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STOCK SIZE OF NORTH-EAST ARCTIC COD
ESTIMATED FROM ACOUSTIC SURVEY DATA 1982

by

ARVID HYLEN AND ODD NAKKEN
Institute of Marine Research
Postboks 1870
5011 Bergen, Norway

ABSTRACT

Assessments of the total stock and spawning stock of North East Arctic cod were carried out on the basis of Norwegian survey data and commercial landings. The total stock, i.e. fish which was 3 years old and older at 1 January 1982, was estimated to 580 million specimens; the corresponding spawning stock amounted to approximately 190 million specimens. The estimates for the total stock were in good agreement with those reported by the Working Group on Arctic Fisheries, with exception of the 6 year old fish (the 1976 yearclass) for which the present estimate is much lower than the one reported by the Working Group. The estimated spawning stock size was considerably larger than the Working Group estimate, because of the contributions to this stock component by fish which was less than 8 years old; the 1975 yearclass (7 year old fish) contributed more than 50 per cent.

INTRODUCTION

The Working Group on Arctic Fisheries and ACFM have several times recommended to make use of fishery independent data in

Cod, stock size, acoustics, Barants na

stock assessment. The recommendation was based on the fact that fishery dependent data has during later years been less reliable as compared with earlier years. This is mainly caused by changes in fishery regimes, introduction of quota schemes and changes in fish distribution patterns due to hydrographical variations. In order to meet this recommendation an intensive survey activity on North-East Arctic cod and haddock has been introduced. The present work is an attempt to estimate the total stock and the spawning stock of North East Arctic cod at the beginning of 1982 on the basis of the results from these surveys.

MATERIAL

In the assessment we have used the results from a series of four surveys:

1. The Barents Sea acoustic survey, 26 January- 5 March 1982 (DALEN et al. 1982).
2. The Lofoten/Vesterålen acoustic survey, 29 January-27 February 1982 (GODØ et al. 1982).
3. The Møre acoustic survey, 16 March-7 April 1982 (GODØ et al. 1982).
4. The Svalbard groundfish/trawl survey, September-October 1981 (RANDA and SMEDSTAD 1982).

Details of each survey are given in the reports referred to. In Fig. 1 are indicated the approximate areas covered by the acoustic surveys.

In addition to survey data, preliminary commercial landing statistics, including landings from foreign vessels, for the period from 1 January to the date of the surveys in the respective areas were used. Biological data from Norwegian landings in February as well as from the surveys were also taken into account.

ASSESSMENT OF TOTAL STOCK

The numbers of fish by age at 1 January 1982 were arrived at, by adding together the 1982-commercial catches prior to the acoustic surveys and the results from each of the surveys. The natural mortality between 1 January and the dates of the surveys were not accounted for. Below is given a brief description of each of the components in the assessment.

Commercial catches

Up to the 21 February the total landings of cod north of the Lofoten islands were about 86 000 tons (Table 1A). South of Lofoten the landings were about 18 000 tons up to the end of March. These quantities represented in total about 27 million fish (Table 1A). In landings from the most northern areas (West and East-Finmark) the 1975 and 1976 year classes were represented by about the same number. Further south the importance of the 1976 year class was reduced. In total, the landings were predominated by the 1975 year class. Very small quantities were landed from the Svalbard region between the survey which ended the 7 October 1981 and 1 January 1982. These landings were therefore neglected.

The Barents Sea region

The estimates arrived at during the different surveys, are given in Table 1B. The Barents Sea component was estimated to 408 million fish (DALEN et al. 1982), and the 1975- and 1976-year classes were represented by 74 and 73 million fish respectively.

The Vesterålen region

An area (Vesterålen) between the area covered by the Barents Sea survey and the Lofoten survey was not worked later than the end of January (GODØ et al. 1982). At this time cod was recorded in 42 rectangles with an average number of 0,6 million fish per rectangle. Assuming the same abundance and geographical

distribution on the 20 February as in late January the stock in the area was estimated to 25 million fish. In lack of representative age distributions from research vessels, an age distribution from long line landings from the region in February was accepted to be appropriate for the stock in the middle of February (Table 1B). This age distribution was predominated by the 1975 year class.

The Lofoten region

The stock in the Vestfjord and outside the Lofoten islands was estimated to about 80 million fish in the period 17-20 February (GODØ et al. 1982). Only a limited number of length measurements and age readings existed from research vessels catches. More data was available from commercial landings by gillnet, long line, hand line and Danish seine. However, ROLLEFSEN (1956) found that purse seine catches would give more representative age distributions of the stock than the gears mentioned. Age-distributions from purse seine catches were available from March, and they were assumed to be representative for the stock at the appropriate time. These data showed a clear predominance of the 1975 year class. The 1976 year class was less abundant than in midwater trawl catches taken by the research vessel (GODØ et al. 1982).

The Helgeland region

The Helgeland region, further south, was not covered by surveys. This area has usually a low density of fish, indicated by small landings. In the first quarter of 1982, a total catch of 3000 tons was recorded which was only 1/5 of the catches taken in the same period in the most southern survey area, Møre. The stock in the Helgeland region was therefore assumed to be 1/5 of the estimated stock at Møre or equal to 2,3 million fish. The age distribution was assumed to be the same as at Møre (Table 1B).

The Møre region

The stock off Møre was estimated to about 11 million fish at the end of March (GODØ et al. 1982), and the 1975 year class was predominant in the stock (Table 1B).

The Svalbard region

In February the mature part of the Svalbard stock component would be along the Norwegian coast and accounted for by the surveys in February-March, but the immature fish will stay in the region. This component was accounted for by data collected during the groundfish survey in September-October 1981 (RANDA and SMEDSTAD 1982). By the swept area method the stock was estimated to about 40 million fish which was reduced by natural mortality ($M=0.20$) to 36 million fish at 1 January 1982. When excluding the mature fish by applying a distribution for the rate of maturation similar to the rest of the stock (see later), an estimate of 28 million immature fish at the beginning of 1982 was arrived at. This component was predominated by the 1979 year class (Table 1B) which was recorded as one of the most abundant year classes in the region since the 1970 year class (RANDA, 1982 and personal communication).

Total stock estimate

The sum of survey estimates and landings made up the total stock size in the beginning of 1982 (Table 1B). It should be observed that no correction was made for the natural mortality in the period prior to the surveys. The stock size of 3 year old and older fish was assessed to about 580 million fish which compares to 630 million arrived at by the Arctic Fisheries Working Group (ANON, 1982). Good agreement was found for all age groups except for the 6 year olds, the 1976 year class. The estimate of this year class was only 57% of the Working group estimate, which was based on the acoustic survey in 1981. However, the survey estimate for 1981 was not in conformity with the estimates for this year class in earlier surveys (DALEN et al. 1982). In 1981 some difficulties in discriminat-

ing between 5 and 6 year olds might have occurred and the 1976 year class might thus have been overestimated in the 1981 survey. Further studies of this problem are needed.

ASSESSMENT OF SPAWNING STOCK

The spawning stock was estimated on the basis of the same data as the total stock. Biological samples from the areas Vesterålen-Møre showed that nearly all fish both in the commercial landings and in the research vessel catches was mature fish and hence the total stock within these areas was assumed to be spawners (Table 1 and 2). The next step was to exclude the immature fish from the landings in Finnmark and from the stock estimate of the Barents Sea and Svalbard components. The stock size by length for the Barents Sea component was splitted in mature's and immature's for each of the 4 areas used in assessing the stock size (DALEN et al. 1982). The age composition of mature fish was arrived at by applying the respective age/length keys. Total age compositions for landings in West- and East-Finnmark were estimated by applying the respective area maturity distributions found in the survey.

The mature fish in the Svalbard component was on migration to the spawning grounds during the period of the acoustic surveys and thus included in the acoustic data. The total spawning stock at the beginning of 1982 was found by summing the landings and the stock estimates of the different components (Table 2); resulting in a spawning stock level of 188 million fish, predominated by the 1975 year class.

DISCUSSION

The stock in the Svalbard region was assessed by the swept area method (RANDA and SMEDSTAD, 1982), assuming the fishing width of the trawl to be 25 m, which is half the average measured distance between the otter boards. For estimating the shrimp stock in the Barents Sea, the fishing width of the trawl was taken to be about 15 m (TEIGSMARK and ØYNES 1981). The effective width of the trawl may thus be discussed, but at the present

low stock level in the Svalbard region the total stock size would not be very sensitive to changes in this parameter (Table 1).

The investigations in 1982 did not cover the Vesterålen area satisfactorily in time. This area was surveyed in late January, at a time when the cod was passing through on the way to spawning areas further south. On the other hand mature fish is continuously passing this area from the north at least up to the end of February. These fishes are the basis for the Norwegian fishery in the area in February and March, a fishery which generally takes place on the same localities throughout the whole season. The assumption made that the fish was distributed in the same manner in February as in late January might thus hold good, but it is the most uncertain parameter in the assessment of the stock.

Less information on fish distributions and abundance was available for the Helgeland region. No surveys were carried out and very few biological data from commercial landings were collected. We have used fishery statistics to estimate the stock component and the figure arrived at seems low. A great number of fishermen are living in that part of Norway, and with a sufficient high fish density in that region they would have preferred to go fishing there. Instead most of them go fishing in Lofoten. Of course, the estimated stock component, based on the catch levels in the two regions (Helgeland and Møre) might be doubted, but on the other hand errors in the estimate of stock level in the Helgeland region would probably not be critical for the assessments of the total stock and the spawning stock.

Based on a representative age distribution of the spawning stock a maturity distribution may be estimated from the stock size by age given in the Arctic Fisheries Working Group Report (ANON, 1982). ROLLEFSEN (1956) indicated that age distributions from purse seine catches in Lofoten were representative for the stock in the area. However, due to different geographical distribution of fish size and segregation with time (SÆTERS DAL

1958), no age distribution from a particular gear is representative for the total spawning stock. In table 3 are given maturity distributions from several authors. It is seen that the maturity rates estimated from the results in the present paper are much higher than those given by previous authors. For example, about 2/3 of the 7 year old fish was mature in the beginning of 1982, compared with an average of 13% for the period 1966/67-1977/78 given by PONOMARENKO et al. (1980). Thus, the question of representative maturity distributions for North-East Arctic cod seem to need further investigations.

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Table 1. North-East Arctic Cod. Stock size by numbers at the beginning of 1982.
 A. Number of cod landed by age in the period 1 January - 21 February 1982 (thousands).

Area	Age-groups													Total Landings		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	(No)	(tons)
East-Finnmark			55	297	665	1519	1437	162	28			4			4167	11919
West-Finnmark			18	336	797	3387	3591	537	122	25					8813	23731
Vesterålen				142	201	902	2411	918	415	131	48	40	4	1	5213	18543
Lofoten				5	21	615	2264	387	225	59	24	13	8	4	3625	13406
Helgeland ^{x)}			2	18	24	46	542	130	22	14	4	6			808	3000
Møre ^{x)}			10	90	120	230	2710	650	110	70	20	30			4040	15000
Sub-total			85	888	1828	6699	12955	2784	922	299	96	93	12	5	26666	85599

B. Stock size by age estimated from survey data (million).

Svalbard region			16.4	5.3	1.5	3.2	1.8	0.1	0.1							28.4
Barents Sea	1	4	71	86	93	73	74	5	1							408
Vesterålen				1.4	1.8	6.2	11.2	2.6	1.5	0.1	0.2					25.0
Lofoten				+	1	7	44	9	8	5	3	2	1			80
Helgeland				0.1	0.1	0.1	1.5	0.4	0.1	+	+					2.3
Møre			+	0.2	0.3	0.6	7.4	1.8	0.3	0.2	0.1	0.1				11.0
Sub-total	1	4	87.4	93.0	97.7	90.1	139.9	18.9	11.0	5.3	3.3	2.1	1			554.7
Total stock size (mill.)	1	4	87	94	99	97	153	22	12	6	3	2	1			581
Stock size (mill.) (ANON 1982)			(100)	76	90	168	156	20	10	4	1	2	+			627

x) Landings in the period 1 January - 31 March 1982.

Table 2. North-East Arctic Cod. Spawning stock size by numbers at the beginning of 1982.
 A. Number of mature cod landed by age in the period 1 January - 21 February 1982 (thousands).

Area	Age-groups														Total (No)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
East-Finnmark				3	47	381	593	81	12			4			1121
West-Finnmark				47	121	1013	1411	286	73	15					2966
Vesterålen				142	201	902	2411	918	415	131	48	40	4	1	5213
Lofoten				5	21	615	2264	387	225	59	23	13	8	4	3625
Helgeland ^{x)}			2	18	24	46	542	130	22	14	4	6			
Møre ^{x)}			10	90	120	230	2710	650	110	70	20	30			4040
Sub-total			12	305	534	3187	9931	2452	857	289	96	93	12	5	17773

B. Mature stock size by age estimated from survey data (million).

Barents Sea				3	6	16	25	2							52
Vesterålen				1.4	1.8	6.2	11.2	2.6	1.5	0.1	0.2				25.0
Lofoten				+	1	7	44	9	8	5	3	2	1		80
Helgeland				0.1	0.1	0.1	1.5	0.4	0.1	+	+	+			80
Møre			+	0.2	0.3	0.6	7.4	1.8	0.3	0.2	0.1	0.1			11.0
Sub-total			+	4.7	9.2	29.9	89.1	15.8	9.9	5.3	3.3	2.1	1.1		170.3
Spawning stock size (million)			+	5	10	33	99	18	11	6	3	2	1	+	188

x) Landings in the period 1 January - 31 March 1982.

Table 3. North-East Arctic Cod. Percentage mature fish by age. (percent)

Age	Garrod 1967	Ponomarenko 1968	Hyllen and Ponomarenko Present	Dragsund et al. 1980	Data
3				.2	
4				.5	
5				2.4	
6	+	+		5.3	
7	3	7		13.2	65
8	10	26		30.8	82
9	24	46		57.4	92
10	42	55		74.2	100
11	61	68		84.6	100
12	79	79		85.0	100
13	92	87		90.5	100
14	99	92		100	100
15	99	97		100	100
16	100	100		100	100

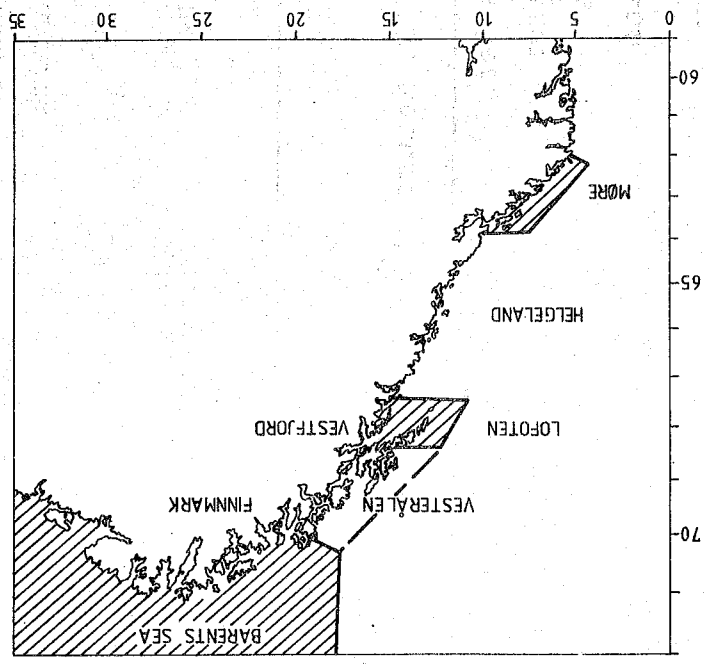


Fig. 1. The Norwegian coast. Areas where estimates of abundance were obtained from acoustic surveys during winter 1982 are indicated.