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Exploration of the Sea

C.M.1972/F:3  
Demersal Fish (Northern) Committee

REPORT OF THE 10th MEETING OF THE NORTH-EAST ARCTIC FISHERIES

WORKING GROUP

Charlottenlund, 8 - 11 February 1972

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General Secretary,  
ICES  
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Report of the North-East Arctic Fisheries Working Group, February 1972

1. Participation

Mr D J Garrod, Chairman	U.K.
Mr A Hylén	Norway
Mr B W Jones	U.K.
Dr V P Ponomarenko	U.S.S.R.
Dr A Schumacher	German Fed. Republic
Dr A I Treschev	U.S.S.R.
Mr J Møller Christensen	ICES.

The Group met to review the state of the Arctic-Norwegian cod and haddock resources and to prepare estimates of catches in 1972 and 1973 (C.Res.1971/2:17).

2. Status of the Fisheries

(i) Cod (Tables 1-4)

The cod fishery changed considerably in 1971. The very strong 1963 and 1964 year classes provided the best catches on the Norway Coast for many years (330 000 t), but the Barents Sea/Bear Island fishery was relatively poor (287 000 t); owing to the series of weak year classes 1965-68 as 3-6 year olds which normally provide a large proportion of the catch. The Norway Coast fishery increased in importance from 27% of the total 876 000 t in 1970 to 54% of the 617 000 t in 1971. Fishing effort on cod in the Barents Sea/Bear Island fishery appears to have been considerably reduced (by approximately one third) but at the Norway Coast it remained much the same as in 1970. The change in relative importance of the different fisheries, though expected, has also changed the overall pattern of exploitation of the different age groups, and although the catch by numbers followed closely the prediction made at the last meeting for the appropriate level of fishing mortality, the catch weight was higher than expected.

This underestimate of the catch weight, despite accurate estimates of the catch number followed from the use in the assessment of an average live weight per age group based on that of cod caught in the Barents Sea. In fact, for the increased proportion being caught on the Norway Coast the live weight of the corresponding age groups and especially of the mature fish was higher.

(ii) Haddock (Tables 5-7)

Provisional estimates of haddock landed in 1971 at 113 000 t were also higher than expected. For this resource the predicted catch of fully recruited age groups was accurate, but landings from the newly recruited 4 year olds of the 1967 year class were unexpectedly high. The greater part of the catch of this age group was taken by U.S.S.R. fishing in the Barents Sea; this is partly because the 1967 year class is more abundant than expected, and also because the catch was generated by the increased concentration of fishing on this age group. Overall the fishing effort deployed on haddock in 1971 is thought not to have changed much since 1970.

3. Fishing Mortality (Tables 8-10)

(i) Cod

This year, for the first time, provisional data were available to the Group for the age composition of the catch in the most recent year, in this case 1971, for all the main participating countries: U.S.S.R., Norway, U.K., and German Federal Republic.

Though no precise technique yet exists to define fishing mortality in the most recent year, a number of approximate methods have been developed which, when used to construct a virtual population analysis (VPA), broadly confirm estimates of fishing mortality used in previous assessments. For cod these methods indicate that in 1971 the fishing mortality on fully recruited age groups fell from a level of 1.00 in 1970 to a level close to that which would in the long term give the maximum sustainable yield per recruit i.e.  $F = 0.5$ . However, the level of fishing mortality on partially recruited age groups remains uncertain.

(ii) Haddock

The stock of fully recruited age groups of haddock is now so small that the commercial fishing statistics no longer provide a reliable guide to mortality in the most recent years. The changes in abundance of a year class between years is small in absolute terms and cannot be measured accurately by the sampling methods in use. As a result the proportional changes in abundance do not provide a good measure of mortality. For the same reason, if substantially different levels of fishing mortality are applied to the stock of older age groups in preparing catch estimates, the differences have little effect on the estimated tons landed. In fact the future yield of haddock will be mainly determined by the abundance of the newly recruited age groups and for these the data are not reliable.

4. Growth (Table 11)

Estimates of the mean weight at age of cod have been revised upward to take account of the higher average weight of 5 years and older cod caught off the Norway Coast. It is expected that this procedure will have to be reversed when the focus of the fishery reverts to the Barents Sea/Bear Island areas. The mean weight at age of haddock has not been changed.

5. Recruitment (Table 12)

Estimates of abundance of year classes just entering the commercial fishery confirm earlier estimates based upon pre-recruit surveys. For cod the year classes 1965-68 are all very weak indeed, and that of 1969 is below average. However, the 1970 year class is very strong and that of 1971 at least average. The 1970 year class will begin to enter commercial catches in 1973.

For haddock the 1967 year class appears to be stronger than expected and the 1969 year class is confirmed as being very abundant.

These revisions make no significant difference to previous estimates of forthcoming recruitment.

6. Estimates of Future Catches (Table 13)

Estimates of catches of cod in 1972 and 1973 have been prepared on the assumption that fishing mortality continues at the reduced level of 1971 ( $F = 0.5$  on fully recruited age groups). In order to illustrate the relative importance of the different fishing areas the expected catches have been divided between the Barents Sea/Bear Island and the Norway Coast fishery on the basis of the ratios of catches of the different age groups between the regions in 1971. These estimates of catches in Division II<sup>a</sup> are not precise. The quantity taken depends on both the availability of non-spawning cod in the northern part of the area, and upon the availability of spawning cod further south. Neither factor can be predicted but the estimates given are thought to represent a realistic minimum. These estimates also represent the catch that would be taken if the fishing mortality were regulated to the level giving the long-term ~~maximum~~ sustainable yield per recruit.

By the end of 1972 the stock of fully recruited age groups will have become small, and the Group considers that although this could be partly offset by regulating fishing mortality to a level below  $F = 0.5$ , a more significant improvement in the stock can be achieved by regulation to prevent an increase of the fishing mortality on the 1970 year class when it enters the fishery.

The Group also considered calculation of the yield which would ensure the stock at the end of 1972 or 1973 remained at the level present at the beginning of each year (replacement yield). However, because the newly recruiting year class will provide an enormous proportion of the available stock, the Group concluded that such a figure would be meaningless; the stock is certain to increase again in 1973/74 at any realistic level of fishing mortality.

Estimates of catches of haddock have been prepared on the same assumption as for cod, that fishing mortality remains at its 1971 level in 1972 and 1973, but to overcome the uncertainty as to what this level is, the Group has only been able to take a mid-point  $F = 0.6$  of probable limiting values  $F = 0.4$  or  $F = 0.8$  on fully recruited age groups. For this resource the expected catches have also been calculated if fishing mortality were reduced to the level giving the maximum sustained yield per recruit ( $F = 0.3$ ).

The estimates of future catches are summarised in Table 13.

7. Comment on the State of the Cod and Haddock Stocks

Although estimates of future catch weight made in earlier years left room for improvement, the estimates of catch numbers and stock size are considered reasonably accurate at the present time. The cod fishery has developed much as expected in the years 1968-71. The strong 1963 and 1964 year classes will continue to contribute a major part of the catch in the Norway Coast fishery in 1972, and, to a lesser extent, in 1973. But the Barents Sea/Bear Island fishery will continue very poor indeed until 1974/75, when the 1970 and 1971 year classes make a substantial contribution to the catches. The following comparison between the estimated average biomass of different age groups 1950-59, and that expected at the beginning of 1973 shows how the resource has become reduced in recent years by the combined effects of heavy fishing and poor recruitment

Age Groups	000 tons			
	3-4	5-7	8+	Total
1950-59	2 411	2 735	1 350	6 496
1973	2 090	90	614	2 794

The spawning stock will become very small indeed by the mid-1970's raising the attendant risks of continuing poor recruitment if the effects of a stock and recruitment relationship become more significant. The Group considers steps need to be taken to reduce this risk, and in this respect it is clear that the immediate and perhaps long-term future of the cod resource depends critically on the level of exploitation of the very rich 1970 year class, especially since it can be expected that the Barents Sea/Bear Island fisheries will become dominant again in 1973/74. One single year class cannot by itself rebuild a stock, but it may sustain the resource until the strength of the 1971 and later year classes becomes evident and the overall risks to the continuity of the stock as a whole of heavily exploiting the 1970 year class can be properly assessed (c.f. the Atlanto-Scandian herring stock). It is important that the 1970 year class should not be too heavily exploited as soon as it reaches fishable size.

We note too that of the estimated yield of 380 000 t in 1973, 80 000 t is expected to be taken from this 1970 year class if, in the absence of abundant older age groups, fishing concentrates in areas where it is most numerous. The catch of the 1970 year class as 4 year olds in 1974 will be higher. If the capture of this year class can be postponed the yield from it over its life span could be increased, with the other potential benefits to the longer term strength of the stock which have been referred to. If the capture of 3 year olds in 1973 could be prevented this would decrease the yield by 80 000 t in that year and it would increase the expected number of 4 year olds by some 150 million fish representing a potential yield of 170 000 t (equivalent to that of the total recruitment of 4 year olds in the 1965-69 year classes). This could be achieved by regulation of the age at first capture but, in the absence of overall regulation of fishing mortality the year class would still be vulnerable to heavy exploitation when the fish do become liable to capture and this might nullify potential benefits that had been achieved. If it is considered that protection of the 1970 year class and of the stock as a whole could best be ensured by regulation of the allowable catch, then so far as possible this should be allocated to regions of the fishery according to the relative abundance of different parts of the stock.

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

Year	Sub-area I	Division IIb	Division IIa	Total
1960	380 962	94 599	155 116	630 677
1961	409 694	222 451	149 122	781 267
1962	548 621	222 611	138 396	909 628
1963	547 469	113 707	116 924	778 100
1964	202 566	126 029	108 803	437 398
1965	241 489	103 407	99 855	444 751
1966	292 244	56 568	134 664	483 476
1967	322 781	121 050	128 729	572 560
1968	642 449	268 908	162 472	1 073 829
1969	670 158	266 117	254 985	1 191 260
1970	551 015	85 423	240 150	876 588
1971 <sup>x)</sup>	240 385	46 383	330 250	617 018

<sup>x)</sup> Provisional figures

Table 2. COD. Nominal catch (in metric tons) by countries  
(Sub-area I and Divisions IIa and IIb combined).

Year	England	Germany	Norway	USSR	Others	Total	Coastal Cod Norway
1960	141 175	9 472	231 997	213 400	34 633	630 677	43 092
1961	157 909	8 129	263 377	325 780	21 072	781 267	32 359
1962	174 914	6 503	225 615	476 760	25 836	909 628	29 596
1963	129 779	4 223	205 056	417 964	21 078	778 100	40 405
1964	94 549	3 202	149 878	180 550	9 219	437 398	46 100
1965	89 874	3 670	197 085	152 780	1 342	444 751	23 786
1966	103 012	4 284	203 792	169 300	3 088	483 476	27 800
1967	87 008	3 632	218 910	262 340	670	572 560	33 102
1968	140 054	1 073	255 611	676 758	333	1 073 829	47 212
1969	231 066	5 434	305 241	612 215	37 287	1 191 260	52 416 <sup>x)</sup>
1970	179 562	9 451	377 606	276 632	33 337	876 588	49 000 <sup>x)</sup>
1971 <sup>x)</sup>	78 160	9 726	407 619	100 000	21 513	617 018	

<sup>x)</sup> Provisional figures

Note: Estimates of coastal cod landed by Norway in 1971 are not complete.

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 Inter-national Effort	National Effort		Total Inter-national Effort	National Effort		Total Inter-national Effort			
	UK <sup>1)</sup>	USSR <sup>2)</sup>	UK units	USSR units	UK	USSR	UK	Norway <sup>3)</sup>	UK units	Norwegian units		
1960	95	43	512	91	42	11	97	34	39	10	232	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 <sup>x)</sup>	74		403		4		65		50	5	533	14

1) Hours fishing x average tonnage x 10<sup>-6</sup> = millions of ton-hours

2) Hours fishing (catch/catch per hour fishing) x 10<sup>-4</sup>

3) Number of men fishing at Lofoten x 10<sup>-3</sup>

x) Provisional figures

Table 4. COD. Catch per unit effort (metric tons, round fresh).

Year	Sub-area I		Division IIb		Division IIa	
	UK <sup>1)</sup>	USSR <sup>2)</sup>	UK	USSR	UK	Norway <sup>3)</sup>
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	0.060		0.071		0.062	10.6

1) UK 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.

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 <sup>x)</sup>	90 828	329	21 627	112 784

x) Provisional figures.

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

Year	England	Germany	Norway	USSR	Others	Total	Coastal Haddock Norway
1960	45 469	5 597	47 263	57 025	100	155 454	5 943
1961	39 625	6 304	60 862	85 345	1 098	193 234	4 031
1962	37 486	2 895	54 567	91 940	1 000	187 888	3 293
1963	19 809	2 554	59 955	63 526	900	146 744	4 285
1964	14 653	1 482	38 695	43 870	200	98 900	6 460
1965	14 314	1 568	60 447	41 750	-	118 079	6 217
1966	27 723	2 098	82 090	48 710	-	160 621	5 223
1967	24 158	1 705	51 954	57 346	1 323	136 486	3 181
1968	40 102	1 867	64 076	75 654	27	181 726	2 766
1969	37 234	1 490	67 549	24 211	27	130 509	2 120
1970	20 344	2 119	36 716	26 802	620	86 601	-
1971 <sup>x)</sup>	15 605	896	46 234	50 000	49	112 784	-

x) Provisional figures.



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

Year	Catch per effort (UK) Kilos/100 ton-hours			Estimated total international effort in UK units  Total catch in tons x 10 <sup>-6</sup> tons/100 ton-hours Sub-area I
	Sub-area I	Divisions		
		Iia	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	14.1

Table 8. Estimates of F in 1971.

Age	Pope	Jones		Garrod	Average	Values used in computation
		F <sub>t</sub> =0.5	F <sub>t</sub> =0.4			
2	< .01					
3	.04	.12	.10	.20	.12	15
4	.16	.46	.37	.51	.38	30
5	.28	.68	.53	.34	.46	45
6	.39	.65	.49	.48	.50	50
7	.49	.54	.39	.48	.48	↓
8	.64	.50	.35	.40	.47	
9	.44	.38	.27	.40	.37	
10	.44	.50	.36		.43	
11	.67	.50	.36		.51	

NB. The methods used to estimate F are being developed or are modifications of existing techniques. None have so far been described or subject to scientific scrutiny, but we believe they provide a more objective approach to this critical aspect of the assessment than has previously been possible.

Table 9. Fishing Mortality 1968-1971 Estimated by Virtual Population Analysis.

Age \ Years	COD. (M = 0.3)				HADDOCK. (M = 0.2)			
	1968	1969	1970	1971	1968	1969	1970	1971
2		.01	.03		.01	.01	.01	
3	.04	.06	.22	(.15)	.08	.20	.18	(.08)
4	.21	.39	.41	(.30)	.47	.37	.54	(.24)
5	.37	.57	.95	(.45)	.66	.66	.72	(.60)
6	.43	.53	.79	(.50)	.58	.74	.83	(.60)
7	.37	.75	.64	(.50)	.81	.59	.81	(.60)
8	.48	.91	.86	(.50)	.80	.67	.75	(.60)
9	.75	1.11	1.01	(.50)	.49	.62	.62	(.60)
10	.74	1.06	1.03	(.50)		.46	.63	(.60)
11		1.41	.92	(.50)			.47	
12								

Table 10. Stock Size 1968 - 1971 (Millions of Fish)

Age \ Years	COD. (M = 0.3)				HADDOCK. (M = 0.2)			
	1968	1969	1970	1971	1968	1969	1970	1971
2	65	53	22		11	193	18	
3	122	48	39	16	9	9	157	15
4	1 051	87	34	23	196	7	6	108
5	986	629	44	17	94	100	4	3
6	352	503	265	13	19	40	42	2
7	100	170	219	89	30	9	16	15
8	49	51	59	86	10	11	4	6
9	25	23	15	19	2	4	5	2
10	8	9	6	4		1	2	2
11		3	2	1			+	1
12			+	1				

Table 11. Mean weight at age data for cod and haddock used in the assessments in this Report.

Age	Mean Weight in Kilos	
	Cod	Haddock
3	0.43	0.41
4	0.84	.62
5	2.15	.97
6	2.47	1.59
7	3.80	2.33
8	4.91	2.72
9	6.88	3.56
10	8.87	4.41
11	9.31	5.40
12	9.75	6.70
13	10.69	-
14	12.64	-
15	15.17	-

Table 12A. COD. Arctic Cod. Year class strength. The number per hour fishing for USSR young fish survey is the mean of 2- and 3- year old fish

Year class	USSR Survey, No/hour of fishing			USSR Assessment	O-group Survey	Virtual Population No. of 3-year olds 10 <sup>-6</sup>
	Subarea I	Division IIb	Mean			
1956	12	24	15	-average		914
1957	10	15	11	-average		1 028
1958	10	20	14	+average		1 233
1959	12	13	12	+average		1 034
1960	6	13	10	poor		693
1961	2	2	2	poor		513
1962	6	5	5	poor		1 117
1963	14	84	46	rich		2 111
1964	51	39	45	rich		1 458
1965	<1	<1	<1	very poor	) very low	122
1966	<1	<1	<1	very poor	) abundance	48
1967	1	<1	<1	very poor	below average	39
1968	4	<1	2	very poor	v.low abundance	16
1969(1+2)	3	1	2	very poor	x)	(400)
1970(0)	18	38	35	rich	xx)	(1 700)
1971				average	xxx)	(1 200)

x) Abundance may not be so abundant as the 1963 and 1964 year classes.  
 xx) More abundant than the 1964-1969 year classes.  
 xxx) Above average abundance

Table 12B. HADDOCK. Arctic Haddock. Year class strength. The number per hour fishing for USSR young fish survey is the mean of 2- and 3- year old fish.

Year class	USSR survey No. of fish/hour fishing. Sub-area I	0-group survey	Virtual population No. of 3-year olds $10^{-6}$
1956	23		326
1957	12		241
1958	4		109
1959	25		239
1960	56		270
1961	42		307
1962	3		93
1963	10		223
1964	14		255
1965	< 1	Very low abundance	9
1966	< 1	" " "	10
1967	10	Average abundance	169
1968	8	Very low abundance	18
1969 (1+2)	56	Most abundant recorded in the period 1965-69	(350)
1970 (0+1)	(10)	Probably lower abundance than 1969 but second in strength in the period 1965-70	(275)
1971	?	Less abundant than 1969-70, but more abundant than 1965-68.	(200)

Table 13 Estimates of nominal catches of cod and haddock (000 tons) at selected levels of fishing mortality.

	1971			1972			1973		
	F	Yield		F	Yield		F	Yield	
		Total	IIa		Total	IIa		Total	IIa
COD	0.50 (present)	617	(330)	0.5	425	(200)	0.5	380 300 <sup>+</sup>	(165) (165)
HADDOCK	0.60 (present)	113		0.6	127		0.6	122	
							0.3 (M.S.Y.)	62	
				0.3 (M.S.Y.)	59		0.3 (M.S.Y.)	80	

NB. Estimates of catches of cod in Division IIa represent a minimum based upon the proportion of the total catch of each group caught in that Division in 1971. This proportion depends critically upon the balance of fishing mortality between the various fisheries and on the availability of both non-spawning cod and spawning cod at the Norway Coast. At present it is not possible to give a precise forecast of this proportion.

+ ) Assuming the capture of 3-year old cod of the 1969 year class in 1972 and of the 1970 year class in 1973 is avoided.

M.S.Y: Maximum sustainable yield per recruit.