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International Council for the
Exploration of the Sea

C.M.1975/F:6

Demersal Fish (Northern) Committee

REPORT OF THE NORTH-EAST ARCTIC FISHERIES WORKING GROUP

Charlottenlund Slot, 17-21 March 1975

x) General Secretary
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Report of the North-East Arctic Fisheries Working Group

1. Participants

O. V. Bakurin	U.S.S.R.
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A. Hylen (Chairman)	Norway
A.Jamieson	U.K. (England)
J. Janusz	Poland
B. W. Jones	U.K. (England)
W. Mahnke	German Democratic Republic
V. P. Ponomarenko	U.S.S.R.
C. J. Rørvik	Norway
A. Schumacher	Federal Republic of Germany
A. Wells	Canada

Mr. D. de G. Griffith (ICES Statistician) also participated in the meeting.

2. Terms of Reference

At the 1974 Statutory Meeting of ICES, it was decided (C.Res.1974/2:22) that:

"(i) the North-East Arctic Fisheries Working Group should meet at Charlottenlund from 17 to 21 March 1975 to:

(a) assess TACs for 1976 for cod and haddock;

(b) re-estimate the effective mesh size in use and its effect on mesh assessments. Special attention should be paid to the effect of the midwater trawl and the effects of various regulatory measures on the size of the spawning stock;

(c) consider the interrelations between cod, haddock and capelin stocks.

(ii) those countries which have recently commenced fishing in the North-East Arctic should also be invited to participate as members of the Working Group or to send detailed catch statistics and age composition data to the meeting.

3. The Status of the Fisheries

3.1 Cod (Tables 1-4)

During 1974 an agreement was made between Norway, U.K. and U.S.S.R. to limit catches of North-East Arctic cod. It was agreed that the total catch to be taken by these three countries would be 500 000 tons and, in addition, allowance was made for a catch of 50 000 tons by other countries. The aim was to limit fishing on the recruiting year classes allowing improved survival to older ages to permit a recovery of the spawning stock which was expected to reach an all-time low level in 1975. It was anticipated that the allowable catch could be increased in successive years, probably reaching a level of about 1 million tons by 1977 or 1978.

The recruitment to the fishery of the very abundant 1970 year class gave high catch rates, which made the North-East Arctic an attractive fishery for countries which in earlier years had not fished in the area or had taken only small catches. By the middle of the year it became clear that the catches by "other countries" were greatly exceeding the quantity anticipated by the signatories of the Tripartite Agreement, and as a result, the Tripartite Agreement was abandoned.

The total landings in 1974 exceeded 1 000 000 tons, with the 1970 year class (and to a lesser extent the 1969 year class) contributing the greater part of the catch. The increases in catch were in Sub-area I and Division IIb. The landings from Division IIa fell to almost half of the catch in 1973, reflecting the reduced abundance of older age groups in the stock.

3.2 Haddock (Tables 5-7)

The Tripartite Agreement for 1974 did not provide for any limitation of haddock catch. Catches in 1974 were 210 000 tons compared with 320 000 tons in 1973, the main reduction being in the U.S.S.R. landings from Sub-area I. The high catch rate recorded by U.K. vessels in Division IIa was due, to some extent at least, to a directed fishery in the early part of the year.

4. Assessment by the Virtual Population Analysis (VPA) (Tables 8-11)

Assessments were made for cod and haddock as in earlier years using updated data. In addition, at this meeting second alternative assessments were made incorporating additional landings of haddock from U.S.S.R. coastal fisheries and of Murman cod caught by U.S.S.R. vessels, which the U.S.S.R. members of the Working Group said had not previously been reported to ICES or to the Working Group.

The new statistics (Table 8) relate to the period 1960-74. It was said that for haddock there were previously unreported landings from the U.S.S.R. coastal fisheries, and that for cod only the proportion of the total landings which corresponded to the Arcto-Norwegian type had been reported to ICES. (Cod from the Barents Sea landed in the U.S.S.R. are split into Arcto-Norwegian cod and Murman cod on the basis of the proportions of two otolith types in samples examined). The additional cod landing data presented at this meeting of the Working Group represent the quantity of cod of the Murman type in the landings of the state fisheries from Sub-area I, plus the total landings of local fishery cooperatives on the Murman coast which are assumed to be 100% of the Murman type.

However, further examination of the U.S.S.R. catch of cod in the Barents Sea reported to "Bulletin Statistique", and the percentages of Arcto-Norwegian type otoliths in the Soviet samples, indicated that there may be some inconsistencies in the U.S.S.R. data.

As their distribution extends westwards along the northern Norwegian coast and northwards into the Barents Sea proper, cod of the Murman type will also occur in the landings of other countries. These countries have made no attempts so far to record the various otolith types separately as they have always considered them to be variations within the Arcto-Norwegian stock, and thus no estimates of the proportions of the Murman cod in the landings of other countries are available at present. However, both types of cod are, to some extent at least, caught together in the North-East Arctic fishery.

In view of these uncertainties concerning the components of the cod catch in the Barents Sea, the Working Group felt that the more reliable VPA results were those which did not incorporate the additional U.S.S.R. figures.

4.1 Results (Tables 9-11)

Estimates of fishing mortality coefficients and of stock size from VPA for recent years are given in Tables 9-11. Also indicated are the assumed values of the fishing mortality in 1974 used to initiate the calculation. Estimates of fishing mortality were the same from both assessments (i.e. excluding and including additional U.S.S.R. landings) but the assessments which include the additional U.S.S.R. landings, give estimates of stock size which are larger, by 12% for cod and 15% for haddock, than estimates from assessments with these landings excluded.

5. Estimates of Recruitment (Tables 12 and 13)

Tables 12 and 13 give updated estimates of the strengths of recruiting year classes. From the VPA, cod year classes 1969 and 1970 appear to be more abundant than earlier estimates based mainly on 0-group surveys and U.S.S.R. young fish surveys. The most recent U.S.S.R. surveys indicate that the year classes 1971-73 are above average. The 1974 year class was very poor in the 0-group survey.

For haddock, the 1968 and 1969 year class strengths have been revised downwards. The recent U.S.S.R. surveys indicate a higher abundance of the 1972 and 1973 year classes than before. The 1974 year class was abundant in the 0-group survey.

6. Calculation of Total Allowable Catch (TAC) (Table 14)

Total allowable catches have been calculated for both cod and haddock based on the parameters given in Table 14.

6.1 Cod (Figure 1, Table 15)

Two calculations were made for cod:

(1) Calculation of F if the TAC in 1976 and 1977 was maintained at about the same level as has been agreed for 1975 (810 000 tons);

(2) Calculation of TAC if F in 1976 and 1977 was at the level which would give the Maximum Sustainable Yield (MSY) with the present exploitation pattern ($F_{8+} = 0.53$) (Figure 1).

In both cases it has been assumed that the 1975 catch will be equal to the agreed TAC. The size of the spawning stock has been calculated for each year in each case. In addition, the calculations have been duplicated for initial stock sizes calculated with U.S.S.R. landings excluded and included.

The results are given in Table 15. The values of F that would be generated if the TAC was maintained at the 1975 level are in fact very close to the value of F giving the MSY. The effect of including in the assessment the U.S.S.R. landings of Murman cod would be to increase the TAC by approximately 100 000 tons. Maintaining the TAC at about 800 000 tons (900 000 tons allowing for U.S.S.R. Murman cod) would allow the size of the spawning stock to increase. On the basis of these assessments the immediate objective of a spawning stock similar in size to that in the period 1970-72 would be achieved by 1978.

6.2 Haddock (Table 16, Figure 1)

Landings of haddock in 1975 are not limited by catch quotas. Normally only a small amount of directed fishing for haddock takes place and most of the haddock is taken as a by-catch in the cod fishery. However, there are indications that 1974 may have been an exceptional year. Estimated catches of

haddock have been calculated for 1975 on the basis of the fishing mortality which might be generated on haddock while the fleet fished for a cod TAC of 810 000 tons. For subsequent years TACs were calculated:

(1) for F on haddock determined in relation to the cod fishery limited to a TAC of about 800 000 tons;

(2) for F on haddock determined in relation to the cod fishery where F on cod is maintained at the level which gives the MSY;

(3) for F on haddock being at the level required to give the MSY for haddock with the present exploitation pattern (F_{6+} = 0.3, Figure 1).

The results of these calculations are given in Table 16. The weight-at-age data used in the assessment give an underestimate of the TAC, but this has been corrected to give the catches shown in the Table.

For Case (1) calculated catches were in the range of 125 000 - 142 000 tons (or 134 000 - 148 000 tons, with allowance for additional landings from U.S.S.R. coastal fisheries). For Case (2) the estimated catches are similar to those for Case (1). A reduction of fishing mortality on haddock to F_{6+} = 0.3 (F for MSY) would give appreciably lower catches in the immediate future.

6.3 Soviet catch equations

Catch predictions have also been prepared by the method of Ponomarenko (Doc. C.M.1974/F:24) based on the abundance of cod and haddock year classes in the U.S.S.R. young fish surveys.

Cod

The main component of the immature stock in 1976 would be the 1970, 1971 and 1972 year classes. The mature stock would be represented by the poor 1968, 1967, 1966 and 1965 year classes. The combined index of the stock would be 138 million of young fish per hour of trawling (Table 3, Doc.C.M.1974/F:24). The method for determination of the index for cod and haddock stocks is discussed in the contribution paper by V.P. Ponomarenko to be presented at the forthcoming ICES Statutory Meeting.

So, using the index of the stock in the prediction equations we get the following estimated catches of cod in 1976:

	'000 tons		
	Total	By areas	
		I + IIb	IIa
1. At the average long-term level of F	1 200	1 000	200
2. Reduced by 25% (for effective reproduction)	900	750	150

Haddock

Immature haddock mainly inhabit Sub-area I where the main components of the catches are the fish of 3-5 years old. The maturation is observed to be reached primarily at the age of 5-6 with a mean length of 47 cm (Sonina,

1969). There is a negligible proportion of mature haddock in the catches by bottom trawl in Sub-area I.

In 1976 the immature stock would be of average strength year classes (1971-1972) and the rich 1973 year class.

The estimated catch based on the equations is given below:

	Estimated Catch ('000 tons)
1. At the mean long-term fishing effort	135
2. Reduced by 25%	100

6.4 Recommended TACs

Cod

Calculations based on VPA data indicate that if the 1976 TAC was maintained at the present (1975) level the average fishing mortality expected to be generated in 1975 and 1976 would be close to that giving the MSY. This would also permit the desired recovery of the spawning stock. Bearing in mind the views expressed in the last paragraph of Section 4 the Working Group has reservations about the assessment which made allowance for additional landings of Murman cod. The catch estimate calculated by the method of Ponomarenko was 900 000 tons, allowing for a 25% reduction in fishing. The Working Group therefore recommends that the TAC for cod for 1976 should be in the range 800 000 tons to 900 000 tons.

Haddock

An immediate reduction in fishing mortality to the level required to give the MSY would involve a dramatic drop in the catch in 1976. On the other hand, a catch in 1976 of about 130 000 tons could be taken if fishing mortality was maintained at about the level prevailing in recent years. This would be consistent with the F on haddock which would be expected to be generated by the cod fishery. It would be desirable to make some reduction in F below present levels. The Ponomarenko method gives a catch of 135 000 tons, or 100 000 tons with fishing effort reduced by 25%. The Working Group therefore recommends that the TAC for haddock for 1976 should be in the range of 100 000 tons to 130 000 tons. A directed trawl fishery for haddock should be avoided.

7. Mesh Sizes

7.1 Effective mesh size in use

Some evidence was presented in the Working Group Report for 1974 which indicated that the effective mesh size used was smaller than the regulation mesh. This evidence was not conclusive. However, information on the effective mesh size currently in use is of great importance for the evaluation of the effects of increasing the regulation mesh size. No new data were available for the Working Group to clarify this point (no new mesh assessments could therefore be made). The Group considers that the best data of mesh size and chafers in use in the North-East Arctic would be the measurements made at sea by the international inspectors which might be of some help to the Working Group if the detailed data could be made available.

7.2 Midwater trawl

At least a part of the trawler fleet operating in the North-East Arctic has been using midwater trawls in the fishery for Arcto-Norwegian cod and haddock. Very little data on the selectivity of these gears are available, and this information would be required if any mesh assessments are to be made. Results

from selectivity experiments made in March 1975 by Norway were reported during the Working Group meeting. Altogether 5 covered hauls were made with a Norwegian designed trawl having a nylon cod end with a mesh size of 112 mm. These experiments gave selection factors in the same range as for bottom trawl selectivity experiments. However, larger catches than were obtained during these experiments might reduce the selectivity of the mid-water trawl as is known to occur with bottom trawls.

The effects of midwater trawls on the stocks, compared with the effects of bottom trawls, will depend not only on their selectivity but also on the distribution and behaviour of fish in relation to depth. There are some indications that small fish are more available to midwater trawls than to bottom trawls. There is also the possibility of bigger, faster swimming fish being better able to avoid capture by midwater trawls.

Very little information is available on this subject. Until age compositions and the quantities taken by midwater trawls are recorded, the fishing mortality generated by the midwater trawl fishery cannot be assessed. The Working Group recommends that all countries involved in the North-East Arctic fishery should distinguish between catches taken with midwater trawls and those taken with bottom trawls in the national statistical returns, and that length and age compositions of midwater trawl catches be obtained.

8. Effects of Regulatory Measures on the Size of the Spawning Stock

No further information was available to allow the Working Group to examine this question in any more detail than had been possible during the 1974 meeting of the Group. The statements in the 1974 Report, therefore, still represent the opinion of the Working Group on this matter. These statements were as follows:

> "Clearly a reduction in fishing mortality will achieve a more rapid recovery of the spawning stock than mesh regulation; the most rapid recovery would be achieved by a combination of measures.....
>
> "A recovery in the spawning stock at least to the 1970-1972 level could be achieved by careful regulation of the catches in the coming years. In effect management can take advantage of the improving stock to reduce fishing mortality without reducing actual catches. It is, however, essential that a regulation be maintained to prevent unrestricted increase in fishing on the whole stock within the period 1975-1977, and to prevent too high a proportion of the allowable catch being taken from the mature stock".

9. Interrelationships between Cod, Haddock and Capelin

Recent work indicates that in summer and autumn the diet of cod in the Barents Sea is quite varied and includes euphausiids, prawns, other invertebrates, capelin, other small fish such as Polar cod, and young fish especially young cod, haddock and redfish. In the winter, capelin is one of the main food items. Around Bear Island on the North Bear Island Bank and off West Spitzbergen the diet consisted mainly of euphausiids from January to September.

Fish, especially capelin and herring, were predominant in cod stomachs in the 1930s, while in the summer euphausiids were most important. In the early 1950s capelin was the main food in the area east of Bear Island from April to October.

In general, heaviest feeding occurs when cod are feeding on capelin and herring.

Haddock feed on capelin to a much lesser degree than cod.

Echo-sounder surveys in 1972-74 show that in late summer and autumn capelin are located mainly north of 76°N. In the winter the whole capelin stock moves southward; the mature capelin move towards the Murman and Finmark coasts for spawning and the juveniles remain in the central part of the Barents Sea. Cod, especially young cod, are distributed mainly south of 76°N in the summer and autumn. In the winter the young cod are in the same area, including coastal waters, but the mature cod are undertaking the spawning migration to Lofoten.

Herring was at least as important as capelin in the cod diet in the 1930s, but the cod stock apparently was not affected when the herring stock declined. It may be that the capelin were able to make use of the food surplus made by the decline of the herring. If the capelin stock were to decline, it is not known if the surplus food thus made available would be used by organisms which could serve as food items for the cod stock.

The most important capelin fishery is on the spawning grounds in winter. Since capelin die after spawning, this fishery has little direct effect on the food supply of cod, unless the fishery does not leave the appropriate proportion of capelin necessary for good recruitment. The supply of juvenile capelin available as food for cod is, however, reduced by the summer capelin fishery.

10. Reference

Sonina, M. A., 1969. Migrations of haddock in the Barents Sea and factors determining them. Trudy PINRO, 26, Murmansk.

Table 1. Cod. Total nominal catch by fishing areas (metric tons).

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 x)	638 916	269 036	119 736	1 027 688

x) Provisional figures.

Table 2. Cod. Nominal catch (metric tons, whole weight) by countries.
(Sub-area I and Divisions IIa and IIb combined)

Year	Faroe Islands	France	German Dem. Rep.	Germany, F.R.	Norway	Poland	U.K.	USSR Arcto-Norwegian cod	Others	Total all countries	Additional landings USSR Murman cod	Total all countries incl. USSR Murman Cod	Norway coastal cod
1960	3 306	22 321		9 472	231 997	20	141 175	213 400	351	622 042	71 000	693 042	43 092
1961	3 934	13 755	3 921	8 129	268 377	-	158 113	325 780	1 212	783 221	108 000	891 221	32 359
1962	3 109	20 482	1 532	6 503	225 615	-	175 020	476 760	245	909 266	114 000	1 023 266	29 596
1963	-	18 318	129	4 223	205 056	108	129 779	417 964	-	775 577	127 000	902 577	40 405
1964	-	8 634	297	3 202	149 878	-	94 549	180 550	585	437 695	63 000	500 695	46 100
1965	-	526	91	3 670	197 085	-	89 962	152 780	816	444 930	52 000	496 930	23 786
1966	-	2 967	228	4 284	203 792	-	103 012	169 300	121	483 704	73 000	556 704	27 800
1967	-	664	45	3 632	218 910	-	87 008	262 340	6	572 605	79 000	651 605	33 102
1968	-	-	255	1 073	255 611	-	140 387	676 758	-	1 074 084	118 000	1 192 084	47 212
1969	29 374	-	5 907	5 343	305 241	7 856	231 066	612 215	133	1 197 226	122 000	1 319 226	52 416
1970	26 265	44 245	12 413	9 451	377 606	5 153	181 481	276 632	-	933 246	70 000	1 003 246	49 000
1971	5 877	34 772	4 998	9 726	407 044	1 512	80 102	144 802	215	689 048	48 000	737 048	
1972	1 393	8 915	1 300	3 405	394 181	892	58 382	96 653	166	565 287	23 000	588 287	
1973	1 916	17 028	4 684	16 751	285 184	843	78 808	387 196	276	792 686	122 000	914 686	
1974*	4 534	38 400	4 860	74 599	292 106	9 898	91 637	450 645	61 000	1 027 679	99 000	1 126 679	

* Preliminary figures.

Table 3. Cod. Estimates of total international fishing effort in Sub-area I and Divisions IIa and IIb.

Year	SUB-AREA I				DIVISION IIb				DIVISION IIa			
	National Effort		Total International Effort		National Effort		Total International Effort		National Effort		Total International Effort	
	U.K.[1]	USSR[2]	U.K. Units	USSR Units	U.K.	USSR	U.K. Units	USSR Units	U.K.	Norway[3]	U.K. Units	Norwegian Units
1960	95	43	512	91	42	11	97	34	39	10	252	26
1961	94	53	518	109	51	22	173	39	30	9	255	20
1962	93	61	590	94	51	16	168	29	34	10	210	21
1963	78	62	635	91	45	9	120	22	29	7	176	19
1964	42	30	351	55	49	17	136	32	36	6	157	17
1965	42	25	367	62	37	11	95	4	33	5	150	16
1966	63	33	387	69	23	16	71	29	46	5	199	15
1967	51	30	395	61	10	12	110	13	50	5	261	22
1968	86	45	584	67	9	24	151	26	52	6	288	15
1969	115	45	593	72	24	19	197	26	73	5	272	18
1970	122	35	573	77	24	15	122	27	55	5	346	16
1971	82	23	576	74	4	27	79	34	48	5	523	14
1972	71	41	418	111	7	11	65	17	35	6	602	14
1973	96	61	860	94	18	12	161	16	27	7	485	14
1974[x]	87	48	780	98	11	18	313	36	27	5	403	15

1) Hours fishing x average tonnage x 10^{-6} = millions on ton-hours.

2) Hours fishing (catch/catch per hour fishing) x 10^{-4}.

3) Number of men fishing at Lofoten x 10^{-3}.

x) Provisional figures.

Table 4. Cod. Catch per unit effort (metric tons, round fresh) in Sub-area I and Divisions IIa and IIb.

Year	Sub-area I		Division IIb		Division IIa	
	U.K.[1]	USSR[2]	U.K.	USSR	U.K.	Norway[3]
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	0.058	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	0.047	0.34	0.051	0.18	0.055	11.5
1973	0.057	0.56	0.054	0.57	0.043	6.8
1974[x]	0.083	0.90	0.089	0.77	0.029	3.4

1) U.K. data - tons per 100 ton-hours fishing.
2) USSR data - tons per hour fishing.
3) Norwegian data- tons per gill net boat week at Lofoten.
x) Provisional figures.

Table 5. Haddock. Total nominal catch by fishing areas (metric tons).

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[x]	143 589	28 272	38 243	210 104

x) Provisional figures.

Table 6. Haddock. Nominal catch (in metric tons) by countries.
(Sub-area I and Divisions IIa and IIb combined).

Year	Faroe Islands	France	German Dem.Rep.	Germany, F.R.	Norway	Poland	U.K	USSR Arcto-Norw. Haddock	Others	Total	USSR Murman Haddock	USSR Total	Grand Total
1960	172	-	-	5 597	47 263	-	45 469	57 025	125	155 651	17 000	74 025	172 651
1961	295	220	-	6 304	60 862	-	39 650	85 345	558	193 234	24 000	109 345	217 234
1962	83	409	-	2 895	54 567	-	37 486	91 940	58	187 438	27 000	118 940	214 438
1963	17	363	-	2 554	59 955	-	19 809	63 526	-	146 224	20 000	83 526	166 224
1964	-	208	-	1 482	38 695	-	14 653	43 870	250	99 158	14 000	57 870	113 158
1965	-	226	-	1 568	60 447	-	14 345	41 750	242	118 578	13 000	54 750	131 578
1966	-	1 072	11	2 098	82 090	-	27 723	48 710	74	161 778	15 000	63 710	176 778
1967	-	1 208	3	1 705	51 954	-	24 158	57 346	23	136 397	17 000	74 346	153 397
1968	-	-	-	1 867	64 076	-	40 129	75 654	-	181 726	22 000	97 654	203 726
1969	2	-	309	1 490	67 549	-	37 234	24 211	25	130 820	9 000	33 211	139 820
1970	541	-	656	2 119	36 716	-	20 423	26 802	-	87 257	10 000	36 802	97 257
1971	81	-	16	896	45 715	49	16 373	15 778	3	78 911	7 000	22 778	85 911
1972	137	-	829	1 433	46 700	1 433	17 166	196 224	2 223	266 145	47 000	243 224	313 145
1973	1 212	3 214	22	9 583	86 767	325	32 408	186 534	-	320 065	50 000	236 534	370 065
1974[1]	810	6 100[2]	439	23 154	68 407	3 045	38 251	59 398	10 500[2]	210 104	9 000	68 398	219 104

[1] preliminary figures

[2] catches estimated according to the proportion of haddock in the U.K. Cod Fishery in Div. IIb.

Table 7. Haddock. Catch per unit effort and estimated total international effort.

Year	Catch per Effort (U.K.) Kilos/100 ton-hours			Estimated Total International Effort in U.K. Units $\frac{\text{Total Catch in Tons} \times 10^{-6}}{\text{Tons/100 Ton-Hours Sub-area I}}$
	Sub-area I	Divisions IIa	Divisions IIb	
1960	33	34	2.8	4.7
1961	29	36	3.3	6.7
1962	23	42	2.5	8.2
1963	13	33	0.9	11.2
1964	18	18	1.6	5.5
1965	18	18	2.0	6.6
1966	17	34	2.8	9.4
1967	18	25	2.4	7.6
1968	19	50	1.0	9.6
1969	13	42	2.0	10.0
1970	7	31	1.0	12.4
1971	8	25	3.0	9.8
1972	14	18	23.0	19.0
1973	22	20	20.0	14.5
1974[x)]	9	74	16.0	23.3

x) Provisional figures.

Table 8. Catches of Murman cod and haddock by Soviet fishermen (in '000 tons)

Year	Total	Cod		Haddock
		By state-owned fishing fleet in the high seas	By cooperative fishermen in inshore areas	Only by cooperative fishermen
1960	71	59	12	17
1961	108	89	19	24
1962	114	105	9	27
1963	127	111	16	20
1964	63	36	27	14
1965	52	30	22	13
1966	73	56	17	15
1967	79	55	24	17
1968	118	107	11	22
1969	122	92	30	9
1970	70	43	27	10
1971	48	22	26	7
1972	23	17	6	47
1973	122	109	13	50
1974x)	99	90	9	9
Average	86	68	18	20

x) Provisional figures.

Table 9. Fishing mortality 1970-1974 estimated by virtual population analysis

Age \ Year	Cod (M = 0.3)					Haddock (M = 0.2)				
	1970	1971	1972	1973	1974 x)	1970	1971	1972	1973	1974 x)
3	.04	.02	.03	.13	.07	.18	.02	.34	.40	.10
4	.12	.10	.15	.16	.31	.27	.29	.40	.81	.40
5	.35	.21	.33	.34	.38	.34	.22	1.26	1.05	.70
6	.49	.23	.39	.51	.48	.55	.27	1.34	.69	.75
7	.55	.46	.34	.49	.74	.54	.47	1.09	.60	.75
8	.76	.76	.61	.86	.80	.47	.41	.76	1.00	.75
9	.83	.86	1.05	.97	.80	.32	.36	.77	.43	.75
10	.84	.65	1.18	.72	.80	.34	.28	.85	.34	.75
11	.56	.54	.94	.61	.80	.45	.29	.47	.31	.75
12	.33	.42	.59	.42	.80	.14	.79	.88	.29	.75
13	.45	.36	.75	.29	.80	1.74	.21	.92	.25	.75
14	.50	.36	.64	.34	.80	x) .60	.60	.60	.60	.75
15 x)	.65	.80	.80	.80	.80					

x) Assumed values

Table 10. Stock size 1970-1974 (millions of fish) estimated by virtual population analysis of nominal catches with Soviet catches of Murman cod and haddock excluded

	Cod (M = 0.3)					Haddock (M = 0.2)				
Age \ Year	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
3	231	520	1 419	2 696	1 190	154	92	875	235	88
4	109	165	379	1 021	1 746	11	106	73	510	130
5	101	71	110	242	644	7	7	65	40	186
6	407	53	43	59	127	57	4	5	15	12
7	260	185	31	21	26	21	27	3	1	6
8	68	111	87	16	10	6	10	14	1	0.4
9	18	24	39	35	5	8	3	5	5	0.2
10	7	6	7	10	10	3	5	2	2	3
11	3	2	2	2	4		2	3	1	1
12	1	1	1	1	1			1	1	0.3
13		1	1							1

Table 11. Stock size 1970-1974 (millions of fish) estimated by vitural population analysis of nominal catches with Soviet catches of Murman cod and Haddock included

	Cod (M = 0.3)					Haddock (M = 0.2)				
Age \ Year	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
3	264	584	1 609	3 054	1 571	178	107	1 007	265	98
4	122	189	425	1 159	1 939	13	120	86	570	140
5	107	81	126	270	724	8	8	73	46	193
6	424	55	48	67	139	60	4	5	16	12
7	281	189	32	24	29	22	27	3	1	6
8	76	117	88	17	11	6	10	14	1	1
9	20	26	39	35	5	8	3	5	5	0.2
10	7	6	8	10	10	3	5	2	2	3
11	3	2	2	2	4	1	2	3	1	1
12	1	1	1	1	1			1	2	0.4
13		1	1							1

Table 12. Arcto-Norwegian Cod. Year Class Strength. The Number per Hour Fishing for USSR Young Fish Survey is for 3-Year-Old Fish

Year Class	USSR Survey. No. per Hour Trawling			USSR Assessment	0-Group Survey	Virtual Population No. of 3-Year-Olds x 10^{-6} (USSR Murman Cod Excluded)	Virtual Population No. of 3-Year Olds x 10^{-6} (USSR Murman Cod Included)
	Sub-Area I	Division IIb	Mean				
1957	12	16	13	- Average		1 061	1 239
1958	16	24	19	+ Average		1 253	1 458
1959	18	14	16	+ Average		1 047	1 221
1960	9	19	13	Poor		700	808
1961	2	2	2	Poor		530	654
1962	7	4	6	Poor		1 158	1 318
1963	21	120	76	Rich		2 249	2 518
1964	49	45	46	Rich		1 812	1 976
1965	< 1	< 1	< 1	Very Poor	Very Poor	227	245
1966	2	< 1	1	Very Poor	Very Poor	149	168
1967	1	< 1	1	Very Poor	Poor	231	264
1968	7	1	5	Poor	Very Poor	520	584
1969	11	6	9	Poor	Rich	1 419	1 609
1970	74	86	79	Rich	Very Rich	2 696	3 054
1971	37	24	32	+ Average	Average	(1 190)	(1 571)
1972	(40)	(16)	(35)	+ Average	Average	(950)	(1 090)
1973	(26)	(1)	(15)	+ Average	Very Rich	(950)	(1 090)
1974				Poor	Poor	(950)	(1 090)

( ): Estimated

Table 13. Arcto-Norwegian Haddock. Year Class Strength. The Number per Hour Trawling for USSR Young Fish Survey is for 3-Year-Old Fish

Year Class	USSR Survey. No. per Hour Trawling Sub-Area I	0-Group Survey	Virtual Population No. of 3-Year-Olds x 10^{-6} (USSR Murman Haddock Excluded)	Virtual Population No. of 3-Year-Olds x 10^{-6} (USSR Murman Haddock Included)
1957	14		241	282
1958	5		110	125
1959	33		240	279
1960	72		275	320
1961	34		319	359
1962	4		99	109
1963	12		235	264
1964	15		285	319
1965	< 1	Very Poor	14	15
1966	< 1	Very Poor	15	18
1967	8	Average	154	178
1968	3	Very Poor	92	107
1969	120	Very Rich	875	1 007
1970		Rich	(235)	(265)
1971	3	Average	(88)	(98)
1972	(9)	Average	(208)	(239)
1973	(23)	Poor	(208)	(239)
1974		Rich	(208)	(239)

( ): Estimated

Table 14. Parameters used in the catch prediction

Age	Cod: Stock size beginning of 1976 in millions of fish*)	Cod: Proportion of F (adult)	Cod: Mean weight per age (kilos)	Haddock: Stock size beginning of 1976 in millions of fish*)	Haddock: Proportion of F (adult)	Haddock: Mean weight per age (kilos)
a) 3	1 090.0 950.0	0.03	0.65	239.0 208.0	0.13	0.41
4	791.5 689.8	0.20	1.00	178.8 156.0	0.53	0.62
5	691.8 549.2	0.40	1.55	41.9 39.0	0.93	0.97
6	561.4 505.3	0.55	2.35	33.8 33.0	1.00	1.59
7	182.3 162.0	0.75	3.45	32.9 32.0	1.00	2.33
8	30.2 27.5	1.00	4.70	1.9 1.9	1.00	2.72
9	4.5 4.1	1.00	6.17	1.0 1.0	1.00	3.56
10	1.8 1.5	1.00	7.70	0.1 -	1.00	4.41
11	0.9 0.8	1.00	9.25	0.04 -	1.00	5.40
12	1.4 1.5	1.00	10.85	0.5 0.5	1.00	6.70
13	0.5 0.7	1.00	12.50	0.2 0.2	1.00	7.40
14	0.5	1.00	13.90	0.1 -	1.00	8.00

*) Upper figure: USSR landing of Murman cod and haddock included
Lower figure: " " " " " " " excluded

a) Average recruitment

Table 15. Estimated sizes of catches and spawning stock of Cod at several levels of fishing. (Catches in thousands of metric tons, spawning stock in millions of fish).

	F values generating stable catch						Fishing at F_{max}		
	USSR Murman Cod excluded			USSR Murman Cod included			USSR Murman Cod excluded		
Year	F	Catch	Spawning stock	F	Catch	Spawning stock	F	Catch	Spawning stock
1975	.50	802	19	.50	904	20			
1976	.62	803	36	.62	919	39	.53	700	39
1977	.56	810	89	.56	935	100	.53	808	96
1978			167			187			180

Table 16. Estimated sizes of catches and F values of Haddock at several levels of fishing. (Catches in thousands of metric tons, spawning stock in millions of fish).

F values of haddock related to fishing for cod

Year	At stable catch levels, USSR coastal fishery included		At stable catch levels, USSR coastal fishery excluded		At F_{max}		F_{max} for haddock, USSR coastal fishery excluded	
	F	Catch	F	Catch	F	Catch	F	Catch
1975	.67	142	.67	148				
1976	.60	125	.60	134	.57	118	.30	61
1977	.58	131	.58	148	.57	132	.30	88

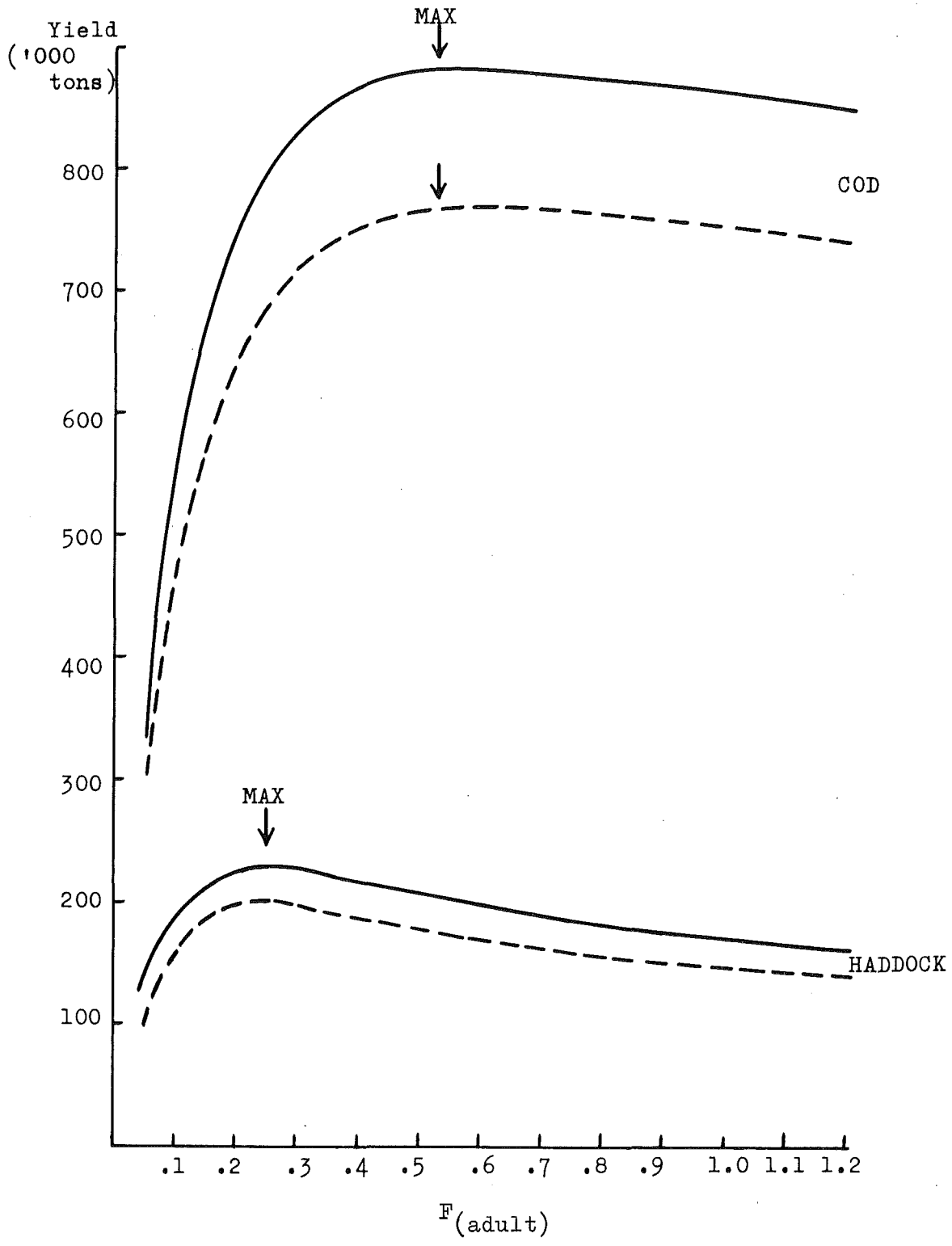

Figure 1. Yield curve calculated on basis of parameters used in the catch prediction and assuming stable recruitment at average level.

APPENDIX I

U.S.S.R. Coastal Cod

by

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There are several local stocks of cod existing near the shore of the Kola Peninsula, namely: coastal cod of the White Sea, winter cod of the White Sea (or cod of the high sea), fjord cod of the Murman coast (or "turjanka") and Murman coastal cod (Svetividov, 1948).

E. M. Mankevich investigated the otoliths of 122 658 samples taken in 1961-73 and determined the ratio of Murman and Arctic cod in the catches of Sub-area I. The otoliths of the Murman cod have distinct clear rings.

There are no supplementary zones. This cod, with such otoliths spreads over from Finmark to the extreme limits of its distribution along the Murman coast, including the coast of Novaya Zemlja. The main spawning grounds are in the Motovsky Bay and in the adjacent areas extending eastwards to Savikha Bay (Rass, 1934, 1949).

The growth rate of Murman cod is faster; it has lower counts of gill rakers, matures earlier and has a short life-span in comparison with Lofoten-Barents Sea cod (Dementjeva and Tanasijchuk, 1935; Glebov, 1963; Mankevich, 1960, 1964, 1975).

Murman cod spawns at depths of 25 m - 215 m, at bottom temperatures from 1.5° - 2°C and at salinities of 32.64‰ - 35‰. The most intensive spawning falls in the period from mid-March until the end of April (Rass, 1949; Mankevich, 1960; Glebov, 1963).

In the inshore areas Murman cod occurs in the catches in greater amounts than in the offshore areas. According to Mankevich (1975) it constitutes about 32% of the total combined catches of cod taken in the high seas and by local fishermen of cooperative enterprises fishing in inshore waters of the Kola Peninsula.

The distribution of catches is given in Table 8 of the Working Group Report.

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APPENDIX II

Proposal to Test Murman Cod Genotypes

The current interest in estimating the fisheries statistics for the North-East Arctic cod in relation to national quotas involves a special interest in defining the racial components of the fishery with particular reference to the hitherto untyped Murman coastal cod element, and its genetic relationship with cod in adjacent areas.

In the North-East Arctic area genotypic data exist for cod at Lofoten and along the Norway coast. The migrant skrei have been typed on spawning and feeding grounds and are seen to differ from the Norwegian coastal cod. The differences between allele frequencies are repeatable and statistically significiant (Møller).

Genetic data are not yet available for the Barents Sea cod showing "Murman" otoliths.

It is proposed to obtain genotypic morphometric data from population samples of cod along the Murman coast containing a proportion of the fish which spawn locally, and to compare this genotype with those from contemporary samples of the adjacent concentrations of cod representing other areas in the North-East Arctic.

Tests would be carried out for the presence of separate races having identifiable and genetically controlled characteristics, and for the extent to which such races are mixed.

Method

It is suggested that the necessary cod protein sampling programme be carried out on RV "Cirolana" in June 1976, calling at Murmansk to invite 2 Soviet biologists and an interpreter to join the sampling programme.

Perhaps the Soviet scientists could take care of most of the morphometric details, while a team from Lowestoft could secure the blood and tissue protein samples for subsequent electrophoretic analysis at Lowestoft.

It would be necessary to sample 1 000 cod (100 at each of 10 positions), six of the sampling positions being in the region of the Murman coast.

A log of all samples would be maintained on board "Cirolana" and a photocopy given to the Murmansk laboratory at the end of the sampling programme.

Some results of protein analysis would be expected after at least 15 weeks work at Lowestoft. The genotypes and morphometrics would be analysed separately and collectively. The results would be searched for any genetic evidence from sub-populations suggesting contemporary isolates or races.

Controls

The log of typed fish would be set out against the log of morphometrics for the same. Otolith pairs for all typed cod could be split between the different laboratories.

Protein type controls are held at Lowestoft. The genotypic data will then conform with the published literature on cod genotypes.

Any other interested scientists wishing to join in testing for cod protein variants as gene markers, should request material from the naturalist in charge of the proposed cruise.

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