.0	4.41	2 421	417
11	1.0	5.40	3 855	1 419
12	1.0	6.70	376	2 495
13	1.0	7.40	140	237
14+	1.0	8.00	79	56

x) Recruitment at age 3 as estimated from USSR youngfish survey index (see Figure 5 ).



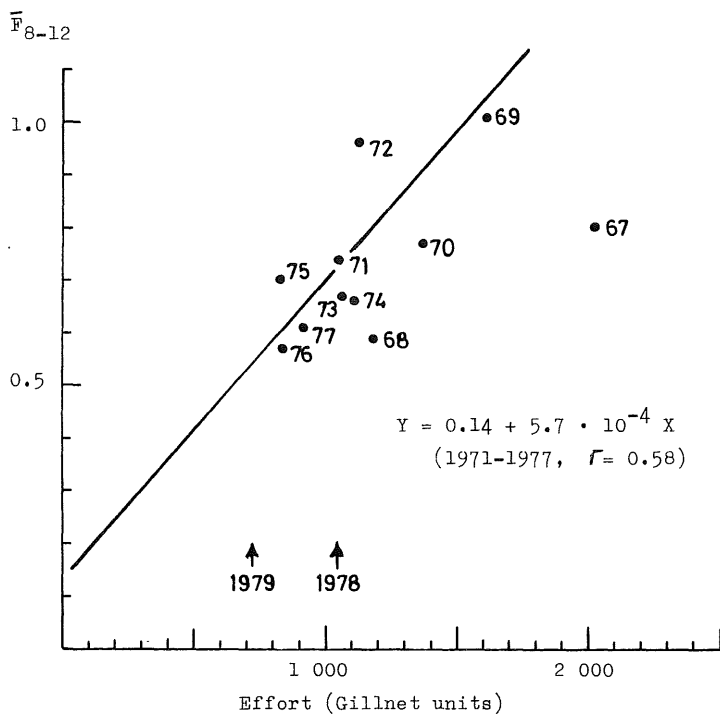


Figure 1. North-east Arctic COD. Effort (= total international catch (8+)/cpue of gillnetters in Lofoten) versus average fishing mortality on 8-12 year olds (from C.M.1980/G:12, Table 10).

Figure 2. Arctic COD.

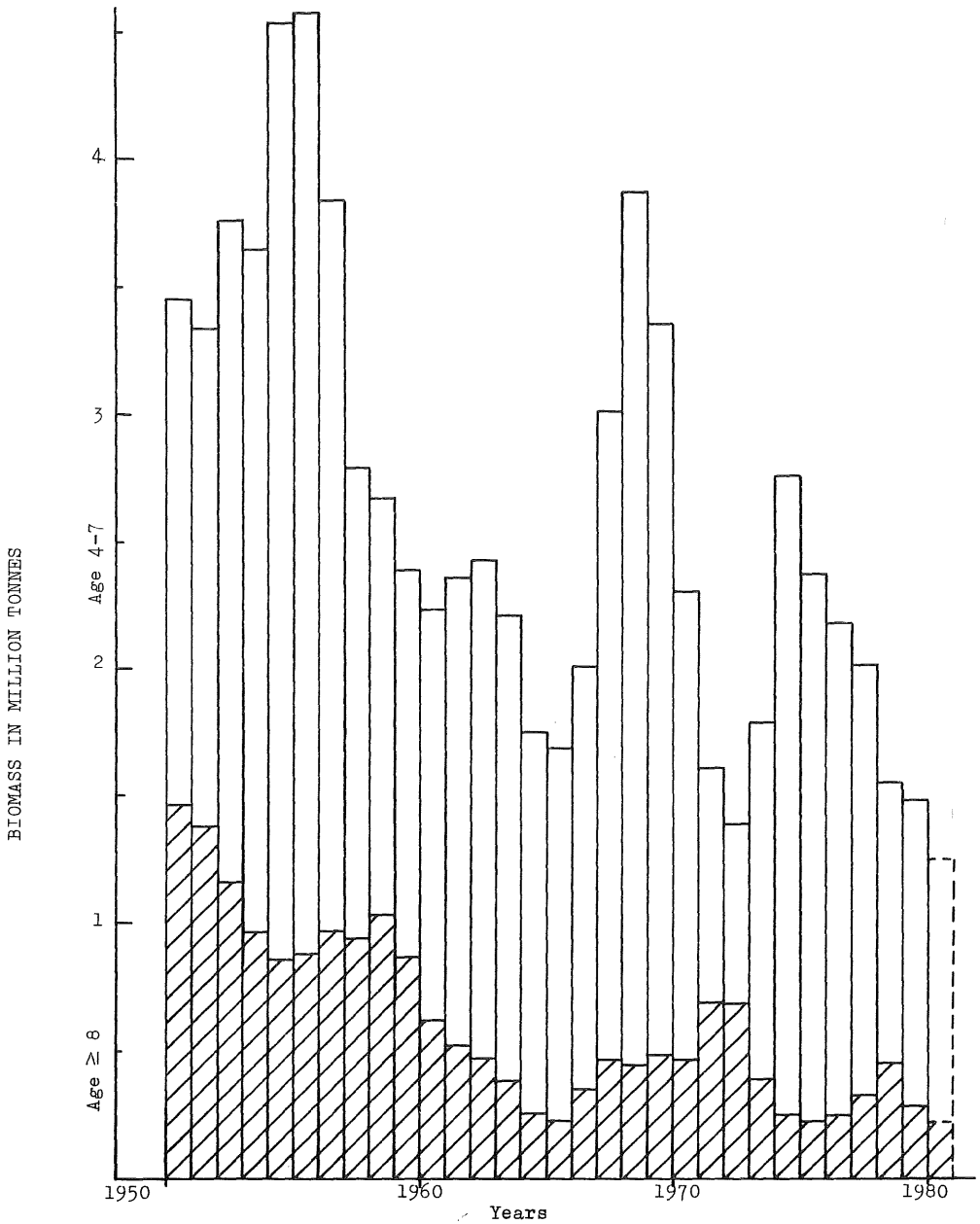
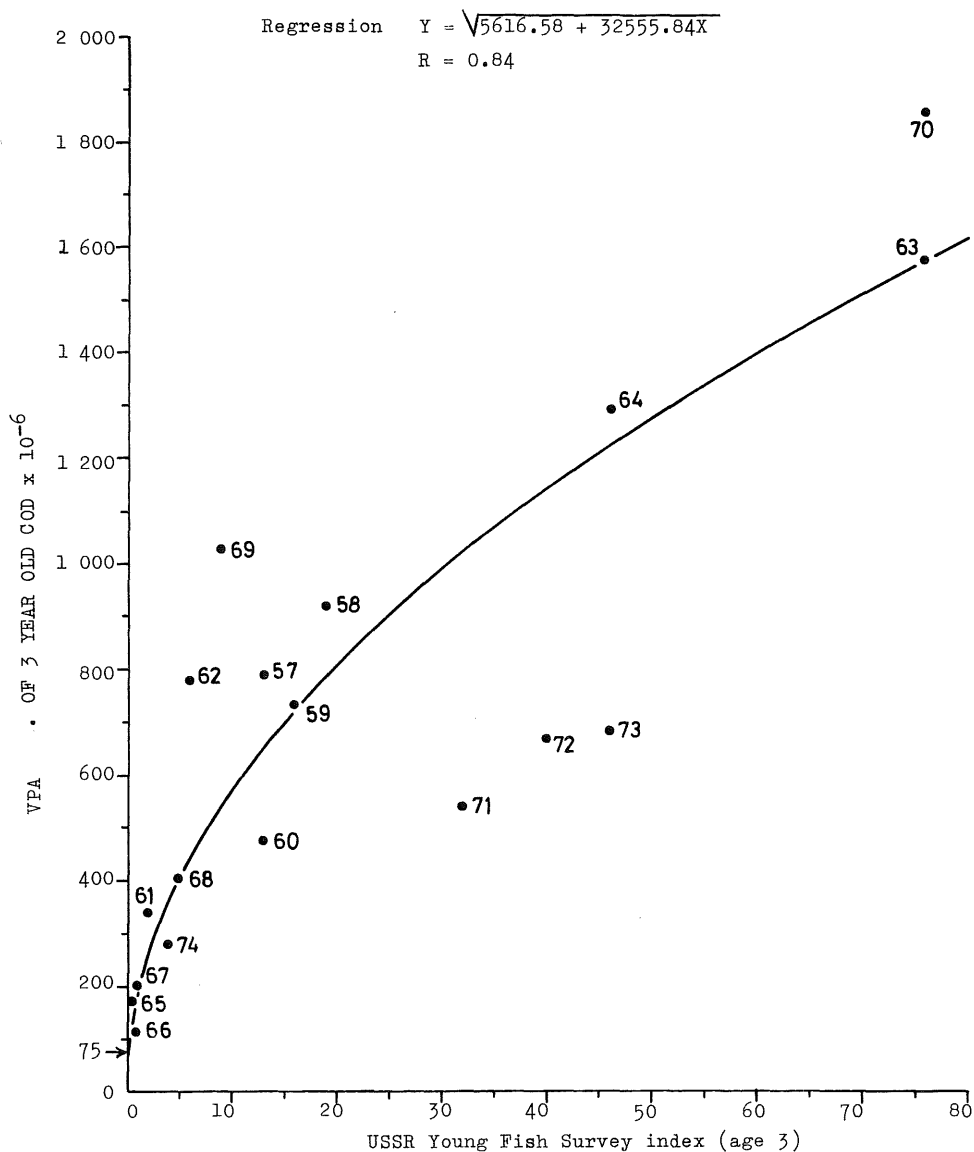
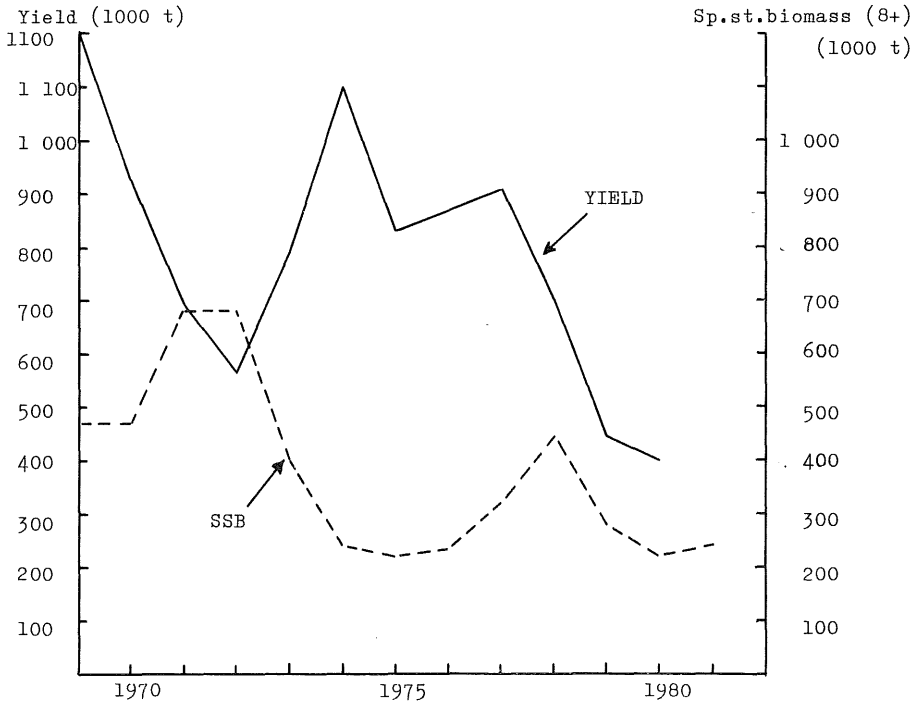
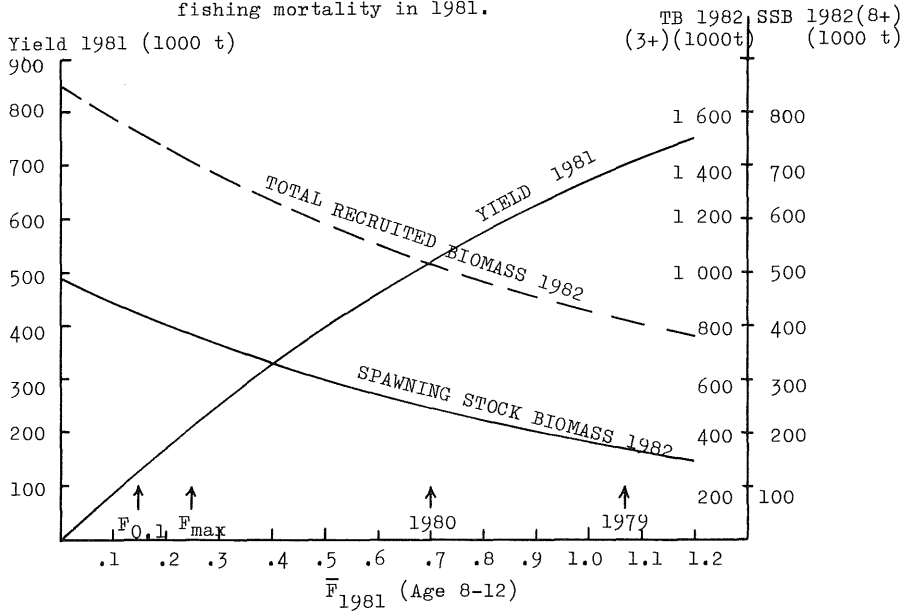


Figure 3. COD. Correlation of VPA recruitment estimates on USSR Young Fish Survey indices for 1957-74. 1975 year class is not included in the regression.



**Figure 4a** NE-Arctic Cod. Yield in 1981, total recruited biomass (TB) and spawning stock biomass (SSB) at different levels of fishing mortality in 1981.



**Figure 4b** Historic yield and spawning stock biomass of Arctic cod 1969-80.

Figure 5. HADDOCK. Correlation of numbers of 3 year olds (from VPA) and USSR Young Fish Survey indices for the year classes 1957-74.

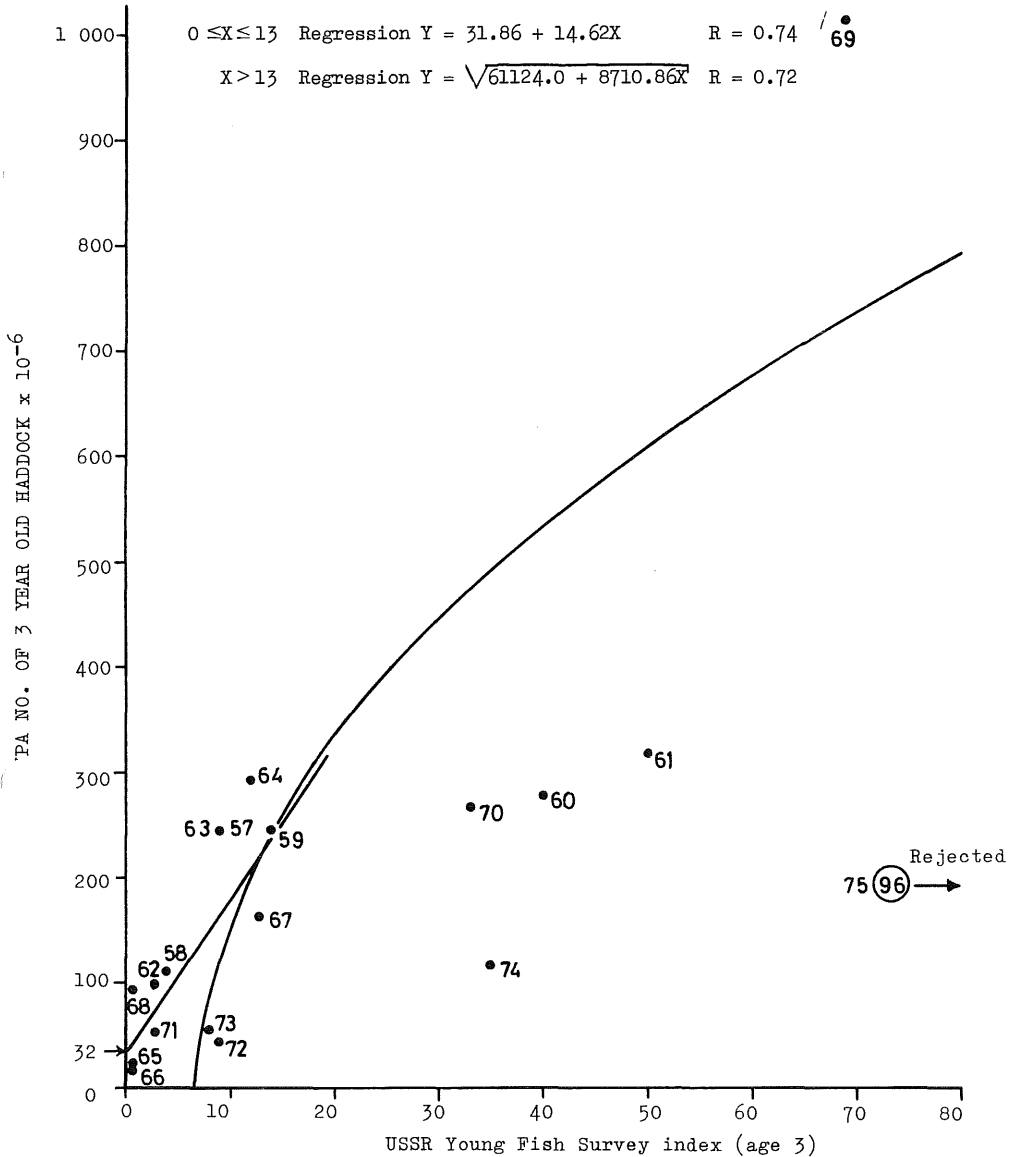


Figure 6.a NE-Arctic Haddock. Yield in 1981, total recruited biomass (TB) and spawning stock biomass (SSB) in 1982 at different levels of fishing mortality in 1981.

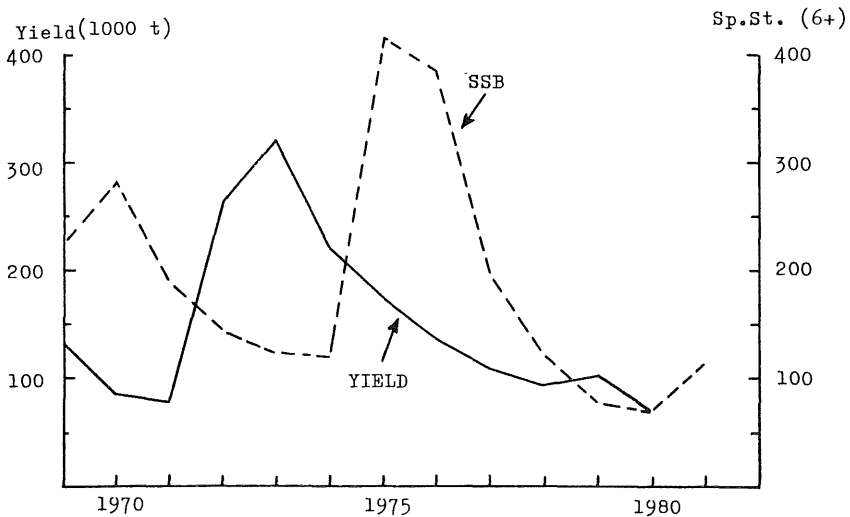
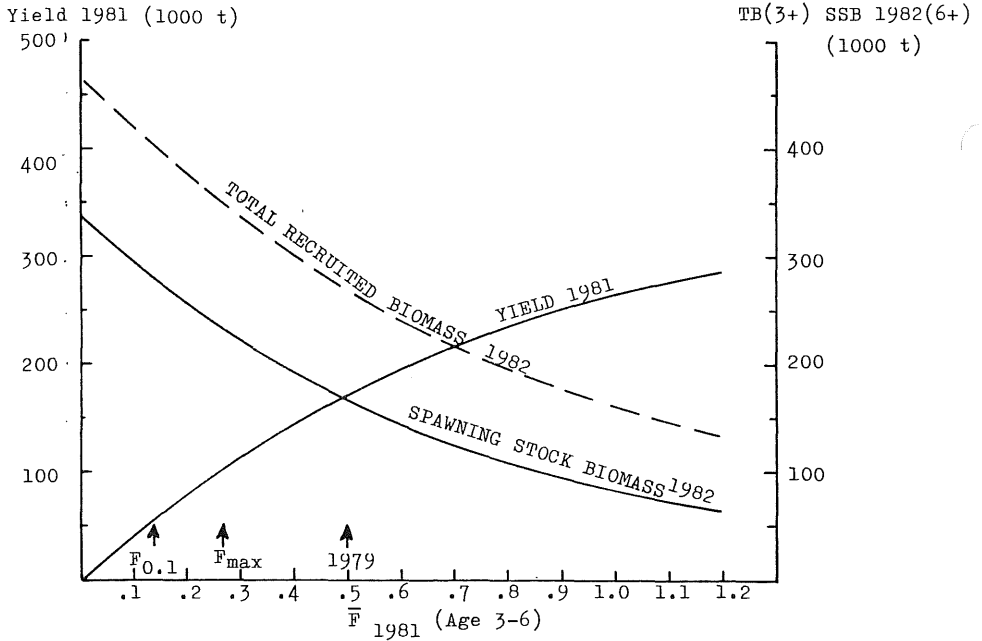


Figure 6.b Historic yield and spawning stock biomass of Arctic haddock 1969-1980.

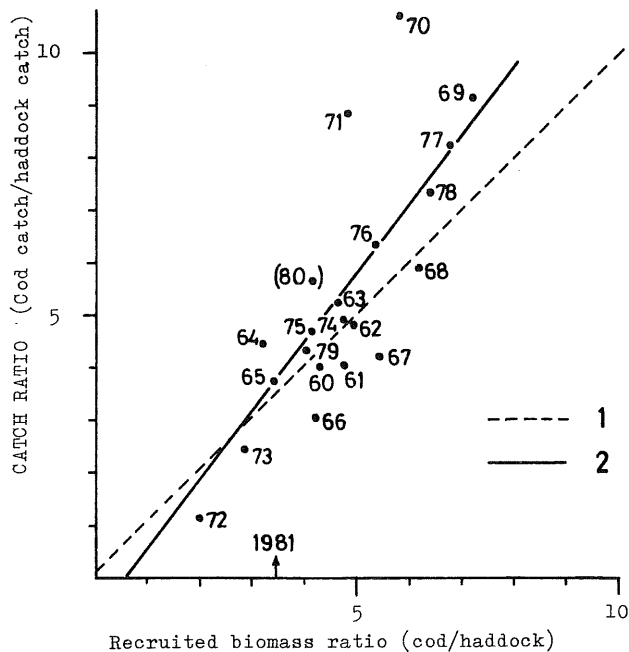


Figure 7. North-east Arctic COD and HADDOCK. Total international catch ratios versus recruited biomass ratios (3+) for the years 1960-80.

Legends: 1 - The 1:1 line  
 2 - fitted line (1960-79)  $Y = -0.84 + 1.33X$   
 $r = 0.77$  (1960-79)