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ACOUSTIC ESTIMATES OF SPAWNING COD  
OFF LOFOTEN IN 1986

by

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ABSTRACT

The annual survey on the spawning stock of North-east Arctic cod were carried out in the Lofoten area in March 1986. This survey was undertaken to estimate the size and age structure of the spawning cod on the main spawning grounds. The area used in the estimation this year is the same as in the Lofoten survey in 1985, including a larger part of the area north of Lofoten compared to earlier years. However, the extent of covering in time is less this year than in 1985. The estimated number of spawning cod in the same area as in 1985 was found to be about 24 million specimens. This is a reduction of 35 percent compared to the result in 1985. No estimate is given for the Møre area this year. This is because that it is clear that the abundance of cod at Møre is very small and not measurable.

INTRODUCTION

Since 1982 the areas off Lofoten and Møre have been surveyed in the spawning period of North-east Arctic cod to get an estimate of the actual number of cod present at the major spawning grounds. Additional areas have been included in the investigations some years, e.g.

Helgeland. A description of the survey design have been given by Godø et al. (1982, 1983, 1984, 1985) together with the results of the respective years. The results of these investigations are used to assess the total spawning stock of the North-east Arctic cod (Hyllen and Nakken, 1982, 1983, 1984, 1985). In this paper the results from the survey in the Lofoten area in 1986 are reported and discussed.

No survey was undertaken in the Møre area this year. This is because the reported amount of cod beeing fished in the area in the winter prior to the survey was very small and thus indicating a density too low to performe an acoustic survey.

#### MATERIAL AND METHODS

The area investigated by the survey is shown in Fig. 1 together with the subarea division.

The survey design and area covering were mainly as in previous years. The area north of Lofoten (Sub area 5, Vesterålen - Troms) was also covered this year. The Lofoten area was covered from 3. March to 20. March. This is a shorter period than previous years. In Table 1 is given the time table of the coverings of the various sub areas and the vessels used in the different coverings.

The vessel "Michael Sars" used in the Lofoten survey was equipped with 38kHz echosounders of type Simrad EK-S connected to a digital echointegration system developed at the Institute of Marine research, Bergen (Blindheim et al. 1982). The acoustic systems were calibrated according to the method described by Foote et al. (1983) and the survey design and data sampling were as described by Godø et al. (1982, 1983).

The target strength (TS) of cod used to convert echo density to number of fish per area was set to  $TS = 10 \log (\sigma/4\pi) = 21.8 \log L - 74.9$  where L is the length of the fish and  $\sigma$  is the back scattering surface of a single fish of that length.

## RESULTS AND DISCUSSION

In Figure 2 are given the course lines from the survey.

In Table 1 is shown the area covering. In this table is also indicated whether or not the covering of the area is assumed to be sufficient to give a proper estimate of cod abundance. The first part of the survey covered all the subareas. The second part of the survey did not cover subarea 5 and only parts of subarea 4 in which cod had been found in the first covering was covered in the second one.

In Figures 3 and 4 is shown the distribution of acoustic abundance of cod. The length distributions obtained by trawling are given in Table 2. The percentage of mature fishes is given in sub area 5 and is used to extract the mature fishes from the estimated total number in this area. In the other sub areas all the cod were found to be mature. In Table 3 is given the corresponding estimated number of cod in each area.

The first covering is assumed to give a good estimate of the cod present in the area. All the areas were covered to their borders and the trawlstations taken seemed to give a good picture of the length distributions and species composition. In area 1 no trawlstations were available, but length distribution from danish-seine-catches were used. This is probably not causing any large error since the amount of fish found in this area is very small.

The second covering is insufficient as to the area covered. Subarea 5 was not covered and subarea 4 was covered only where cod was observed in some amounts in the first covering.

The main result from this survey is the observation that there were practically no immigration of cod into the Vestfjorden-area (subarea 1 and 2). All the mature cod entering the survey-area seemed to stop at the Moskenesgrunnen (subarea 4b) where more fish was observed this year than in 1985 at the same time. The mature cod found in Vestfjorden was most probably cod of coastal type for the most of it.

Based on a judgement of the two estimates and the age readings available, the estimate of the first covering is given as the estimate of the spawning cod present in the area during the spawning period. This estimate is given in Table 4. The age readings are obtained from the same trawl stations that gave the length distributions. In addition age readings from one danish-seine and one purse-seine catch in the Vestfjorden are used.

As in previous years (Hysten and Nakken 1982, 1984, 1984) the estimates of spawning cod made from these surveys are not the total spawning stock of North-east Arctic cod. This is because the cod spawns over a larger area than these surveys cover.

#### FINAL REMARKS

Based on the surveys treated in this paper a final estimate of the spawning stock will be performed as a part of the work using the results from all the surveys on North-east Arctic cod and haddock to assess the total stock of these species.

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Table 1. Area covering during the cruise in Lofoten 1986.

+ is sufficiently covered, - is insufficiently covered,  
"blank" is not covered.

Ship	Period	Subarea				
		1	2	3	4	5
Michael Sars	3 -15 March	+	+	+	+	+
Michael Sars	16 -20 March	+	+	+	-	

Table 2. Length distributions used in acoustic estimation. Refere to fig. 1 to find the areas in wich the distributions are used. Percentage maturity is given in area 5.

Length cm	40 -45	45 -50	50 -55	55 -60	60 -65	65 -70	70 -75	75 -80	80 -85	85 -90	90 >	Number measured
Areas												
1,2a		0.4	0.0	2.0	4.7	14.4	13.6	9.7	10.1	14.8	30.4	257
2b,3,4a			11.9	24.1	17.6	9.0	1.8	14.1	12.7	3.5	5.5	33
4b			0.3	2.4	7.8	12.6	15.2	15.2	15.2	13.4	17.9	632
5a		15.2	15.2	24.2	24.2	6.1	6.1	3.0	3.0		3.0	33
% mat		0.0	19.7	37.6	75.2	100	100	100	100		100	
5b	1.1	3.4	15.7	28.1	30.3	14.6	2.2	1.1	1.1		1.1	89
% mat	0.0	30.8	33.3	11.1	76.9	100	100	100	100		100	

Table 3. Estimated number of cod in the different areas in the two coverings. Numbers are in million specimens.

Period	Subarea					Total
	1	2	3	4	5	
March 3 - 15	2.345	2.103	.276	14.069	5.277	24.070
March 16 - 20	3.329	1.273	.374	8.763		13.739

Table 4. Estimated number at age for the various areas. Numbers are in million specimens.

Area	Age								Total
	3	4	5	6	7	8	9	10+	
1	.003	.017	.389	.564	.646	.236	.157	.333	2.345
2	.001	.156	.550	.380	.559	.192	.086	.179	2.103
3		.044	.105	.029	.070	.022	.002	.004	0.276
4		.791	2.661	2.313	4.973	2.463	.340	.528	14.069
5		.505	3.511	.431	.550	.205	.016	.059	5.277
Age total	.004	1.513	7.216	3.717	6.798	3.118	0.601	1.103	24.070

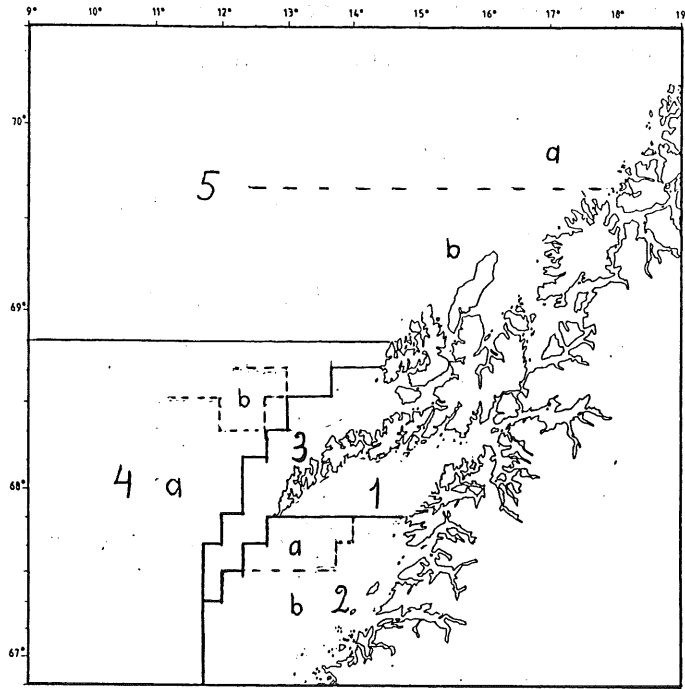


Figure 1. The investigated area with subareas. The subareas are divided into smaller areas indicating where the various lengthdistributions are used.

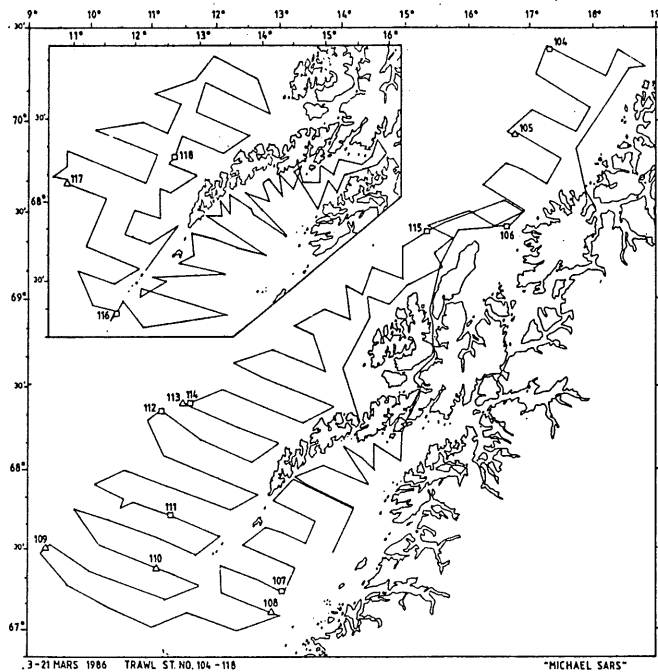


Figure 2. Course lines from the cruise with R/V Michael Sars 3. to 20. March 1985 in the Lofoten area. Trawlstations are given, triangles are pelagic and squares are bottom trawl.



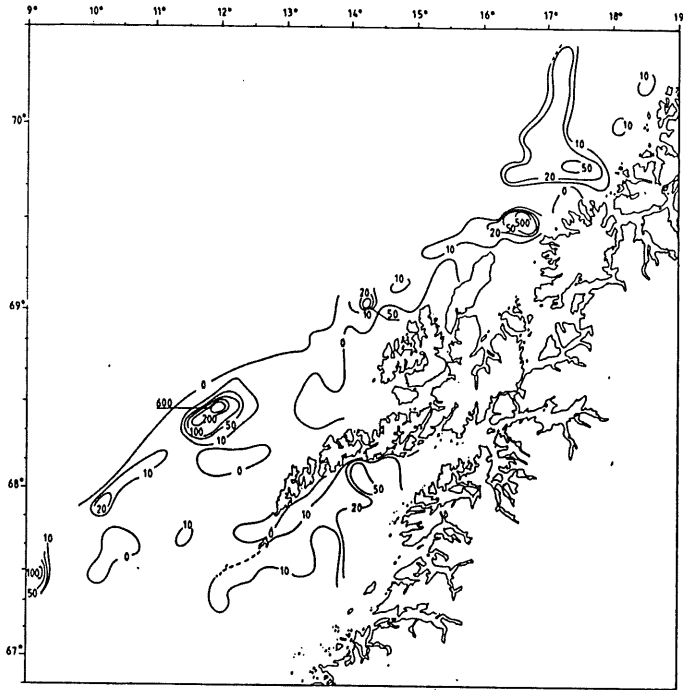


Figure 3. Distribution of cod in the Lofoten area measured with acoustic methods by R/V M.Sars 3.- 15. March 1986. Units are back scattering surface per square nautical mile ( $\text{m}^2 / \text{nm}^2$ ).

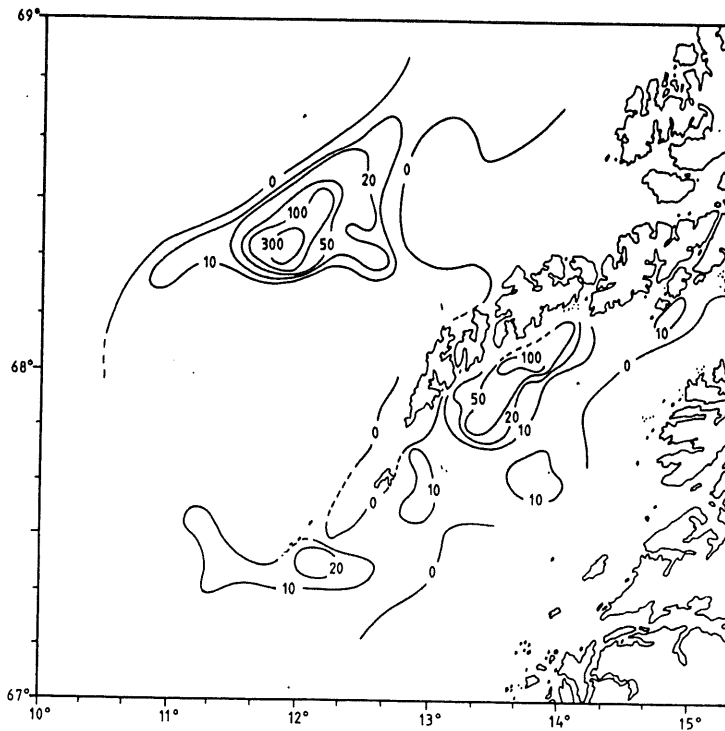


Figure 4. Distribution of cod in the Lofoten area measured with acoustic methods by R/V M.Sars 16. 20. March 1986. Units are back scattering surface per square nautical mile ( $\text{m}^2 / \text{nm}^2$ ).

