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ACOUSTIC ESTIMATES OF THE BARENTS SEA CAPELIN STOCK 1971 - 1976

by

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ABSTRACT

NAKKEN, O. and DOMMASNES, A. 1977. Acoustic estimates of the Barents Sea capelin stock 1971 - 1976. Coun. Meet. Int. Coun. Explor. Sea 1977 (H:35): 1-6, 3 Figs. 2 tabs. [Mimeo]. Acoustic estimates of the size and yearclass composition of the Barents Sea capelin stock are given for the period 1971 - 1976. The surveys were carried out in June and in August - October. No estimates were obtained for o-group capelin. 1 year old capelin are grossly underestimated in June. To a lesser extent this is also the case for older capelin. The estimates from the autumn surveys seem to be more reliable, and with respect to the spawning stock they correspond reasonably well with the estimates from tagging experiments and the trend of the catches.

INTRODUCTION

Acoustic methods are now widely used to obtain information on stock size of both exploited and unexploited fish populations. At the Institute of Marine Research such methods are being applied regularly to provide estimates of stock size of Barents sea capelin (DRAGESUND et al. 1973, NAKKEN and DOMMASNES 1975).

The annual catch of Barents sea capelin has been increasing during the last years and was in 1976 approximately 2,4 million metric tonnes, out of which 1,9 million metric tonnes were landed by the Norwegian purse seine fleet. Due to the increasing catch, great efforts have been made to establish a system for monitoring the stock size; an important part of this monitoring system being regular acoustic surveys (DOMMASNES 1977a). The present paper deals with the results achieved from such surveys during the period 1971 - 1976.

MATERIAL AND METHOD

The material was collected by research vessels. In 1971 and 1972 the cruises were carried out in late summer only, but each year since 1973 cruises have been undertaken both in June and in September - October. A typical survey grid is shown in Fig. 1.

The technique applied was described by NAKKEN and DOMMASNES (1975) and can be summarized as follows:

Integrated echo intensities are recorded continuously from the entire depth column along the ship's track. The echosounder paper record is kept under constant watch. When the recording changes its appearance, trawling is carried out for the purpose of species- and/or size identification. In addition trawling is also undertaken at regular intervals in order to have adequate biological sampling of the stock. The observations of integrated echo intensity are converted to fish densities using the equation

$$\rho_i = \frac{k_i}{\sum_{i=1}^{i=n} \frac{k_i}{C_i}} \cdot M$$

where:

ρ_i is the density in terms of numbers per unit area of the i-th category (species and/or size of fish).

M is the integrated echo intensity from the entire depth column, accumulated over each nautical mile.

k_i is the contribution of the i-th category to the total trawl catch. (The number of fish of the i-th category divided by the total number of fish in the catch).

$\frac{1}{C_i}$ is the contribution to the integrated echo intensity from a density of 1 fish of the i-th category per unit area.

n is the number of categories

The survey area is divided into suitable subareas. Mean values of M, k_i and C_i are established and ρ_i calculated for each subarea. Finally the total number of specimens included in each category is found by integrating ρ_i over the survey area.

For the period 1971 - 1973 each yearclass was taken as one category. After 1973, the computations have been carried out using each half cm length group as one category.

In NAKKEN and DOMMASNES (1975) the age of the specimens was taken as the number of otolith zones minus one. In the present paper the age is set equal to the total number of zones in the otoliths in accordance with HAMRE (1977).

RESULTS AND DISCUSSION

An example of the distribution of integrated echo intensities is presented in Fig. 2. The results of the computations are given in Table 1 and Fig. 3. Table 1 presents the total number of fish and the biomass in each yearclass for each of the surveys. The maturing portions of the stock are given in Table 2 as estimates of the size of the spawning stock next winter.

o-group capelin is not included in Table 1. The main reason for this is in the sampling: It is a necessary assumption for use of the formulas given by NAKKEN and DOMMASNES (1975) that the trawl samples give the true density ratios between the different categories of fish. The assumption probably holds reasonably well for fish down to approximately 10 cm. However, o-group capelin in August - September has an average length of approximately 5 cm (see for example ANON. 1976). Although it is somewhat larger during the surveys in September - October, the o-group is mostly filtered through the meshes and is grossly underrepresented in the trawl-catches. In addition, the behaviour and vertical distribution of o-group capelin make the conditions for detection with echosounder unfavourable (BELTESTAD, NAKKEN and SMEDSTAD, 1977) and it is therefore underrepresented also in the integrated echo intensities. Lastly, the distribution area of o-group capelin is covered only to a limited extent by the surveys. As a result, no attempt has been made to compute the size of the yearclasses of capelin on the o-group stage.

During the surveys in June, the factors mentioned also result in low estimated values for the stock size of the 1 year old capelin (Table 1; Fig. 3). However, in the autumn the situation is different. The numbers of 1 year old fish is increased between 5 and 25 times from June to September/October, thus indicating a large change in the availability for the acoustic method within that period. Comparing the estimates of 1 and 2 year old fish of the same year-class, it is evident that concerning the 1972-yearclass even the estimates obtained in September when the fish were 1 year old were too low. This seems also to be the case for the 1970 year-class, but here it was expected as the coverage in 1971 was considerably poorer than during the later surveys especially in the southernmost areas where the young fish were distributed.

Fig. 3 shows the number of fish in each yearclass as a function of time. With the exception of the younger stages already mentioned the picture seems reasonable; a gradual decline from year to year due to natural- as well as fishing mortality. However, if we again compare the estimates from June with those obtained in September the same year (Table 1) some discrepancies are discovered. In 1975 the estimates both of 2 and 3 years old fish were considerably less in June than in September. As later estimates tend to support the September observations, it seems likely that the amount of both 2 and 3 years old fish were underestimated in June 1975. Two factors may have caused this: First, a portion of the stock might have been distributed outside the survey grid due to unfavourable ice conditions. Second, parts of the stock might have been situated in the near bottom layer within the deadzone of the echosounder. Recent data, from June 1977, indicate that a combination of those two factors may lead to serious underestimation of the capelin stock size with the present technique. Although some of the discrepancies observed from year to year and from June to September the same year might be explained by difficulties in age determination (HAMRE 1977) it seems that similarly to the 1 year old fish also the 2 and 3 year old fish have been insufficiently covered during the surveys in June at least some of the years. The magnitude of this error will depend on the ice situation in the Barents sea as well as the vertical distribution of the fish. A towed transducer system is now being developed in order to obtain a better coverage of the surface- and bottom layers.

A comparison of estimates of the spawning stock sizes can be made from Table 2, where the estimates based on the acoustic surveys in September are presented together with those based on tagging experiments during the fishing season for spawning capelin in the following winter. Table 2 also shows the Norwegian winter catches.

In general the acoustic estimates appear to be lower than those obtained from tagging experiments, but for the period 1974 - 1976 the results from the acoustic surveys correspond well with the lower figures of the tagging experiments as well as with the trend of the catches. This indicates that a fair degree of confidence might be given to the estimates of the maturing portion of the stock obtained during the acoustic surveys in September. Hence, the figures from the September cruises given in Table 1 for 1 year and older capelin might also be considered reliable.

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Table 1. Estimates of the number of specimens, N, and the biomass, W, of each yearclass of Barents Sea capelin during the acoustic surveys in the years 1971-76.
N: numbers x 10^{-11}; W; metric tonnes x 10^{-6}.

Cruise / Year-class	1971 Sep.		1972 Aug.-Sept.		1973 Sep.-Oct.		1974 May-June		1974 Sep.-Oct.		1975 June		1975 Sep.-Oct.		1976 June-July		1976 Sep.-Oct.	
	N	W	N	W	N	W	N	W	N	W	N	W	N	W	N	W	N	W
1967	0.5	0.9																
1968	1.3	1.3	0.4	0.8														
1969	2.2	3.5	1.4	2.2	0.1	0.3												
1970	0.2	0.04	1.8	1.8	0.2	0.5	0.1	0.1	0.03	0.05								
1971			6.4	1.8	2.4	1.7	2.8	1.6	1.6	1.3	1.0	0.9	0.6	0.9				
1972					4.1	1.4	4.1	1.2	5.5	2.9	2.1	1.2	2.4	2.5	0.9	0.9	0.7	1.1
1973							0.2	0.02	4.7	1.6	1.3	0.5	3.4	2.2	1.5	1.2	1.4	1.7
1974											0.3	0.03	2.7	0.9	4.2	2.2	2.4	1.9
1975															0.6	0.2	2.7	1.0
Total stock	4.2	5.7	10.0	6.6	6.8	3.9	7.2	2.9	11.8	5.9	4.7	2.6	9.1	6.5	7.2	4.5	7.2	5.7

Table 2. Estimates of the spawning stocks in the years 1972 - 77 based on
1) acoustic estimates during the previous autumn;
2) tagging experiments during the winter fishery;
3) egg and larvae surveys.
The Norwegian catches during the winter fishery are also given. All quantities in metric tonnes x 10^{-6}.

Year	Estimates of the spawning stocks			Norwegian catch during the winter fisheries
	from acoustic surveys	from different tagging experiments	from egg and larvae surveys	
1972	1.7	4.8 (1)	1.8 (4)	1.2 (5)
1973	3.7	2.2;4.1 (2)		1.1 (5)
1974	1.0	1.1;2.0 (2)		0.7 (5)
1975	0.8	1.1;1.1 (2)		0.6 (5)
1976	1.8	2.1;4.2;4.4 (3)		1.2 (5)
1977	1.8			1.4 (6)

(1) DRAGESUND, GJØSÆTER and MONSTAD, 1973
(2) DOMMASNES, 1977 b.
(3) JAKUPSSTOVU, 1976
(4) GJØSÆTER and SÆTRE, 1974
(5) ANON, 1977
(6) Preliminarly statistics.

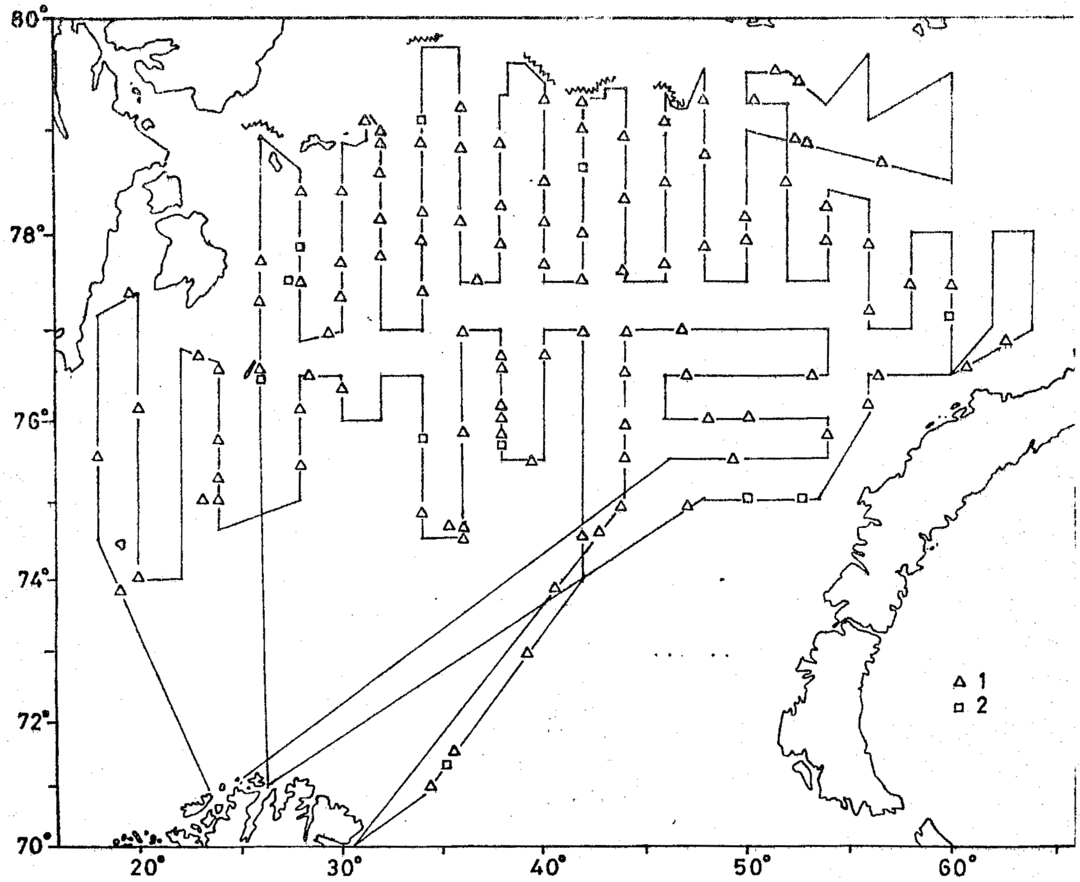

Fig. 1. Survey routes and fishing stations in September - October 1973. 1) Pelagic trawl 1) Bottom trawl.

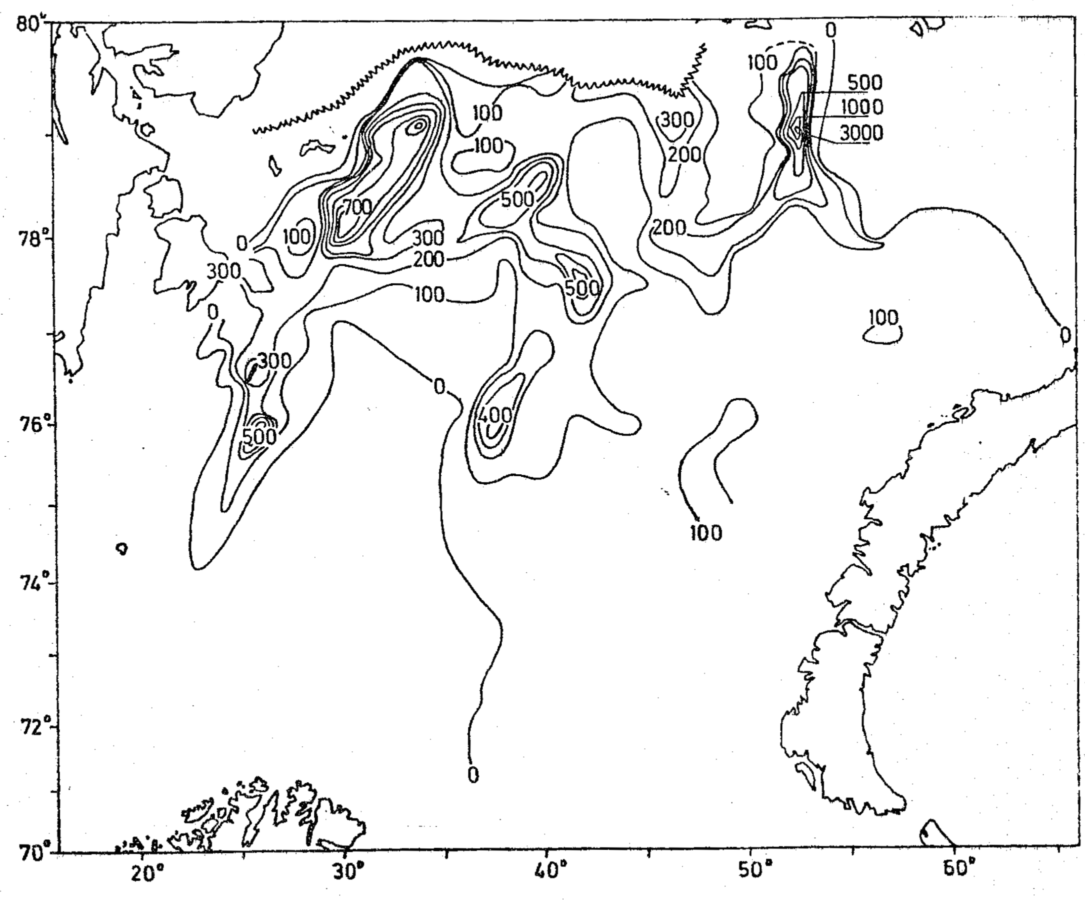

Fig. 2. Distribution of integrated echo intensities for capelin in September - October 1973.

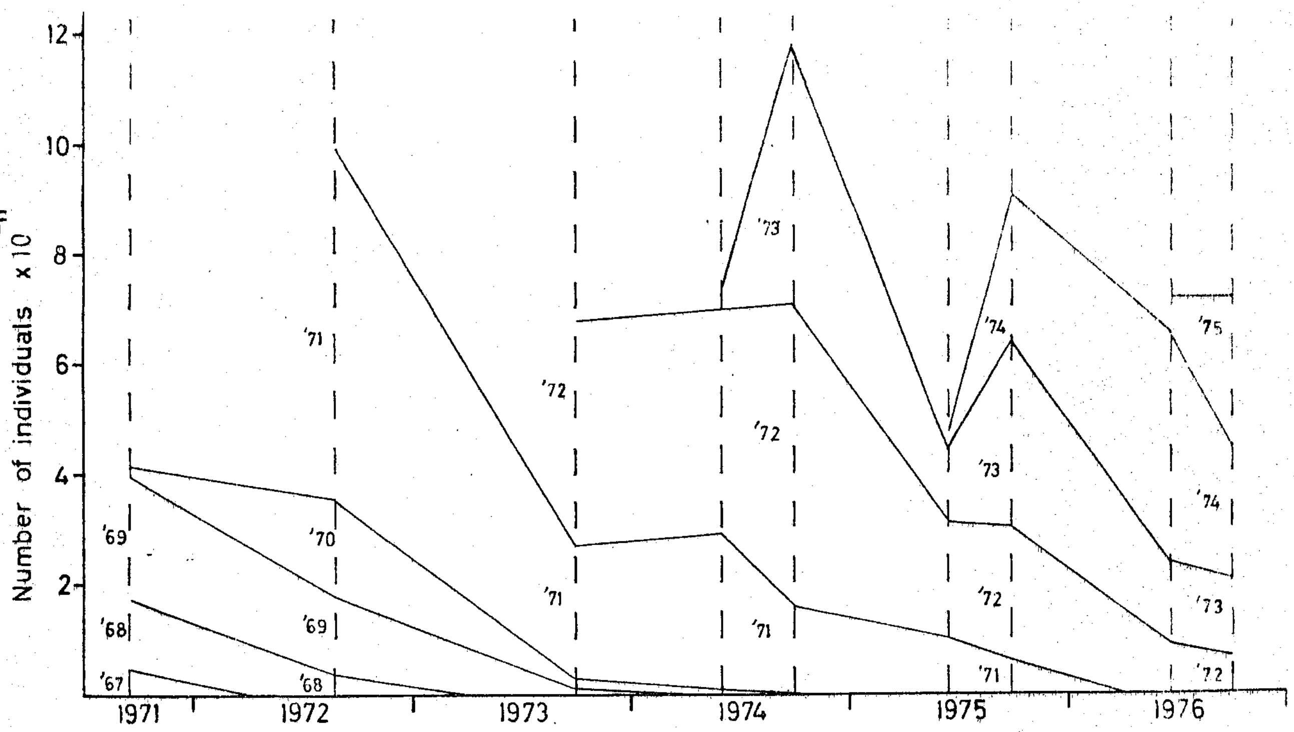

Fig. 3. Numbers of specimens in each yearclass and in the total stock of Barents Sea capelin at different times, obtained from acoustic estimates (ref. Table 1).