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Status of Capelin Stocks in Divisions 2J and 3K in 1978

by

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Abstract

The results of the fifth traditional annual autumn survey of capelin stocks conducted in Divisions 2J and 3K showed that due to very poor recruitment and end of life cycle of the strong 1973 year class the abundance and biomass of capelin decreased sharply. 2.7 milliards of specimens with biomass of 0.059 mill. tons were distributed beyond the borders of the Canadian 12-mile territorial waters. Calculations by Allen's model are also indicative of the stocks decreasing but not so substantial, to 0.598 mill.tons.

Introduction

In September - November with the cooling of coastal waters the mass run of shoals of fattened capelin from South Labrador and northern part of Newfoundland is observed.

Capelin are concentrated therewith in a band with the width of 20-40 miles and length of about 120-250 miles depending on temperature conditions of a year. The distribution like that is favourable for conducting surveys, however in warm years not all fish move out of the Canadian 12-mile territorial waters as it happened in 1977 (Bakanev, Seliverstov, 1978).

In autumn capelin usually form rather large shoals convenient for determination of their parameters and fishing. In 1977 the decrease in mean sizes of shoals was observed and in a number of cases the dispersed distribution of fish was recorded. In the

last case the fish being found in water masses were so scattered that echo sounders did not record them; though catches by a pelagic trawl turned to be 10-20 kg per trawling hour the automatic cameras recorded single fish.

Methods

As in previous years (Bakanev,Seliverstov,Serebrov,1976; Bakanev,Seliverstov,1978) the assessment of abundance and biomass of capelin included the following works:

1. Control for fleet dislocation and fishery.
2. Analyses of size and age compositions.
3. Observations of peculiarities of the behavour.
4. Istrumental survey.

Some peculiarities in the fish behavour and distribution not marked earlier were observed in 1978 which necessitated to change slightly methods of the survey. In particular,large shoals of capelin traditional for previous years were seldom met with in 1978. Small schools were also relatively scarse. At the same time near-bottom sound-scattering layers the height of which ranged from 10 to 40 m were regularly observed along the frontal zone of spreading of cold coastal waters. Control trawlings and photo survey showed that capelin were also found in sound-scattering layers in the day-time but in this case the density of their concentrations was by an order lower than that in traditional shoals.

Due to rare occurence of shoals and their small sizes in 1978 we failed to obtain the sufficient number of photographs necessary for statistically reliable estimate of the shoals density.

The density of shoals for 1978 was accepted to be equal to the mean value of previous years which was a serious shortcoming of the survey in 1978.

In other respects the methods of the survey and treatment of data did not differ from the used ones in previous years.

Results

In the course of echometric survey accompanied by control fishing of concentrations of pelagic species it was found that echo recordings of three types are obtained in the area surveyed:

1) echo recordings of typical capelin shoals of different sizes;
2) near-bottom echo recordings of complex composition including crustacea, young polar cod and in the day-time capelin;
3) echo recordings of polar cod at times very similar to those of capelin.

The density of capelin concentrations in the near-bottom layer is given in Table 1. Capelin shoals were met with rarely and only southward of 52°N. Rather large concentrations of polar cod were found northward of that parallel.

Table 1. Density of capelin concentrations in the near-bottom layer.

Series	Photo No.	No. of Spec.	Volume (M^3)	Local density (no./M^3)	Total no. of photos	Total volume (M^3)	Mean density (no./M^3)
1. (trawl no. 7)	-	1	1.24	0.8	43	266	0.0037
2. (trawl no. 8)	141	1	2.03	0.49	297	1841	0.0010
	259	1	2.03	0.49			
4. (trawl no. 9)	9	9	20.4	0.44			
	39	2	9.3	0.21			
	48	1	1.47	0.67			
	53	2	0.93	2.15	74	459	0.065
	72	7	4.2	1.6			
	73	7	0.93	7.5			
Total		31	42.5	14.35	414	2566	
Mean spec./M^3				0.73			0.012

Three zones with the specific abundance above 10 mill.spec. per $mile^2$, from 1 to 10 mill.spec/$mile^2$ and less than 1 mill.spec/$mile^2$ were singled out after the primary treatment of survey data. The area of zones, total abundance and biomass of capelin are given in Table 2.

Table 2. Abundance and biomass of capelin (Div. 2J and 3K).

Zone	Gradation of density (millions/ sq. mile)	Mean abundance (millions/ sq. mile)	Area of concen-trations ($mile^2$)	Total abundance (10^6)	Total biomass (10^6 t)
1	> 10	34.5	53.14	1833.0	0.043
2	1.1-10.0	2.83	178.6	505.0	0.012
3	< 1	0.304	539.5	164.0	0.04
	Total		771.2	2502.0	0.059

In contrast to 1977 (Bakanev,Seliverstov,1978) the increase in mean length of capelin was observed not from the south to the north but from the north to the south. For the period of the survey capelin 14-19.5 cm long made up 95.0% (M_{mean} = 15.79) in the southernmost part of the area and only 74.2% in the north (Table 3).

Capelin shorter than 14 cm constituted a cosiderable portion in catches of FRV "Perseus-III" just in the area limited from 50°45' to 50°58'N and 54°58' to 54°48'W (Table 3).

Table 3. Size composition (%) of capelin in Division 3K.

Length cm	Coordinates 50°15'N 55°04'W	50°33'N 55°06'W	50°58'N 54°48'W	51°47'N 54°47'W
10.5	-	-	3.3	1.6
11.0	-	-	5.8	3.2
11.5	-	0.2	10.0	4.5
12.0	-	0.8	4.6	4.9
12.5	0.5	1.2	6.0	3.8
13.0	1.0	4.0	3.8	4.0
13.5	3.5	4.1	7.4	2.8
14.0	5.5	6.9	5.4	8.0
14.5	5.5	8.7	11.4	6.9
15.0	11.4	9.3	10.2	12.0
15.5	12.4	12.9	10.6	12.0
16.0	20.0	14.3	8.0	15.0
16.5	15.9	14.2	6.0	8.8
17.0	9.4	8.1	2.9	7.5
17.5	6.5	6.6	2.2	1.8
18.0	3.4	5.5	1.3	1.8
18.5	2.0	2.1	0.9	0.3
19.0	2.0	0.5	0.1	0.1
19.5	1.0	0.4	0.1	-
20.0	-	0.2	-	-
M_{mean}	15.79	15.71	13.6	
mean	29.8	25.2	21.1	19.46

Commercial vessels operated in the southernmost part of the area fishing large capelin longer than 14 cm.

Age samples collected during the survey show that the 1973 year class practically completed its life cycle and specimens of the 1975 and 1976 year classes prevailed in the stock in autumn 1978 (Table 4).

Table 4. Age composition of capelin in the area of survey in November 1978, %.

	Age						
	1+	2+	3+	4+	5+	6+	n
Males	2.6	22.2	14.8	4.2	1.6	-	227
Females	2.2	19.6	16.8	13.0	2.8	0.2	273
Total	4.8	41.8	31.6	17.2	4.4	0.2	500

Discussion

Like in 1977 (Bakanev,Seliverstov,1978) the results of the assessment of capelin stocks cannot be regarded as an absolute abundance and biomass of the stock in Divisions 2J and 3K. It is well seen from Fig.1 that practically all concentrations of capelin were distributed along the border of the Canadian territorial waters. Therefore it is difficult to say what part of the stock was inside the 12-mile coastal zone. However,one cannot also explain so sharp decrease in biomass and abundance of the stock (Table 2) by merely unfaveurable for survey distributien of fish. It is quite evident that there occurred the decrease in total biomass and abundance.

The 1973 year class completed practically its life cycle at an age of 5 years. The dynamics of age composition shows that this year class was truly thought to be abundant. It agrees fairly well with the dynamics of the abundant 1969 year class (in percentage) which was also considered to be strong and completed its life cycle at an age of 5 years too. The percentage of the rest of the 1969 year class aged 5+ in autumn 1974 is quite comparable with the

rest of the 1973 year class at the same age (Bakanov,Seliverstov, 1978; Table 4) however it does not give any idea of biomass and abundance of that remainder.

The ICNAF statistics unifies in the same class some types of the Soviet large trawlers having the different capacity of engines and refrigerating plants. Therefore, data on the catch per fishing effort are not sufficiently representative to make analysis of the stock status. Indices of the catch per fishing effort depend to a great extent on the prevalence of either type of vessels in the fishing area.

At the same time only the Soviet fleet fished regularly in Divisions 2J and 3K since 1972. That is why it was reasonable to analyse the change of the catch per fishing effort of the Soviet trawlers. To make statistical data representative a type of vessels of one modification was chosen. Vessels of that type fished capelin in Divisions 2J and 3K from 1972 to 1978 (Table 5). The analysis of the catch per fishing effort even on the basis of more representative statistics does not give a concrete answer to the change of the stocks status. In 1972, the first year of fishery, the catch per fishing effort was found to be lower than that in autumn 1978. In 1977 when the instrumental survey showed certain decrease in the stock the catch per effort was practically the same as in 1973 with specimens of the abundant 1969 year class at an age of 4+ prevailing in the stock. All surveys of previous years indicate that abundant year classes of capelin give the largest recruitment to the stock just at an age of 4 years but the above catch per fishing effort does not show it.

Table 5. Catch per fishing effort (tons) in Divisions 2J and 3K.

Type of vessel	Catch per fishing effort	Years						
		1972	1973	1974	1975	1976	1977	1978
BMRT-A	Per hour	2.81	3.29	4.56	6.47	5.27	4.14	2.29
	Per day	26.54	47.41	61.53	78.98	73.60	43.55	41.83

If to analyse the relation of the catch per fishing effort and assessments of the stocks in 1974 and the relation of those indices in 1978 it appears that the catch per fishing effort (per day of fishing) decreased by 1978 only by 11.8 % and the stocks according to data of the instrumental survey by 96.2 %.

The statistics of the capelin catch shows that the total catch of capelin started decreasing after 1976 and since that year national quotas were not realized completely (ICNAF, Nominal catches, 78/VI/26).

According to preliminary data the catch in Divisions 2J and 3K in 1978 amounted in all to 50 thou.t.,i.e. practically the same volume as in the first year of the fishery (Table 6).

The above data are indicative of the decrease in the stocks since 1977.

Table 6. Catch of capelin (000 tons) in Div. 2J and 3K in 1972-1978.

Year	1972	1973	1974	1975	1976	1977	1978
Whole catch	45.6	136.0	127.0	199.0	216.0	153.0	50.0*
Soviet catch	45.1	133.5	119.8	175.9	204.0	133.5	40.0*

* Preliminary data

Having discussed three indicators of biomass and abundance of the stock we found the marked difference between the data of instrumental surveys, total catch and catch per fishing effort.

It is quite obvious that such contradictory data cannot be used for the objective assessment of the stocks status. The question is, what data are more representative?

If the catch per fishing effort is taken as an indicator of the stocks it appears that the instrumental valuation of abundance and biomass proves to be not the absolute index as it was repeatedly mentioned in the Soviet reports (Klochkov, Seliverstov, Serebrov, 1977; Bakanev, Seliverstov, 1978) since the part of the stock was always left not taken into account in the narrow coastal zone of Canada. It means that in 1974-1975 the stocks were apparently more numerous that those from data

of instrumental surveys and greater portions of the stock were taken into account during the subsequent surveys. As a result the decrease in abundance and biomass was not observed by 1977. And only very marked decrease in abundance and biomass was expressed in the data of the instrumental survey in 1978.

It is very difficult to use generally accepted mathematical models for determination of parameters of capelin stock from Divisions 2J and 3K since the spawning period of this stock remains unstudied until now. There is not so far any approach to estimation of the magnitude of post-spawning mortality as it was made for the stock of capelin from Division 3NO (Carscadden, Miller, Winters, 1978).

That's why to use all available and rather contradictory data the combinatorial analysis of the stocks status was applied, consisting of:

a) comparison of actual and possible catches by Allen's model (Seliverstov, Korytov, Shulga, 1977) at different preset levels of natural mortality;

b) subsequent choice of such natural mortality which would give in calculations the values of biomass at approximate to instrumental valuations.

The level of natural mortality equal M = 0.55 met the requirement.

Calculations show that the decrease in the stocks started since 1977 and in autumn 1978 the stocks accounted for 0.59 mill.t., the least value for the period since 1971. The conclusion is also confirmed that the instrumental method failed to count overall stocks in all years of investigations.

The instrumental survey in autumn 1978 estimated biomass of the stocks at 0.059 mill.t. whereas the mathematical model at 0.59 mill.t. One of the reasons of so marked difference between values of stocks in 1978 is mentioned above - it is impossible to count overall stocks with the help of instrumental method. The method systematically gives underestimated values.

The second reason is the magnitude of stocks. To obtain the quantitative estimate of capelin concentrations more perfect methods and technical equipment, mainly the use of hydroacoustic instruments with high resolving power and echo-counting systems, might have been needed if biomass of the stock decreased and concentrations were widely scattered in 1978. One could face the same problem during investigations of Atlanto-Scandian herring. The last assessment of the stocks was made in 1968 when they decreased to 2.0 mill.t. (Rep. Meet. Work.Gr. Herring 1972). With further decrease in abundance of herring the survey using the photogrammetric method failed due to widely-scattered concentrations and small number of shoals. The analogous phenomenon was observed in Divisions 2J and 3K since autumn 1977.

Conclusions

The main reason for the decrease of capelin stocks was the lack of strong year classes since 1973. The 1974-1977 year classes have not yet completed their life cycles and for the present time it is consequently impossible to receive an absolute estimate of their strength by results of the fishery. However, the comparison of the catch of those year classes at an age of 1 to 3 years with the catch of the 1971-1972 year classes at the same age is indicative of considerably lower abundance of the 1974-1977 year classes. Thus, an abundant 1973 year class made the bulk of the stocks in 1975-1977.

To judge the abundance and biomass of capelin, since the data of the instrumental survey of stocks carried out according to the above methods with their decrease by 1978 become unrepresentative, it is reasonable to use data on the catch per fishing effort, total catch and catch by year classes for Allen's model with the subsequent choice of natural mortality at such a level which would give in calculations the magnitude of stocks close to sufficiently representative data of instrumental surveys in 1974-1975. Calculations by the above scheme showed the de-

crease in the stocks by 1978 threefold in comparison with the period of 1971-1976. In autumn 1978 the stocks amounted to 0.598 mill.t. (Table 7).

Hence, it follows that the total allowable catch at 0.3 mill.t. is excessive for Divisions 2J and 3K. To avoid the further decrease in abundance of capelin the total allowable catch should not exceed 50 thou.t. within the period of abundance decrease and lack of strong year classes in the stock.

Table 7. Assessment of capelin stocks in Division 2J and 3K by Allen's model (000 tons).

Year	1971	1972	1973	1974	1975	1976	1977	1978
Biomass	1,607	1,759	1,496	1,319	1,368	1,374	851	598

References

Bakanev V.S.,Seliverstov A.S.,Serebrov L.I.,1976 . Preliminary instrument estimate of abundance and biomass of capelin off South Labrador and the North Newfoundland Bank(div.2J 3K).Intern.Comm.Northw. Atlant.Fish.Res.Doc. 76/VI/54: 1-16.

Bakanev V.S.,Seliverstov A.S.,1978.Capelin investigations in the waters off southern Labrador (Div.2J) and on the North Newfoundland Bank (Div.3K) in the Autumn 1977. Intern.Comm.Northw.Atlant.Fish.Res. Doc. 78/VI/30: 1-11.

Carscadden J.E.,Miller D.S.,Winters G.H.,1978. Biological aspects of the Div.3NO capelin stock in 1977 and a capelin sequential abundance model. Intern.Comm. Northw.Atlant.Fish.Res.Doc. 78/VI/52: 1-20.

Klochkov D.N.,Seliverstov A.S.,Serebrov L.I.,1977. Estimate of capelin stocks in the South Labrador and Northern Newfoundland Bank Area in the Autumn of 1976. Intern.Comm.Northw.Atlant.Fish.Res.Doc. 77/VI/33: 1-11.

Nominal catches (1967-1976) by country and stock area, with TACs and allocations (1974-1978) for species and stocks proposed for regulation in 1979. Intern. Comm.Northw.Atlant.Sum.Doc. 78/VI/26: 1-57.

Report of the Meeting of the Working Group on Atlanto-Scandian Herring. 1972.ICES.Coop.Res.Report.Ser.A, No.30: 1-27.

Seliverstov A.S.,Korytov V.G.,Shulga A.D.,1977. The estimate of abundance and biomass of the adult part of the Barents Sea capelin stock by the method of Allen. Trudy PINRO,vyp.XXXVIII: 106-110.

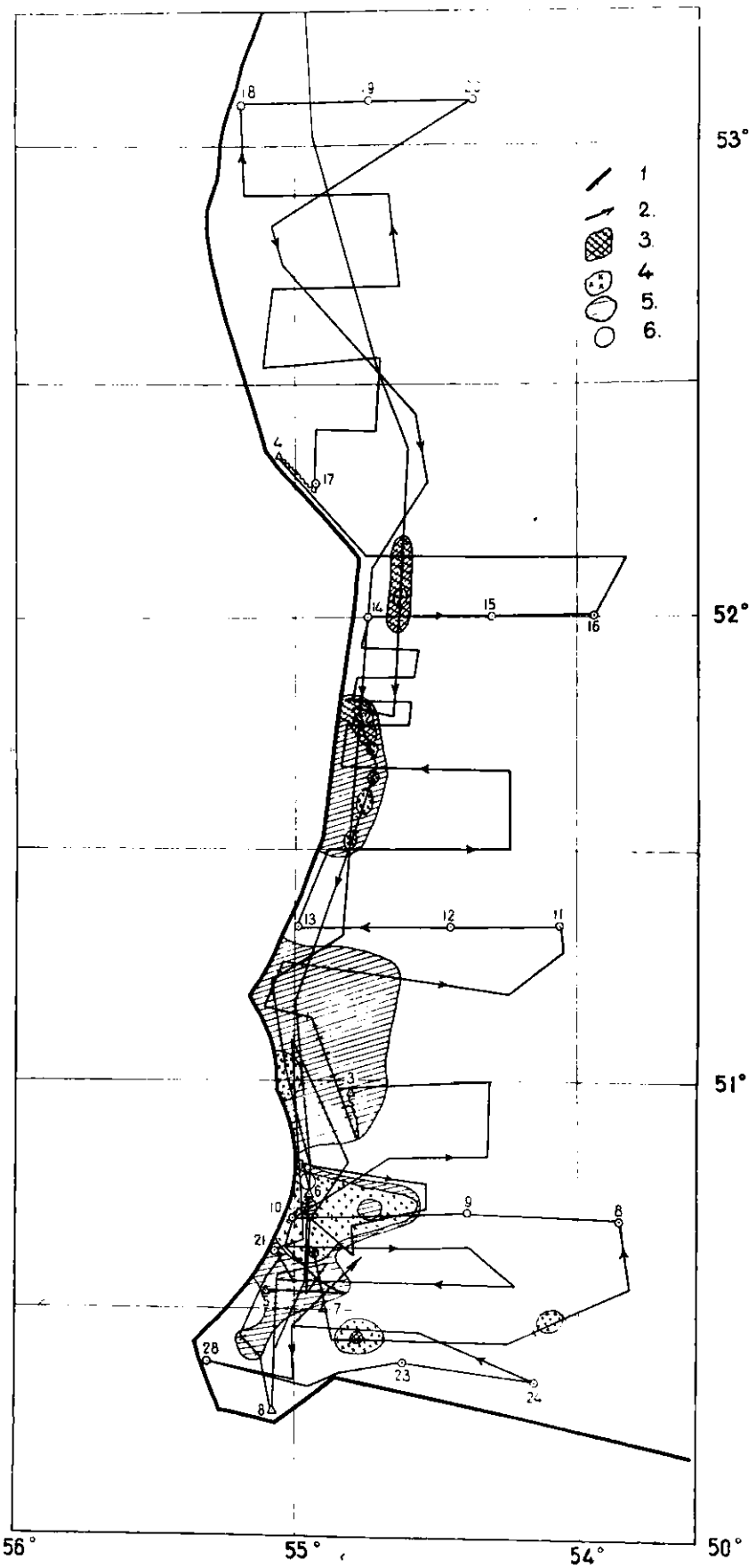

Fig. 1. Status of capelin stocks in Divisions 2J and 3K in 1978.