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Hydroacoustic Assessment of Capelin Abundance in NAFO Divisions 3LNO in May-June 1981

by

V. S. Bakanev and V. A. Ermolchev

Polar Research Institute of Marine Fisheries and Oceanography (PINRO)
6 Knipovich Street, Murmansk, USSR

Abstract

The report presents results of Soviet hydroacoustic and ichthyological investigations of capelin abundance and biomass assessment in Divisions 3LNO of the Grand Newfoundland Bank. Investigations conducted by the R/V "Persey-III" in the period from 28 May to 15 June, 1981, showed that capelin mainly consisting of immature specimens of the 1979 year class, juvenile capelin of the 1980 year class and a small amount of prespawning fish were observed in a large area in Div. 3L. An aggregation of prespawning capelin was found in Div. 3N.

Total abundance of immature and prespawning capelin and their biomass were assessed as 52.5 x 10^9 specimens and 530 000 tons, respectively. Recruitment of the capelin stock with an abundant 1979 year class will help to recover it.

Introduction

According to the results of the acoustic survey conducted by the R/V "Poisk" in May-June 1980 there were found no considerable concentrations of mature capelin in Div. 3LNO (Bakanev, 1981). According to this survey and similar Canadian survey (Miller and Carscadden, 1981) capelin stocks appeared to be at the lowest level during all the period of investigations.

However, a great amount of juvenile capelin of the 1979 year class was registered. Juvenile capelin of this year class 5-10cm in length were found in Div. 3LNO in a vast area of 4 000 sq. miles. In this connection the most abundant capelin year class was supposed to have appeared since 1973 and it allowed us to expect a good recruitment of their stock next years. Results of

the 1981 echo-survey of capelin abundance in Div. 3LNO confirmed expectations of good recruitment of capelin stock with a rich 1979 year class.

This paper presents the results of acoustic assessment of capelin abundance in the Grand Bank area, their length/age composition, areas of distribution and living conditions.

Materials and methods

The acoustic survey of capelin aggregations in Div. 3LNO was carried out by the R/V "Persey-III" in the period from 28 May to 15 June. The survey was carried out by the EK-S-38 echo sounder connected with the ISP-I device consisting of 5-channel echo-integrating and echo- counting systems.

Trawlings were carried $\overset{out}{\vee}$ with a midwater trawl with a 10 mm mesh-sized netting. It should be noted that the proportion of juvenile capelin and the rest of fish wasn't determined by means of trawlings because of high gear selectivity (practically juvenile capelin were not caught but meshed the trawl netting). The 0-250 m range, duration of emitted impulse- 1mc, emitted power- 1kw, angles of antenna beam width - 8°x8° were established in the echo sounder. The 0-250m range in the ISP-1 dfvice was divided into 5 channels: 5-50m, 50-100m, 100-150m, 150-200m and 200-250m.

In the first channel (5-50m) the echo intensity measured from capelin aggregations was taken for the echo intensity of juvenile capelin (M_{juv}) if they were registered in the trawl netting. This decision was accepted on account of the 1980 survey experience when only yearlings of the 1979 year class were found, and these fish were noted to sink not deeper than 50m during a 24-hour period.

In the four other channels of the ISP-I echo intensity was distributed on the rest trawled fish. As a result echo intensity from juvenile capelin (M_{juv}) and total echo intensity from all capelin (M) were assessed separately and the ratio (M) for daytime appeared to be

$$M_{juv} = 0.4M - 1.1 \; ; \; R = 0.8 \qquad (1)$$

This ratio was applied to night- time when all fish were mixed

in the upper depths and distribution of echo intensities of juvenile and the rest of capelin was determined separately in all the area surveyed.

In the night- time when capelin were registered separately the calibration of echo integrating system readings with the help of the echo counting system was carried out according to the methods described earlier (Ermolchev et al. 1979). As a result the following parameters of absolute calibration of the ISP readings for capelin in length ($\bar{L}$ = 14.1) were established:

$$S_s = CM + d = 1.62 \cdot 10^5 M + 0.27 \cdot 10^5 \; ; \; R = 0.92 \qquad (2)$$
$$C = CnL^{-1.72} = 15.33 \cdot 10^6 L^{-1.72}$$

The general chart of M echo intensities distribution (for 5 miles covered by the vessel) and of capelin length composition was processed by 4 known methods.

The first method is averaging of general combination of echo intensities and fish length composition. $\bar{M}$ intensity of echo signals, $\bar{L}$ fish length, $\bar{W}$ mass averaged for the whole area, length/weight composition averaged by all catches and the total area S were taken as a basis. N abundance and W biomass of all fish were determined by the formulas

$$N = C\bar{N}S \; ; \quad W = N\bar{W} = C\bar{N}S\bar{W} \qquad (3)$$

N_i abundance and W_i biomass of each capelin i length group were determined by the formulas

$$N_i = P_i N \; ; \; W_i = P_i N \bar{W}_i \qquad (4)$$

where C is an absolute calibration coefficient of N readings for capelin with $\bar{L}$ length ;

P_i - % of i length group abundance in catches ;

$\bar{W}$ - i length group average mass in catches.

The second method consists in dividing general combination of echo signal intensities and length composition in the area of relatively equal intensities and length composition of fish by means of isolines. Squares with relatively equal echo intensities and mean values of $\bar{N}$ for each square were determined in each area where fish of this $\bar{L}$ mean length and $\bar{W}$ mean mass were registered.

Capelin abundance and biomass for each square were determined

by the formulas (3). The results were summarized. Capelin abundance and biomass of each length group were determined by the formulas (4) taking length/weight composition of fish averaged by all catches as a basis.

The third method is averaging general combination of echo signal intensities and length/weight composition along with differentiated estimation of each length group abundance by trawl-acoustic method. $\bar{M}$ mean intensity for the whole S area where capelin were observed and length/weight composition averaged by all catches were taken as a basis. N_i abundance and W_i biomass of each i length group were determined by these formulas (Nakken, Dommasnes, 1975) :

$$N = \sum_{i}^{m} N_i \; ; \quad W = \sum_{i}^{m} W_i \; ;$$

$$N_i = \frac{\frac{P_i}{C_i}}{\sum_{i=I}^{m} \frac{P_i}{C_i}} \bar{M} S \; ; \quad W_i = N_i \bar{W}_i \qquad (5)$$

where m - number of length groups, = 1,2,..., m ;

C_i - absolute calibration coefficient of M readings of capelin i length group.

The fourth method is the method of elementary squares. The principle of dividing the whole area into elementary squares considered when describing the second method was taken as a basis but abundance and biomass of each length group in each area with fish of a given $\bar{L}$ mean length for each square with relatively equal echo intensity $\bar{M}$ were determined by the formulas (5).

Length/weight composition for each square was taken from the trawlings made in this square only. Obtained results were summarized.

Results

During the acoustic survey capelin were distributed in the southern part of Div. 3L and northern part of Div. 3N (Fig. 1). In the day-time most shoals kept nearer to the bottom at the depth from 50 to 200m but in the night-time they moved to the upper depths and were distributed at the 10-70 m depth in the

form of a "path". In Div. 3O no capelin aggregations were found.

Immature capelin 9-13 cm in length (11cm mode) of the 1979 year class dominated in the trawlings (Table 1,2). While trawling in the southern part of Div. 3L (Virgin Rocks area) a great amount of juvenile capelin 6-10 cm in length of the 1980 year class were observed meshed in the trawl netting. On the whole, the area of juvenile aggregations and the density of their concentrations were lesser than those of the 1979 year class in the similar 1980 survey.

Mature capelin were found near traditional spawning grounds in the shoal waters of the Grand Bank South-East slope (3N). In the day-time frequent schools of fish were registered at the 60-70 m depth, in the night-time they rose up to the 20-30 m depth. Specimens 12-17 cm in length at the age of 3-4 made up the bulk of catches. Almost all specimens were prespawning (the stage of sexual products maturity was III-IV).

Radiational heating of the surface waters was observed in Div.3L and in the northern part of 3NO. During the investigations water temperature varied from 3.5°C in the north to 9.2°C in the south. Transport of the Labrador Current cold waters with t° below 1° from the north-west was well seen at the 30 m depth. Isotherm 0° passed between the 100-200 m isobaths at the 50 m depth, and the Labrador Current waters with temperature to below 1°C were distributed in the Newfoundland coastal waters (Fig.2). In the area of mature fish aggregations (Div.3N) water temperature varied from 1°C at the bottom to 8°C in the surface layer.

Estimates of capelin total abundance and biomass obtained by the mentioned methods are presented in Table 3 and have insignificant discrepancies (a little more than 20% for immature fish in Div. 3LN, less than 10% for mature specimens in Div. 3N). Actual abundance and biomass of capelin should be accepted by the lower limit (the third method) taking into account possible errors in methods of instrumental assessment and processing. Mature capelin abundance in Div. 3N will be 5.97×10^9 spec. and 109 000 tons, immature capelin abundance in Div. 3LN will be 46.53×10^9 spec. and 421 000 tons.

Juvenile capelin abundance and biomass estimates of the 1980 year class are 42.3 x 10^9 spec. and 95.3 thou. tons according to our calculations.

Thus, results of the acoustic survey of the Newfoundland capelin in Div. 3LNO showed that next years commercial stock would be recruited with a rich 1979 year class (Table 4). Apparently, the 1980 year class of average abundance (at the age of 1) will recruit capelin stock considerably.

The abundance of the Newfoundland capelin stock at present is not sufficient to renew an intensive fishery notwithstanding the recovery tendency. Experimental fishing for capelin in Div. 2J3K should be continued and similar works in Div. 3LN in May-June 1982 should be renewed in order to get materials on capelin biology and state of their stocks. In future acoustic surveys in Div. 3LNO and 2J3K should be continued to determine the recovery rate of stock abundance and fishery perspectives.

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Table 1 Length composition of capelin in Divisions 3LN in May-June 1981, %

Length cm	3L (May) male	3L (May) female	3L (June) male	3L (June) female	3N (June) male	3N (June) female	3LN(June) juvenile
6,0							0,4
6,5							3,8
7,0							II,8
7,5	0,I	0,I					I8,5
8,0	0,3	-	0,I	-	+		20,6
8,5	I,4	I,2	0,4	0,6	0,I	-	22,7
9,0	4,I	5,7	0,6	I,2	0,4	0,I	II,3
9,5	4,9	7,6	I,7	2,3	0,2	0,2	6,7
I0,0	9,0	I0,7	2,3	4,I	0,4	0,I	2,5
I0,5	6,5	6,2	4,9	6,5	-	0,5	I,7
II,0	6,0	7,9	8,4	I0,5	0,I	0,5	
II,5	4,9	4,5	7,6	8,4	0,2	2,6	
I2,0	4,6	4,5	6,6	6,5	0,3	4,4	
I2,5	2,0	I,7	4,7	4,2	0,3	I3,2	
I3,0	I,8	0,6	2,7	3,6	0,4	I4,4	
I3,5	I,0	0,4	I,3	2,I	0,4	I5,6	
I4,0	0,2	0,2	I,2	I,4	I,I	7,3	
I4,5	0,I	0,2	I,0	0,9	2,4	4,9	
I5,0	-	0,2	I,0	0,6	6,3	I,5	
I5,5	0,I	-	0,5	0,2	5,3	I,0	
I6,0	0,3	0,2	0,5	0,2	8,6	0,I	
I6,5	0,I	-	0,5	0,2	3,8	0,I	
I7,0	0,4	0,I	0,3	0,2	2,7		
I7,5	-	-			0,4		
I8,0	0,2	-			0,I		
Total	48,0	52,0	46,3	57,7	33,5	65,5	I00,0
No. of spec.	662	7I6	2324	2700	I364	2734	I572

Table 2. Age composotion of capelin in Divisions 3LN in June 1981, %

Div.	Sex	Age I	2	3	4	5	6	No. of spec.
3L	Male	0,5	47,5	3,5	0,2			207
	Female	0,8	43,3	3,2	0,5	0,5		I93
3 N	Male		8,6	39,0	I3,6	2,5	0,5	I28
	Female		I,0	I7,7	I2,6	4,5		72

Table 3. Abundance and biomass of capelin in Divisions 3LN in 1981

Division	Indices	Method of processing I	2	3	4
3LN	Abundance, 10^9 spec.	48,80	58,75	46,53	56,95
Immature	Biomass, thou.t	444,0	527,2	42I,0	573,9
3N	Abundance, 10^9 spec.	4,90	4,9I	5,97	5,05
prespawning	Biomass, thou.tons	I03,0	I02,8	I09,0	I00,0
3LN	Abundance, 10^9 spec.	42,30			
juvenile	Biomass, thou.tons	95,3			

Table 4. Age composition of capelin in Division 3L in 1972-1981, %

Year	Age I	2	3	4	5	6	7	No. of spec.
I972	9,9	5,2	48,5	34,2	22,0			592
I973		32,I	7,I	42,6	I8,0	0,2		396
I974	I,I	I,9	36,7	32,5	25,8	2,0		786
I975		32,8	3I,0	22,5	3,5	2,5	0,7	400
I976			66,4	27,0	5,6	I,0		300
I977		2,4	32,3	6I,0	4,0	0,3		300
I978		8,8	8,I	45,2	36,2	I,5	0,2	900
I979		0,6	4I,5	27,8	25,I	4,8	0,2	550
I980			28,0	50,0	22,0			I00
I98I	I,3	90,6	6,7	0,7	0,5			400

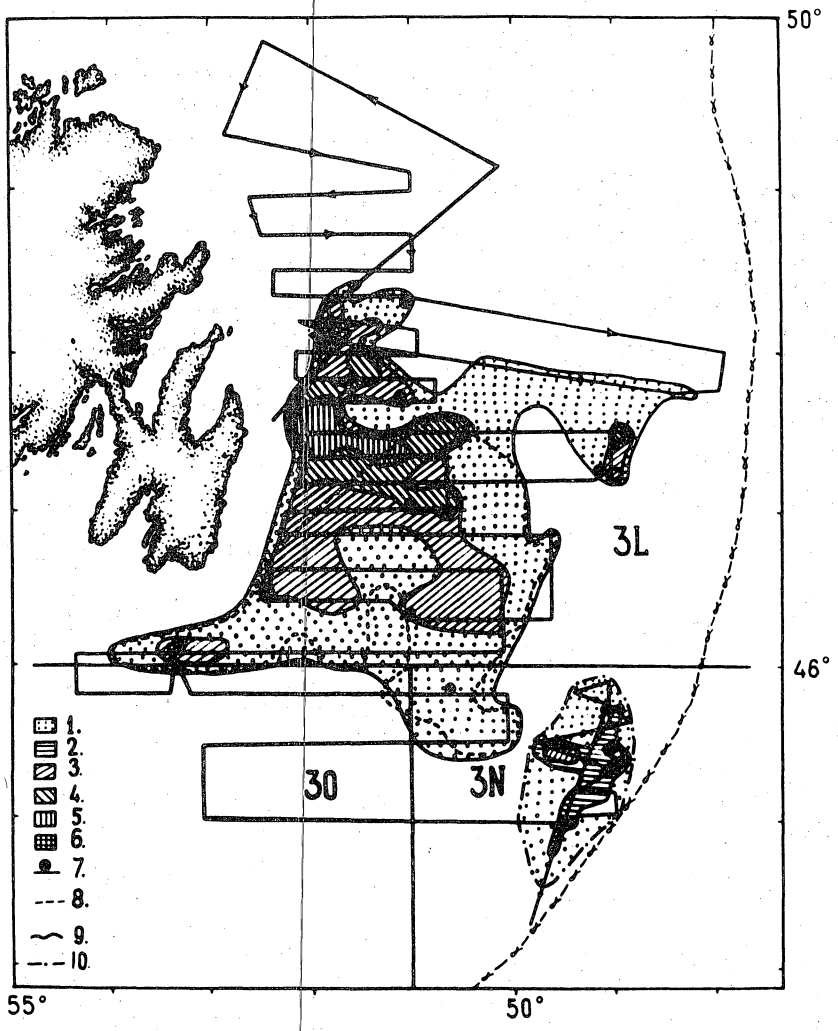

Fig.1. Chart of the hydroacoustic capelin survey in May-June 1981

1. Density of capelin aggregations from $1 \cdot 10^6$ to $2 \cdot 10^6$ spec. per sq. mile
2. -"- $3-5 \cdot 10^6$ -"-
3. -"- $6-10 \cdot 10^6$ -"-
4. -"- $11-15 \cdot 10^6$ -"-
5. -"- $21-25 \cdot 10^6$ -"-
6. -"- $31-35 \cdot 10^6$ -"-
7. Route, trawling
8. Boundary of juvenile capelin distribution
9. -"- immature -"-
10. -"- prespawning -"-

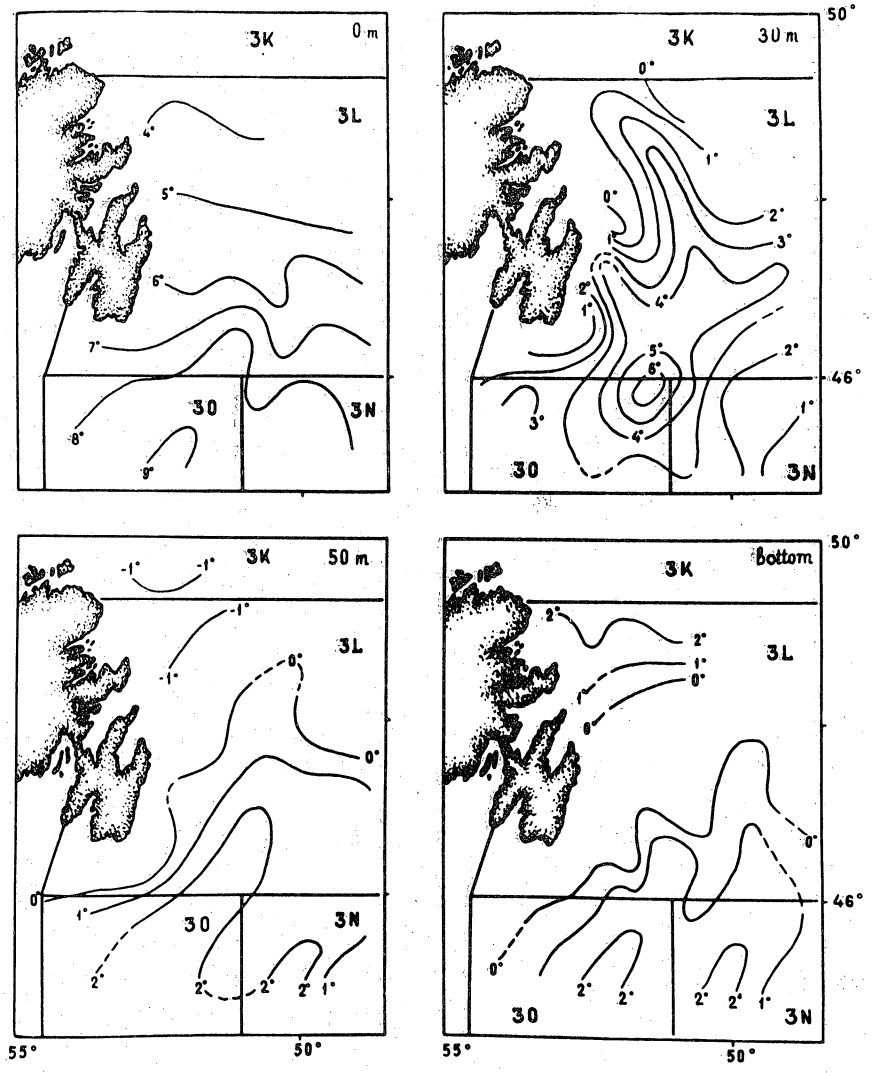

Fig.2. Temperature conditions of water during the hydroacoustic survey in May-June 1981.