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Size of the Newfoundland Capelin Stock According to the Results of  
Acoustic Surveys in Divisions 3LNO in May-June 1985

by

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**ABSTRACT**

The results of acoustic survey carried out in May/June 1985 for assessing the capelin stock abundance in the NAFO Divs. 3LNO are presented.

It was noted that 80% of capelin stock consisted of immature specimens of very abundant 1983 year class which in the two nearest years will make up the bulk of commercial stock. The total abundance and biomass of fishes were estimated at 290 bill.spec. and 2.2 mill.t respectively.

**INTRODUCTION**

The hydroacoustic surveys carried out at a proper time are of great importance for the quantitative assessment of capelin stock abundance.

The first Soviet surveys started in 1975 and performed in June in a period of mass migration of capelin to spawning grounds off the southeastern slope of Grand Bank (Divs. 3NO) embraced mainly the mature part of the stock (Seliverstov, Kovalev, 1976; Kovalev et al., 1977). From the end of the 70s the area of the survey expanded considerably and overlapped nearly all the areas of Grand Bank assessing both the mature fishes and prerecruits. The surveys were usually conducted by the Soviet vessels in the second half of May - first half of June which was a favourable period for more complete assessment of abundance of all age groups. But it was impossible at that time to distinguish between the

capelin spawning on the shoal of southeastern slope of Grand Bank (Div. 3N) and fishes spawning off the coast of Newfoundland (Div. 3L). And the survey carried out in later terms (late June/July) did not assess the fishes migrating to territorial waters of Canada.

In spite of this the similar surveys were conducted in the area by Canada. Recently two surveys were performed: the first one - in April/May in Div. 3L on mixed concentrations of mature and young fishes and the second one - in June/July when the fishes spawning on the shoal of Div. 3N separated from fishes of coastal spawning grounds located in Div. 3L. These surveys had also their own shortcomings: in certain years due to severe ice conditions in the north of Grand Bank the concentrations of mainly immature fishes were underestimated by the first survey. The part of concentrations of immature capelin seemed to be underestimated during the second survey too when the schools migrating northward were distributed beyond the limits of Grand Bank (Miller, 1985 a,b).

Besides, there was a number of discrepancies between the Soviet and Canadian surveys concerning methods, the most essential of which was a different approach to the use of the target strength TS in situ on conversion of the echo intensity values to the fish distribution density.

The results of the Soviet acoustic survey of capelin carried out in Divs. 3LNO in summer 1985 are set out in the present paper and the differences in methods of data processing on the Soviet and Canadian vessels being, apparently, the main reason of inadequacy of the survey results of two countries are discussed.

#### MATERIAL AND METHODS

The acoustic survey of capelin was performed by the RV "Poisk" from 5 May to 13 June 1985. From 5 to 14 May the survey was carried out in the south of Grand Bank beyond the limits of the 200-mile economic zone of Canada and later it was continued inside the zone. The survey tracks are shown in Fig.1.

The survey was made using the EK-38 echo sounder and two SIORS digital integrators which worked with different gain coefficients, thus, permitting to overlap the dynamic range of echoes returned

from dense capelin schools and scattered concentrations. During the survey the transmission level was about 50 dB.

The identity of integrator readings was established according to the results of test hauls and accurate analysis of echograms. Besides, the data were used on the target strength distribution of objects by depths taken from Simrad QD-200 integrator which was connected to EK-38 echo sounder, the procedure was described earlier (Mamylov, Bakanev, 1985). In this case the values TS in situ for capelin 8-19 cm long ranged approximately from -57 to -49 dB in accordance with the used relationship TS (L) for capelin  $TS = 19.1 \lg L - 74.4$ .

The echo integrator readings were taken every 5 miles. In all 53 test hauls were made during the survey. All the fishes from each haul were measured with the sex and maturity stage determination, and usually 50 spec. were aged. These data were used for obtaining the length-age keys.

To calculate the abundance and biomass of capelin the whole area of survey was divided into 7 Subdivisions with a relatively identical composition of fishes and ratio of mature and immature specimens. Each subdivision was further split into smaller strata with a relatively regular grid of tracks and echo intensity. For each strata the area (S), mean echo intensity (M) and abundance in each length group ( $N_i$ ) were determined by the following formula:

$$N_i = \frac{C_I P_i}{\sum P_i \sigma_i} MS$$

where:  $P_i$  - portion of fish in the i-th length group by mass measurements;  
 $C_I$  - instrument constant ( $1.5 \times 10^3 \text{ cm}^2/\text{mile}^2$ );  
 $\sigma_i$  - acoustic backscattering cross section for capelin ( $3.64 \times 10^{-4} L_i^{1.91} \text{ cm}^2$  where  $L_i$  - zoological size of capelin, cm).

All the information from SIORS integrator was transmitted through a special interface to computer "Iskra-226" with the subsequent data print out.

## RESULTS AND DISCUSSION

The densest capelin concentrations were distributed in the northwestern areas of Div. 3L (Subdivision I) and consisted mainly of immature fishes 8-13 cm long of the 1983 year class (Fig.2). The two-year-olds prevailed also in test hauls taken in the eastern part of Grand Bank (Subdivision V) though the density of concentrations was much lower<sup>there</sup> than that in Subdivision I.

The numbers of mature fishes were registered in the central part of Div. 3L (Subdivision II) and in adjacent strata of Divs. 3L and 30 (Subdivision IV). The fishes 12-16 cm long at age 3 prevailed in the catches (Fig.3).

The largest fishes occurred along the eastern continental slope of Grand Bank (Subdivisions V, VI, and VII in the northern part). Males 14-19 cm long dominated in the catches. Females 14-17 cm long at age 3-5 were observed in smaller quantity.

On the whole the mature fishes (maturity stage of gonads III and more) accounted for 2.3% (mainly females) of the two-year-olds, constituting the bulk of the assessed capelin stock, and 52.6% of the three-year-olds. All the capelin at age 4-6 were mature. Females alone were found among the six-year-old fishes.

It should be noted that during the acoustic survey the juvenile capelin at age 1 (the 1984 year class) occurred in minute quantity in four test hauls taken in the southern part of Div. 3L where their catch did not exceed 200 specimens per haul. It correlated well with the data obtained earlier (Bakanev, Gorchinsky, 1985) and was indicative of a poor abundance of the 1984 year class.

The results of the capelin abundance and biomass assessments by age groups are given in Table 1. In all areas of Grand Bank the abundance and biomass were 289 bill.spec. and 2.2 mill.t. respectively, the portion of mature fishes amounting to 13.4% in size and about 30% by weight. On the whole the abundance of the 1983 year class accounted for about 80% of the total estimated stock. Considering a low abundance of the 1984 year class, the rich 1983 year class will dominate in the nearest two years in commercial catches.

The results of the Canadian acoustic surveys carried out in May and in June/July 1985 in Divs. 3LNO differed notably from those of the Soviet survey. In Div. 3L the capelin biomass was 4.2 mill.t

during the first survey and no more than 1.5 mill.t - during the second one. The different methods of data processing applied by two countries were the main reason of this inadequacy.

The known equation  $TS(L)$  in situ used for many years during the Soviet/Norwegian acoustic surveys in the Barents Sea  $TS_1 = 19.1 \lg L - 74.4$  (1) was employed by the Soviet vessels when carrying out the surveys. The results of special measurements of  $TS$  in situ for capelin from Divs. 3LNO and 2J made on the RV "Poisk" in 1984/1985 differed from  $TS$  values calculated from the formula (1) by no more than 1 dB.

The Canadian researchers used the target strength  $TS$  equal to -34 dB per 1 kg of capelin for the whole length range of fishes. In this case, the target strength of individual fish was determined as  $TS = 10 \lg W - 64$  (2) where  $W$  - the weight of the fish, g.

To compare the formulae (1) and (2) let us use the length-weight key obtained for capelin during the present survey ( $\lg W = 37.4 \lg L - 3.24$ ) and re-arrange the equation (2) in the following form:  $TS_2 = 3.74 \lg L - 96.4$  and plot after this the graphs of two relationships  $TS_1(L)$  and  $TS_2(L)$  (Fig.4). The Figure 4 shows that the values  $TS$  in situ used during the Soviet and Canadian surveys coincided only for capelin about 15-16 cm long while the biomass of smaller capelin calculated by the Canadian method was overestimated by 1-4 dB compared with the Soviet result.

Taking into account that the prevalent size of fishes of the 1983 year class constituting the bulk of capelin stock in summer 1985 was 10-12 cm the differences between  $TS_1$  and  $TS_2$  made up about 2-3 dB. As a consequence, the capelin biomass was overestimated during the first Canadian survey and, on the contrary, during the second one the immature fishes seemed to be underestimated due to migration northward beyond the limits of Grand Bank.

Thus, the Soviet and Canadian acoustic surveys duplicated to some extent each other and were economically inefficient. Besides, the Soviet acoustic surveys carried out in late May/early June, though embracing the larger part of the stock, did not estimate separately the mature capelin from spawning grounds located on the shoal of Div. 3N and coastal spawning grounds of Div. 3L. The second half of June/first half of July should be regarded as the

most favourable time for the survey since the isolation of two spawning groupings was nearly completed but it is reasonable to do the joint Soviet/Canadian research which will permit to cover more fully the area of distribution of all age groups of capelin including the fishes spawning in territorial waters of Canada where the Soviet vessels do not enter.

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Table 1. Abundance (N, mill.spec.) and biomass (W, t.) of capelin  
in Divs. 3LNO in May/June 1985

Subdi- vision	Area, mile <sup>2</sup>	Mean integral	Maturity	Num- bers and mass	A g e					Total
					2	3	4	5	6	
I.	10680	498	immature	N	199900	21530				221430
				W	1077765	240576				1318341
			mature	N	1286	7366	1691	390		10733
				W	12680	131535	51052	13376		208643
II.	6020	84	immature	N	1271	1127				2398
				W	10147	15459				25606
			mature	N	1338	8910	965	185	20	11418
				W	13918	147949	28715	6103	714	197399
III.	3050	178	immature	N	10850	1562				12412
				W	63628	17723				81351
			mature	N	1237	5005	596	124	7	6969
				W	11833	78374	17262	4182	220	111871
IV.	4530	75	immature	N	1297	315				1612
				W	10010	3802				15424
			mature	N	1255	5763	474	161	6	7932
				W	11635	93895	22353	53323	188	133394
V.	13995	20	immature	N	11566	673				12239
				W	64874	7210				72084
			mature	N	101	623	69			793
				W	998	9982	2040			13020
VI.	1400	15	immature	N	115	15				130
				W	812	202				1014
			mature	N	5	167	150	36	1	359
				W	53	4257	4904	1408	25	10647
VII.	2345	12	immature	N	429	27				456
				W	2317	278				2595
			mature	N	42	198	141	37	1	419
				W	398	4031	4135	1283	41	9888
All areas as a whole	42020	157	immature	N	225428	25249				250677
				W	1229553	285250				1514803
			mature	N	5264	28032	4359	933	35	38623
				W	51515	470023	130461	31675	1188	684862
Total				N	230692	53281	4359	933	35	289300
				W	1281068	755273	130461	31675	1188	2199665
Mean weight of 1 spec., g					5.5	14.2	29.9	33.9	39.9	

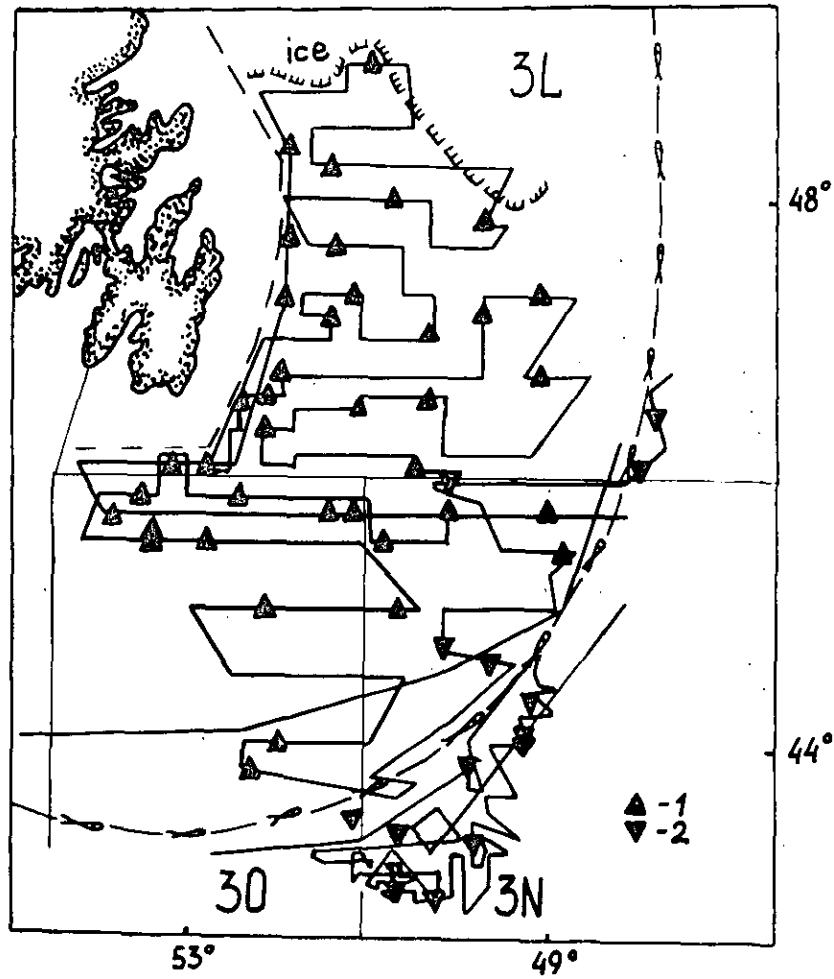


Fig.1 The survey tracks

1 - pelagic hauls

2 - bottom hauls



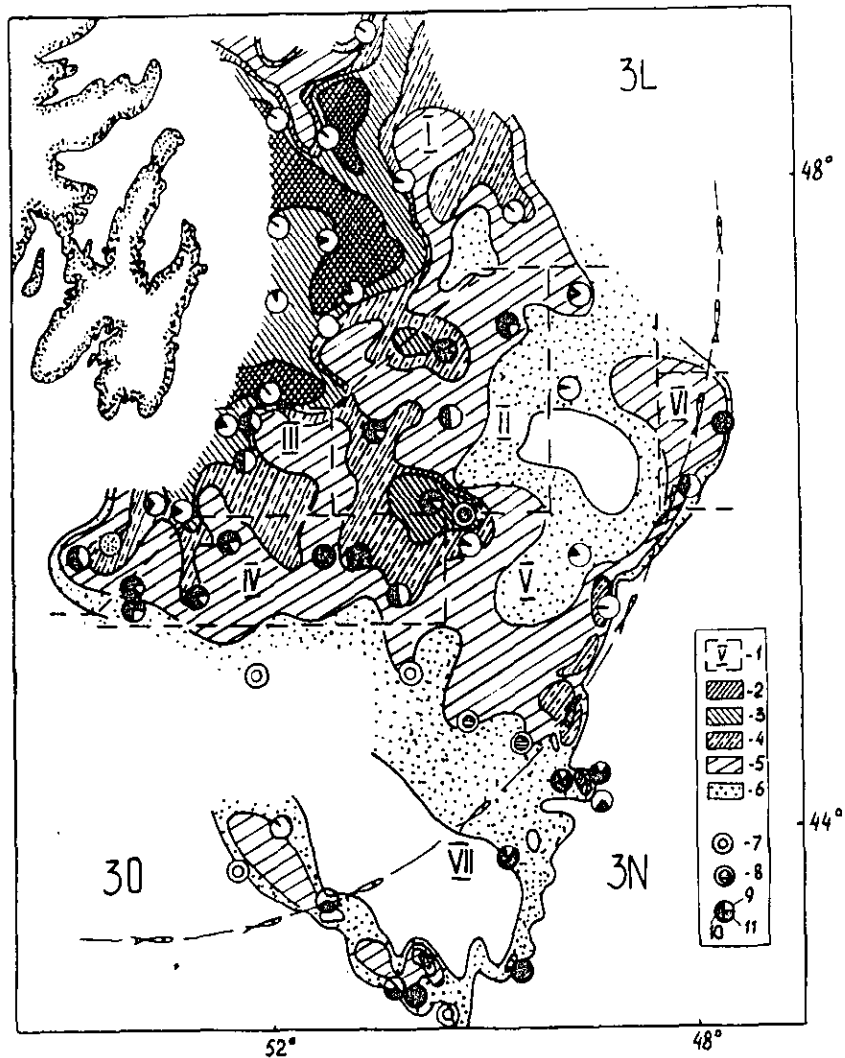


Fig.2 Distribution of capelin in May/June 1985

1 - boundaries of subdivisions

Density of distribution in the integrator units (M):

2 - M 1000; 3 - M=250-1000; 4 - M=100-250;

5 - M=10-100; 6 - M=1-10

Results of test hauls:

7 - no catch; 8 - capelin found only in stomachs of bottom fishes; 9 - portion of immature capelin;

10 - portion of mature capelin; 11 - portion of juvenile capelin (1-year-olds).

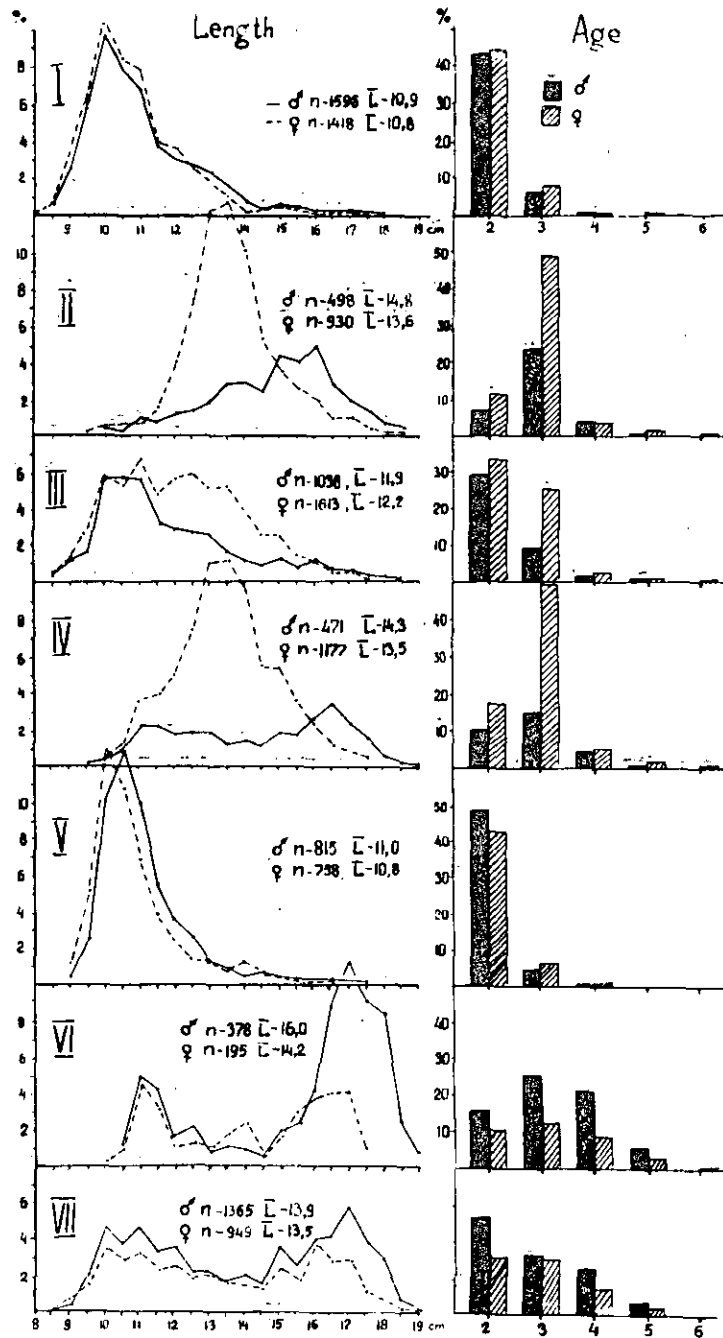


Fig.3 The length-age composition of catches by subdivisions.

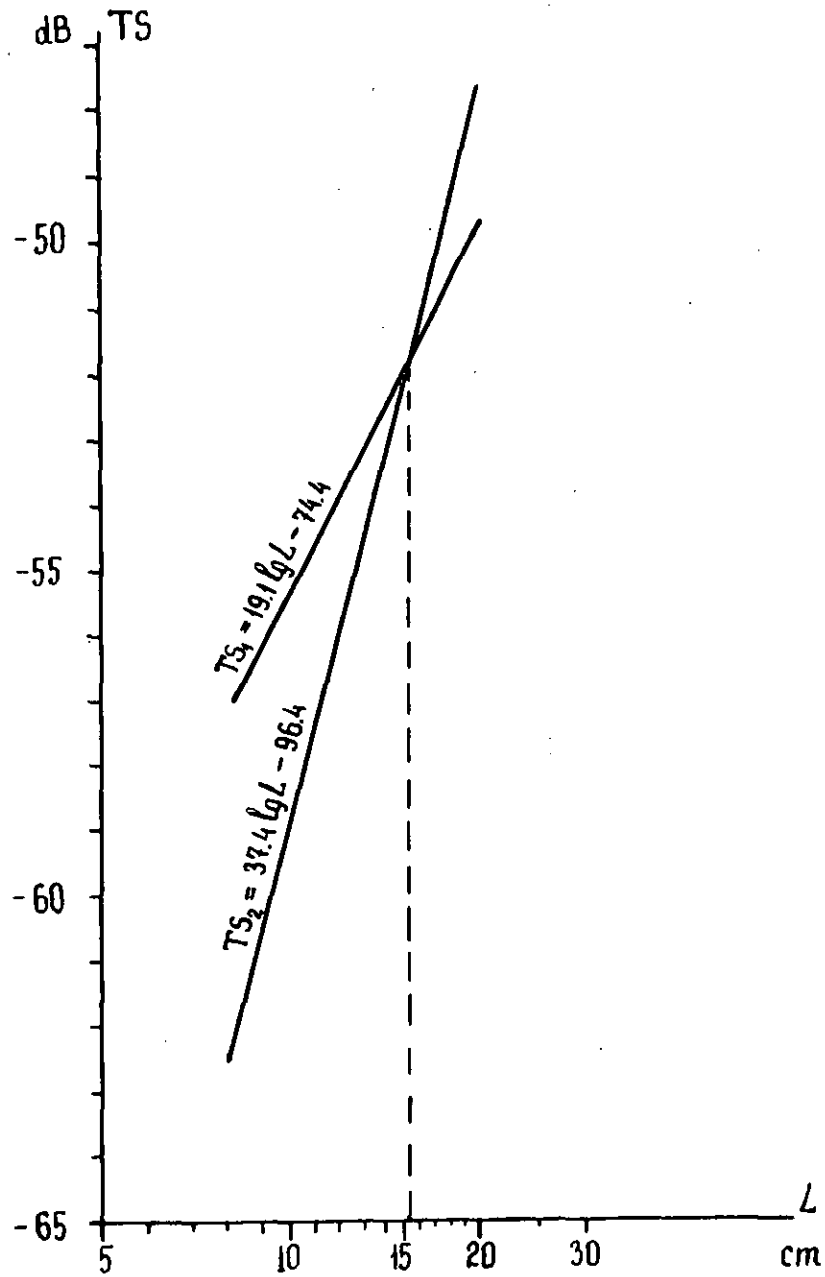


Fig.4 The relationship between the target strength of capelin in situ and their length used by the Soviet ( $TS_1$ ) and Canadian ( $TS_2$ ) scientists during the echo surveys on Grand Bank in recent years.