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The state of Newfoundland capelin stock[1]

by

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INTRODUCTION

The Newfoundland capelin is a wide spread species of the North-West Atlantic. They are found along the Atlantic coast of America from Hudson Bay to Bays of Fundy and Man. In summer and autumn considerable abundances of mature capelin are observed in the areas of the North Newfoundland Bank and South Labrador where they feed.

As the water gets colder and reproductive products mature a considerable abundance of capelin migrates to the South and in the spring-summer period comes to the traditional spawning grounds inshore Newfoundland and the South-Eastern slope of the Grand Bank.

The density of concentration formed by the Newfoundland capelin in individual periods of the year allows fishing to be carried out in an efficient manner. Fishing of spawning stocks has been carried out by Canadian fishermen. Soviet fishing vessels began to fish for capelin in 1971. During the years which followed catches of capelins had considerably increased and by 1974 had exceeded 200,000 tons. Further development of fishing for the Newfoundland capelin necessitates a more detailed study of the life cycle and more precise estimation of the strength of the commercial stock.

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The commercial stock of the Newfoundland capelin as those of other commercial fishes is subject to variance resulting from permanent changes in the amount of recruits which is connected with the yield of year classes.

Following from the age composition for the period under study /1971-1974/ the Newfoundland capelin stock consisted of 2-5 year old fishes /year classes of 1971-1968/ which may be considered abundant.

In 1971 3 year old capelins /year class of 1968/ accounted for the bulk of the catches. This year class also comprised a considerable part /36,2%/ of the catches in 1972

The capelins of 1969 year class were caught in great numbers by commercial vessels at the age of 3 and 4 years. In 1972 and 1973 this year class accounted for more than 50 per cent of a catch /Table I/.

Table I.

Age composition of the Newfoundland capelin / per cent/

year	age						
	I	2	3	4	5	6	
1971	0,I	I4,7	57,4	26,5	I,3		I246
1972	3,0	3,7	55,4	36,2	I,7		I963
1973	0,I	I2,9	I5,4	59,6	II,8	0,2	3245
1974	-	3,I	39,5	3I,6	25,0	o,8	I32I

Growing intensity in fishing from 1971 to 1974 did not result in conspicuous changes in the age composition of the Newfoundland capelin population which must be evidence of the fair state of its stocks.

For rational exploitation of the commercial stock of the Newfoundland capelin it has become imperative to estimate a permissible catch causing no decrement of the stock.

According to the data obtained by Norwegian researchers who were the first to carry out an instrumental estimation of the capelin in I972 biomass of the spawning stock of this species amounted to about 800000tons./8/

The work of Canadian specialists carried out in I973-I974 shows that the annual catch for the Newfoundland capelin can be increased up to 750ooo tons./9/

From October 25,I974 to November 8,I974 instrumental estimation of the strength of capelin stocks was made with the help of hydro-acoustic instruments and undersea cameras on board the PINRO e/v Procion.

METHODS AND RESULTS OF INSTRUMENTAL ESTIMATION OF THE CAPELIN STOCK

Instrumental estimation of stock in all cases envisages the solution of two main problems:

I. estimating the total volume of fish stocks,shoals and schools of the area under study,

2. calculating the absolute density of fish distribution in stocks,shoals and schools.

The first task is usually solved with the help of fish-scouting hydro-acoustic instruments while the second task is solved with the help of undersea photogrammetry, visual observation and integration of fish-echo.

Concrete methods of estimating the stock depend on the behaviour and distribution of the object under study. Large schools of winter herring,for instance,are usually measured individually and their volume is multiplied by the density /2,5,6,7/.If the abundance consists of small schools calculating their total volume is made either by the mean volume of one school /I/ or by the so-called coefficient of school-filling of the abundance volume /4/. When the abundance is very dispersed and the echo-gram shows individual specimens the method of direct counting of fish within the area under survey is used /2,5,6,7,Io/.

In the area under study the capelin formed schools of different size ranging from very small ones i.e. less than IOm in length horizontally, up to very big ones, i.e. I-I.5 miles along the track of the vessel.

The size of the schools greatly depended on the time of the day therefore to obtain comparable data it was decided to measure each school registered during the survey. This method is the most laborious of all the methods ever applied. Though it made the data much more precise. Survey traverses were laid longitudially from the borders of the fishing area to the continental slope. Distance between the traverses was not constant. It varied depending on the density of fish distribution and was equal to IO,5 or 3 miles respectively /fig.5/.

Each school was measured in metres horizontally / along the track of the vessel/ and vertically. Following from the horizontal range of the school-l, the correction- Z was calculated. It was equal to the mean value of the cross section of the echo-range at the depth of school-location.

The volume of the school- V_{sch} was calculated by the formula $V_{sch} = (l-Z)^2 h$ /I/, where h is the height of the school.

The total volume of the schools registered during each I5 minutes of vessel progress was recalculated per sq.mile

$$V_{sp} = \frac{\sum V_{sch}}{DP} \qquad /2/$$

where D is the cross section of the range of the echo-sounder at the depth of the location of the schools and P is the distance covered by the vessel during I5 minutes. After that the specific strength of fish - Q per sq. mile was calculated by the formula

$$Q = V_{sp} \cdot \rho \qquad /3/$$

where ρ is the absolute mean density of the capelin schools (in the number of specimens per cubic meter) by photos.

The Pictures of the schools were taken by the undersea automatic camera "Triton" /3/.The camera was towed on the ground rope,sinkers,trawl warps and cables of the mid-water trawl.

The lens of the camera was looking downward which allowed the fish outside the fishing zone to be registered too.

The scale of the survey,the extent of space and absolute density of fish distribution were calculated by the method described in papers 5,6,7 by comparing the factual mean length of fish with the length of the remotest specimens on the negatives.The results of the undersea photography are shown in Table 2.

Table 2. Mean absolute density of capelin schools

time	total number of pictures	number of pictures showing fish	total number of spec. in pic.	mean h /meters/	mean V, m^3	mean ρ spec./m^3
07.30a.m.- -07.30p.m.	I352	76	349	3,69	5,83	0,8I
07.30p.m.- -07.30a.m	57o	33	II8	4,04	7,33	0,48
total	1922	I09	467	3,80	6,30	0,69

The mean density of the capelin schools in the day time as can be seen from Table 2 was less than two times higher than at night.Though the mean volumes of the night schools were several times larger than those of the night schools. To study the quantitative aspect of this phenomenon and to introduce corresponding corrections into the calculation of specific strength an experimental survey of an area of abundance of fish was made both in the day time and at night. The interval between the surveys was about 10 hours, the area of the patch approximating 60 sq.miles.

The mean specific strength of capelins within this patch at night was 6,8 times higher than in the day time. This must be accounted for by daily changes in capelins' behaviour effecting the probability of schools being registered by the echo-sounder rather than by real changes in the amount of fish at the given area. What is the cause of these changes and their nature are not quite clear and we cannot assert which of the two specific strengths (for day or night) is closer to reality. Therefore to escape overestimating the results of calculation it was decided to assume specific strength for the day time as real value of specific strength. Accorgingly all the results obtained by formula 3 for the dark hours were divided by 6,8.

The specific strength - Q derived by this method for each 15 minutes' patch covered by the vessel was then averaged for zones of the following ranges of Q:

zone 1 - under $1 \cdot 10^6$ spec./sq. mile

zone 2 - from 1 to $10 \cdot 10^6$ spec./sq.mile

zone 3 - from 10 to $100 \cdot 10^6$ " "

zone 4 - from 100 to 1000^6 " "

The boarders of the zones were plotted on plane-tables /fig, 1./ The area of each zone was multiplied by its mean specific strength of capelins:

$$E = Q_{mean} \cdot I \qquad /4/$$

where E total strength of fish in the zone, I - the area of the zone.

The biomass of fish for each zone was calculated by the mean weight of one specimen:

$$J = E \cdot m \qquad /5/$$

where J - the total biomass, and m - the mean weight of one specimen.

The strehgth and biemass of stecks was calculated by summing up respective values fer individual zenes.

The fânal results of data-precessing are shewn in Table 3. -

Table 3. Strength and biemass ef capelin in abundances under survey

abun-dance	zones of strength in spec./sq.mile	mean strength spec./sq. mile	zene area in sq. miles	tetal strength in spec.	mean weight of one spec. in gr.	tetal biomass in centners
I	under $I \cdot 10^6$	$0,3 \cdot 10^6$	528,0	$158,4 \cdot 10^6$	30,54	$48,4 \cdot 10^3$
	from $I \cdot 10^6$ to $10 \cdot 10^6$	$4,2 \cdot 10^6$	381,0	$1605,5 \cdot 10^6$	30,54	$490,3 \cdot 10^3$
	from $10 \cdot 10^6$ to $100 \cdot 10^6$	$19,2 \cdot 10^6$	305,0	$5856,0 \cdot 10^6$	30,54	$1788,4 \cdot 10^3$
	from $100 \cdot 10^6$ to $1000 \cdot 10^6$	$192,4 \cdot 10^6$	8,2	$1577,7 \cdot 10^6$	30,54	$481,8 \cdot 10^3$
	tetal	$12,2 \cdot 10^6$	1222,2	$9197,6 \cdot 10^6$	30,54	$2808,9 \cdot 10^3$
2	under $I \cdot 10^6$	$0,4 \cdot 10^6$	176,2	$70,5 \cdot 10^6$	30,54	$21,5 \cdot 10^3$
	from $I \cdot 10^6$ to $10 \cdot 10^6$	$3,2 \cdot 10^6$	162,5	$520,0 \cdot 10^6$	30,54	$158,8 \cdot 10^3$
	from $10 \cdot 10^6$ to $100 \cdot 10^6$	$28,9 \cdot 10^6$	154,3	$4460,3 \cdot 10^6$	30,54	$1362,2 \cdot 10^3$
	tetal	$12,4 \cdot 10^6$	493,0	$5050,8 \cdot 10^6$	30,54	$1542,5 \cdot 10^3$
3	under $I \cdot 10^6$	$0,4 \cdot 10^6$	474,1	$1896,0 \cdot 10^6$	30,54	$57,9 \cdot 10^3$
	from $I \cdot 10^6$ to $10 \cdot 10^6$	$3,6 \cdot 10^6$	468,3	$1687,0 \cdot 10^6$	30,54	$515,2 \cdot 10^3$
	from $10 \cdot 10^6$ to $100 \cdot 10^6$	$28,7 \cdot 10^6$	253,2	$7266,8 \cdot 10^6$	30,54	$2219,3 \cdot 10^3$
	from $100 \cdot 10^6$ to $1000 \cdot 10^6$	$254,9 \cdot 10^6$	79,6	$20290,0 \cdot 10^6$	30,54	$6196,5 \cdot 10^3$
	tetal	$27,1 \cdot 10^6$	1275,2	$29433,4 \cdot 10^6$	30,54	$8988,9 \cdot 10^3$
	tetal general	$18,5 \cdot 10^6$	29902	$43681,8 \cdot 10^6$	30,54	$13340,4 \cdot 10^3$

DISCUSSION OF THE RESULTS AND CONCLUSION

The instrumental survey of the capelin was carried out in a period of active migration when abundance of fish were very mobile and dispersed over a great area.On the strength of this condition all mature specimens of the population fell under estimation.It should be also taken into account that a considerable amount of fish kept within the fishing zone of Canada and was not available when making the survey.

The methids of instrumental survey as well as our knowledge of the behaviour of the Newfoundland capelin in many aspects are not perfect.Therefore when calculating only assumptions most likely to lead to decreasing the final unknown strength and biomass values for fish in the given area taken into consideration.Thus,for instance,if the correct ive coefficient 6,8 had not beeh taken when calculating the specific strength for the dark hours,the total biomass of the capelin in the area investigated might have been assumed equal to 3.970.000 tons instead of I.330.000 tons.

The comparison of data on the absolute density of Newfoundland capelin schools (Table 2) and those of the Barents Sea capelin /I/ shows that with rather similar dimensions and morphologic characteristics of these fishes the density of the Newfoundland capelin is IO-I5 times lower than that of the Barents Sea. It may be conditioned not so mush by the real difference between the density values of schools as by the high activity of Newfoundland caprlins near the trawl which makes their registering by the trawl camera less probable.

Assuming the density of Newfoundland capelin schools close to that of Barents Sea capelin schools,the total biomass of fish in the given area may by an order and more exceed the values given in Table 3.

All this makes it possible to believe that the biomass of I.330.000 tons is much lower than the real biomass of capelins in the area under survey.The Newfoundland capelin belongs to fishes with a comparatively short life cycle. Assuming the permissible withdrawal to be 50 per cent of the total stock the annual catch in 1975 may approximate 650.000-680.000 tons.

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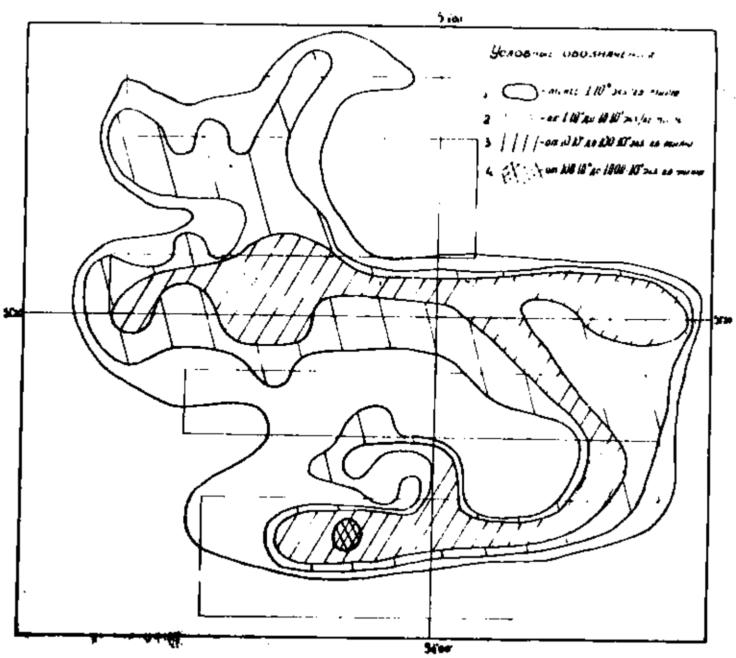
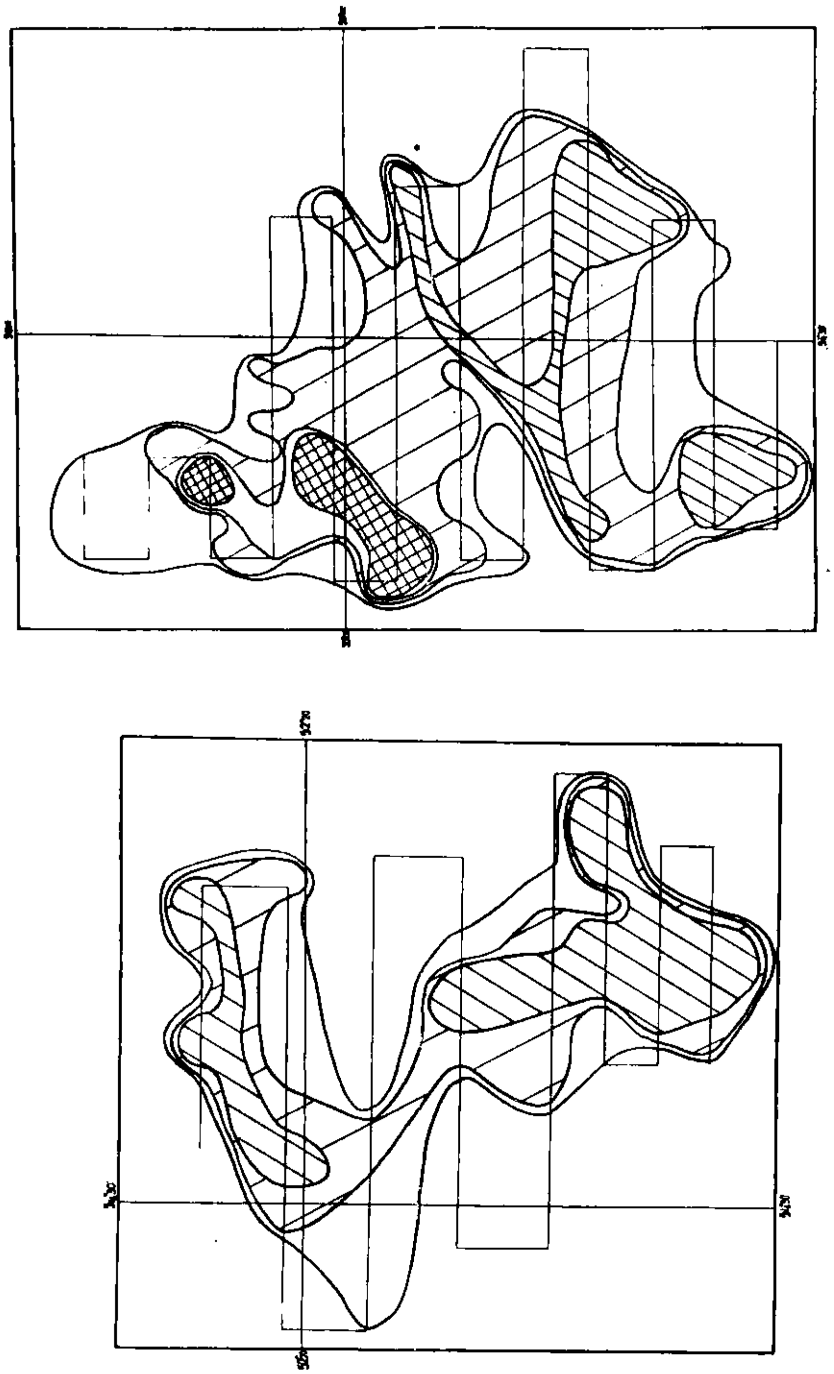


A

Fig.I Plane-table of echo survey of abundances of Newfoundland capelin, October-November 1974, in Div. 2J and 3K.

conventional signs:

under $I \cdot 10^6$ spec./sq mile
from $I \cdot 10^6$ to $10 \cdot 10^6$ -"-
from $10 \cdot 10^6$ to $100 \cdot 10^6$ -"-
from $100 \cdot 10^6$ to $1000 \cdot 10^6$ -"-



C

B

Fig. 1