Northwest Atlantic Fisheries Organization

Serial No. N1881

NAFO SCR Doc. 91/9

SCIENTIFIC COUNCIL MEETING - JUNE 1991

Acoustic Assessment of Capelin Stock in NAFO Divisions 3LNO and 2J+3K in 1990

V. S. Bakanev, and V. I. Zubov

Polar Research Research Institute of Marine Fisheries and Oceanography (PINRO)
6 Knipovich Street, Murmansk 183763, USSR

Abstract

By the results of the acoustic survey carried out in May 1990 in Divs 3LNO the biomass of capelin was estimated at 3.75×10^6 tons. The bulk of stock consisted mainly of the 1988 and 1987 year-classes (52% and 35.3%, respectively).

According to the data of a similar survey carried out in November 1990 on feeding grounds (Divs 2J3K) the capelin stock was almost 6 times lower than that in 3LNO (0.63×10^6 t). The stock was underestimated in fall-winter presumably due to peculiarities of the fish distribution; probably a part of the stock did not leave the Grand Bank area (which is usually not surveyed during this season) because of low heat content of water masses.

Introduction

After a long-time depression of the capelin stock state which had begun in late 1970-ies there has begun a considerable growth in abundance and biomass of this species important for both commercial fishery and other fishes and mammals feeding. This occured due to a long-period limitation of capelin fishery for foreign fleets and recovery of capelin spawning stock as a result of appearing of strong 1983 and 1986-88 year-classes.

Regular investigations of capelin have been carried out by Soviet research ships since 1972. Acoustic assessment of capelin biomass is very important for the stock state monitoring, and together with Canadian data it serves as the grounds for the TAC estimates. As for acoustic surveys, - they have been conducted by PINRO ships since 1974.

Methods

An acoustic capelin survey in Divs 3LNO was carried out by R/V "Persey III" from 15 to 29 May 1990 over the Grand Bank area within the period of total bottom-fish trawl survey.

In Divs 2J3K capelin were surveyed by R/V "Kokshaisk" from 6 to 21 November 1990.

During the spring survey an acoustic complex consisting of an

EK-S-38 echo-sounder, echo-integrator SIORS and ISKRA-226 computer was used. The computer was used for processing of integrated echo-signals and further transformation of the latter into density indices (t/sq.mile).

During the fall-winter survey an EK-400 echo-sounder was used together with the above-mentioned equipment. Conditions and calibration parameters for the two surveys are presented below:

Parameters	R/V"Persey" 3LNO	R/V"Kokshaisk" 2J3K
Source level and voltage response (SL + VR)	131.1 dB	134.6 dB
TVG	20 lg	20 lg
Sound absorbtion term	0.009 dB/M	0.009 dB/M
Pulse duration	1.0 ms	1.0 ms
Bandwidth	3.0 kHz	3.0 kHz
Threshold	50 mV	50 mV
Beam angle	-19.6 dB	-19.6 dB
Target strength	19.1 lgL-74.4(dB)	19.1 lgL-74.4(dB)

Survey tracking, dividing of the study area into strata, computation of biomass and its standard deviation (σ) have been done for the first time in accordance with the technique proposed by CAFSAC (O'Boyle and Atkinson, 1989).

Check haulings with mid-water trawl with a fine-mesh (10 mm) netting in the codend were conducted to identify echo-recordings and collect biological samples.

Samples for mass measurements (200 specimens) were taken at random from each catch; 2 individuals of both sexes were taken from each length group (0.5 cm basis) for age-length keys. Then the combined mass measurements for each stratum were recalculated for age using the age-length keys. Sampling was accompanied by measurements of length, weight, determination of sex, maturity, stomach fullness and food components.

Results and discussion

Divs 3LNO. Cruise tracks and check haulings positions are presented in Fig.1. Calculations of capelin biomass are given in Tables 1 and 2. The total biomass over the study area equalled to 3.75×10^6 t and standard deviation (σ) from that value was 0.61×10^6 t. This stock was almost by 1.3×10^6 t larger than that assessed during similar survey in 1989 (Bakanev et al., 1990). The biomass has increased due to recruitment of strong 1988 year-class which constituted 52% of the whole stock abundance. Though the 1987 year-class was dominating in biomass (44.3%), of which 69% of individuals were mature, whereas only 11% of individuals from the 1988 year-class were mature. Capelin at age 5 years and older were completely mature (Table 3).

The largest amount of mainly immature capelin were distributed

during the survey period in the western part of Div. 3L, and prespawning capelin - in the northern part of Div. 30. No capelin concentrations were found in Div. 3N. Only in the second half of June capelin entered this Division for spawn; and just in this Division outside the 200-mile zone Soviet and Norwegian fishermen were fishing it successfully. But a repeated survey there turned impossible because of lack of time.

Steaming from the northern limits of the survey area towards the southern ones the number of senior age-groups of capelin as well as their mean length gradually increased (Table 3).

Pursuant to the NAFO Scientific Counsil requirements concerning separate assessment of capelin stock in Divs 3L and 3NO the total stock in strata A, B, C and D which equals to 2.76×10^6 t may be regarded as the biomass in Div. 3L, and the stock in strata E and F (about 1×10^6 t) - as the biomass in Div. 30. Nonetheless, such separation is conditional because the stock size in this area may vary both temporarily and spatially. Separate spawning stock size may be differentiated only in the end of the spawning period when one part of the capelin aggregation distributed within Div.30 migrate to southern Newfoundland and the other one migrate to spawning grounds of the southeastern Shoals (3N). Besides, there are indications (Carscadden, pers.comm.) that a certain part of capelin aggregations come back to the North. In particular, tagged prespawning capelin from Div. 30 were captured during the same season on the spawning grounds of the NW coast of Newfoundland (3L). In total, the principal mechanism of spawning stocks separation as well as a degree of their reproductive isolation are not clear yet and require further comprehensive studies.

Divs 2J3K. Cruise track and positions of check haulings in this area are presented in Fig.2. Calculations of the biomass are given in Tables 4 and 5. The total biomass over the study area equalled to 631×10^3 t at mean square deviation (σ) - 105×10^3 t. This is the lowest stock level during the latest 5 years which is almost 6 times less than the stock assessed in that year in Divs 3LO (Table 6). Most probably that in fall-winter period the stock in Divs 2J3K was underestimated which might be related with peculiarities of the fish distribution and behaviour. Canadian researchers assessing the capelin stock size came across the same difficulties; their acoustic estimate for Divs 2J3K capelin in October 1990 was 80×10^3 t (Miller, pers.comm) while the relevant figure for 1989 was 1.7×10^6 t (Miller, 1990).

The main reason for the stock underestimation is caused by anomalously low heat content of the Labrador Current water masses (Table 7) which resulted in wide easterly distribution (70-90 miles to the east compared with traditional distribution) during the period of capelin feedinf and southward migration. Besides, a part of the capelin stock (particularly younger age groups) most probably did not leave the Grand Bank area that is not surveyed in fall-winter

as a rule. But the information from the Soviet ships steaming through the northern areas of Div. 3L in late November testifies that their fish-finding instruments registered (during 6-7 hours at full speed) considerable concentrations of the capelin type.

During the survey in 2J3K the largest amount of capelin was registered in strata D and E where the biomass constituted almost a half of the estimated stock size. The largest capelin (the 1987 year-class predominating) was registered in strata C and D (Table 8).

On the whole the two year-classes (1988 and 1987) constituted over 90% of the total stock (48.4 and 42.5%, respectively).

REFERENCES

BAKANEV V.S., A.A.VASKOV and V.N.PETROV. 1990. Results of the Soviet Acoustic Survey on Capelin Stock in Summer 1989 and 0-group Capelin Survey in Autumn 1988 and 1989 in Div. 3LNO. NAFO SCR Doc., No. 90/07, Serial No. N1718, 10 p.

MILLER D.S. 1990. An estimate of Capelin (Mallotus villosus) biomass from an acoustic survey conducted in NAFO Divisions 2J3K in October, 1989. CAFSAC Res.Doc., No. 90/8, 17 p.

O'BOYLE and D.B.ATKINSON. 1989. Hydroacoustic Survey Methodologies for Pelagic Fish as Recommended by CAFSAC. CAFSAC Res.Doc., No. 89/72, 12 p.

Table 1. Results of capelin acoustic survey in NAFO Divs 3LO in May 1990

Stratum	Biomass, '000 t	Number of tacks (actual)	Number of tacks (possible)	Stratum area, sq.mi	Mean biomass along the tack in a stratum, t	Standard deviation, t
A	629	3	35	2030	I7972	I8304
B	353	3	27	I43I	I3074	4937
C	II28	5	4I	3854	275I7	I30II
D	65I	5	56	5376	II627	I4807
E	900	4	35	2765	25724	I6229
F	9I	3	I7	7I4	5357	2II9
Total	3752	22	2II	I6I70	I7786	29I2
Standard deviation, (σ)	6I4					

Table 2. Some indices of the capelin acoustic survey in Divs 3LO in May 1990

Stratum	No. of tack	Tack length mi	Mean density t/sq.mi	Biomass along the tack, t	No. of haulings	Mass measurement, spec.	Age sample, specimens
A	1	58	74.1	4298	1	0	0
	2	58	187.1	10852	0	0	0
	3	58	668.4	38767	1	206	57
B	1	53	159.2	8438	0	0	0
	2	53	344.6	18264	1	203	60
	3	53	236.2	12519	1	200	63
C	1	94	194.3	18264	1	200	59
	2	94	160.1	15049	2	412	124
	3	94	225.3	21178	1	200	59
	4	94	453.1	45591	2	400	127
	5	94	430.9	40504	1	202	74
D	1	96	379.8	36461	1	212	59
	2	96	146.0	14016	1	200	57
	3	96	45.7	4387	1	0	0
	4	96	28.7	2755	1	0	0
	5	96	5.4	518	0	0	0
E	1	79	545.6	43102	3	611	154
	2	79	184.1	14544	0	0	0
	3	79	452.4	35740	0	0	0
	4	79	120.4	9512	2	401	100
F	1	42	178.0	7476	1	200	44
	2	42	77.1	3238	1	200	41
	3	42	127.5	5357	0		
Total	23				22	3847	1078

Table 3. Age composition (%), mean length (L, mm), weight (W,g) and per cent of mature capelin (M) by strata in Divs 3LO in May 1990

Strata	Index	Age, years 2	3	4	5+	Total
A	%	52.9	41.8	5.3	-	100.0
	L	117.0	138.0	162.0	-	127.0
	W	6.5	13.6	26.6	-	10.5
	M	0.0	31.3	100.0	-	16.0
B	%	74.9	22.8	2.3	-	100.0
	L	110.0	136.0	154.0	-	116.0
	W	6.2	15.0	21.6	-	8.5
	M	2.0	31.5	100.0	-	10.9
C	%	65.3	27.7	6.3	0.7	100.0
	L	110.0	139.0	154.0	168.0	120.0
	W	6.2	14.0	22.2	28.8	9.5
	M	4.5	41.4	97.4	100.0	21.4
D	%	32.7	50.3	17.0	-	100.0
	L	117.0	145.0	164.0	-	13.9
	W	8.0	16.9	28.3	-	15.9
	M	32.8	69.3	100.0	-	62.5
E	%	5.6	46.4	43.7	4.3	100.0
	L	125.0	147.0	163.0	169.0	154.0
	W	11.4	20.8	31.7	34.4	25.6
	M	47.4	91.5	100.0	100.0	93.1
F	%	5.5	45.5	43.2	5.8	100.0
	L	127.0	145.0	164.0	169.0	154.0
	W	11.9	20.2	31.9	34.3	25.6
	M	90.9	97.2	100.0	100.0	98.2
Total	%	52.0	35.3	11.8	0.9	100.0
	L	119.0	143.0	162.0	169.0	139.0
	W	7.1	17.6	30.2	33.8	16.7
	M	11.0	68.9	99.7	100.0	52.6

Table 4. Results of capelin acoustic survey in Divs 2J3K in November 1990

Strata	Biomass, tons	Number of tacks (actual)	Number of tacks (possib.)	Area of stratum sq.mi	Mean biomass along the tack tons	Standard deviation, tons
A	I0425	3	25	I075	4I7	I27
B	II4576	4	28	I260	4092	I02
C	60800	5	40	I000	I520	49I
D	I36425	4	25	775	5457	8762
E	I36320	4	30	930	4544	752
F	8I594	4	27	756	3022	I397
G	9I078	4	3I	I333	2938	I50I
Total	63I2I8	28	206	7I29	3064	5I0
Standard deviation (σ)	I05060					

Table 5. Some indices of the acoustic capelin survey in Divs 2J3K in November 1990

Strata	No. of tack	Tack length mi	Density, t/sq.mi	Biomass along the tack, t	No. of hauling	Mass measurement, ind.	Age sample, indiv.
A	I	45	6.I	274	0		
	2	45	I0.8	487	I	200	4I
	3	45	II.I	499	I	20I	38
B	I	45	93.I	4I90	0		
	2	45	87.8	395I	I	200	42
	3	45	9I.8	4I3I	0		
	4	45	9I.0	4095			
C	I	25	55.I	I377	0		
	2	25	30.9	772	0		
	3	25	60.9	I522	0		
	4	25	8I.6	2040	0		
	5	25	75.5	I887	I	200	40
D	I	3I	II.7	363	0		
	2	3I	56.9	I764	I	200	40
	3	3I	36.5	II3I	0		
	4	3I	599.I	I8572	I	200	43
E	I	3I	I79.4	556I	0		
	2	3I	I4I.9	4399	I	200	45
	3	3I	I20.9	3748	0		
	4	3I	I44.I	4467	2	403	8I
F	I	28	84.0	2352	0		
	2	28	I46.4	4099	I	200	44
	3	28	I52.2	4262	0		
	4	28	49.I	I375	I	200	48
G	I	43	I05.I	45I9	0		
	2	43	90.7	3900	I	200	45
	3	43	33.6	I445	I	204	42
	4	43	43.9	I888	I	204	40
Total	28				I4	28I2	589

Table 6. Acoustic capelin survey abundance and biomass in Divs 3LNO and 2J3K during 1986-1990

Year	Div.	Age, years					Total
		I	2	3	4	5	
I986	3LNO	-	I8.4	70.9	5.9	-	95.2
	2J3K	0.5	I9.0	44.6	3.6	0.2	67.9
I987	3LNO	-	45.7	30.9	30.0	0.6	I07.2
	2J3K	6.0	44.6	6.9	7.0	0.2	64.7
I988	3LNO	2I.5	I77.5	9I.7	34.I	7.6	332.4
I989	3LNO	0.8	78.8	96.5	I0.8	I.5	I88.4
I990	3LNO	-	I56.0	I05.9	35.5	2.5	299.9
	2J3K	-	I4.9	I3.I	2.7	0.I	30.8
I986	3LNO	-	I90	II64	I37	-	I49I
	2J3K	2	300	III3	III	9	I535
I987	3LNO	-	374	7I0	I058	I9	2I6I
	2J3K	52	727	I84	I96	5	II64
I988	3LNO	5I	93I	I508	II5I	3I0	395I
I989	3LNO	3	498	I562	338	57	2458
I990	3LNO	-	I004	I662	I004	82	3752
	2J3K	2	245	308	75	3	63I

Table 7. Water temperature anomalies (t°) along the 8-A transect in the 0-200 m layer in the Coastal (A), Main (B) and Warm (C) branches of the Labrador Current

Year	A	B	C
	Temperature		
I986	0.53	0.88	3.I4
I987	-0.I9	0.59	3.30
I988	0.50	I.23	3.42
I989	0.46	I.02	2.94
I990	0.20	0.09	3.07
	Normal for 1964-1990		
	0.36	I.05	3.43
	Deviation from the normal		
I986	0.I7	-0.I7	-0.29
I987	-0.55	-0.46	-0.I3
I988	0.I4	0.I8	-0.0I
I989	0.I0	-0.03	-0.49
I990	-0.I6	-0.96	-0.36

Table 8. Age composition (%), mean length (L, mm) and weight (W, g) of capelin from the acoustic survey data in 2J3K in November 1990

Strata	Index	Age, years				Total
		2	3	4	5	
A+B	%	44.9	45.4	9.3	0.4	100.0
	L	14.2	15.2	16.1	16.4	14.9
	W	18.2	22.6	26.8	28.8	21.0
C	%	34.9	52.4	12.5	1.2	100.0
	L	14.6	15.8	16.4	16.5	15.4
	W	18.7	25.2	28.3	30.1	23.4
D	%	34.3	54.0	11.2	0.05	100.0
	L	15.0	15.9	16.4	16.7	15.6
	W	21.6	26.6	29.9	31.2	25.3
E	%	54.4	37.8	7.5	0.3	100.0
	L	13.2	15.2	16.2	16.5	14.6
	W	15.4	22.0	27.3	28.4	18.8
F	%	52.4	38.2	9.0	0.4	100.0
	L	13.8	15.3	16.2	16.4	14.6
	W	15.2	22.8	27.7	29.4	19.3
G	%	61.5	32.9	5.3	0.3	100.0
	L	13.6	15.3	16.2	16.4	14.3
	W	13.7	21.5	26.0	27.6	16.8
Total	%	48.4	42.5	8.7	0.4	100.0
	L	13.9	15.4	16.2	16.5	14.8
	W	16.5	23.5	27.8	29.4	20.5

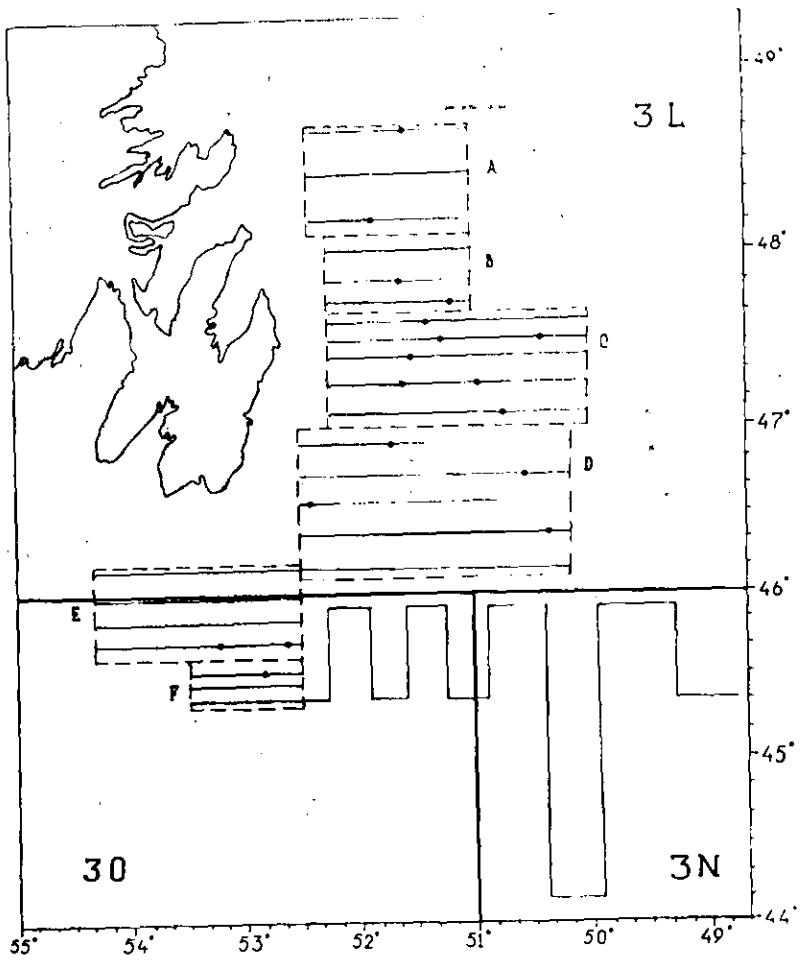

Fig.1. Route of the capelin survey, strata and check haulings in May 1990

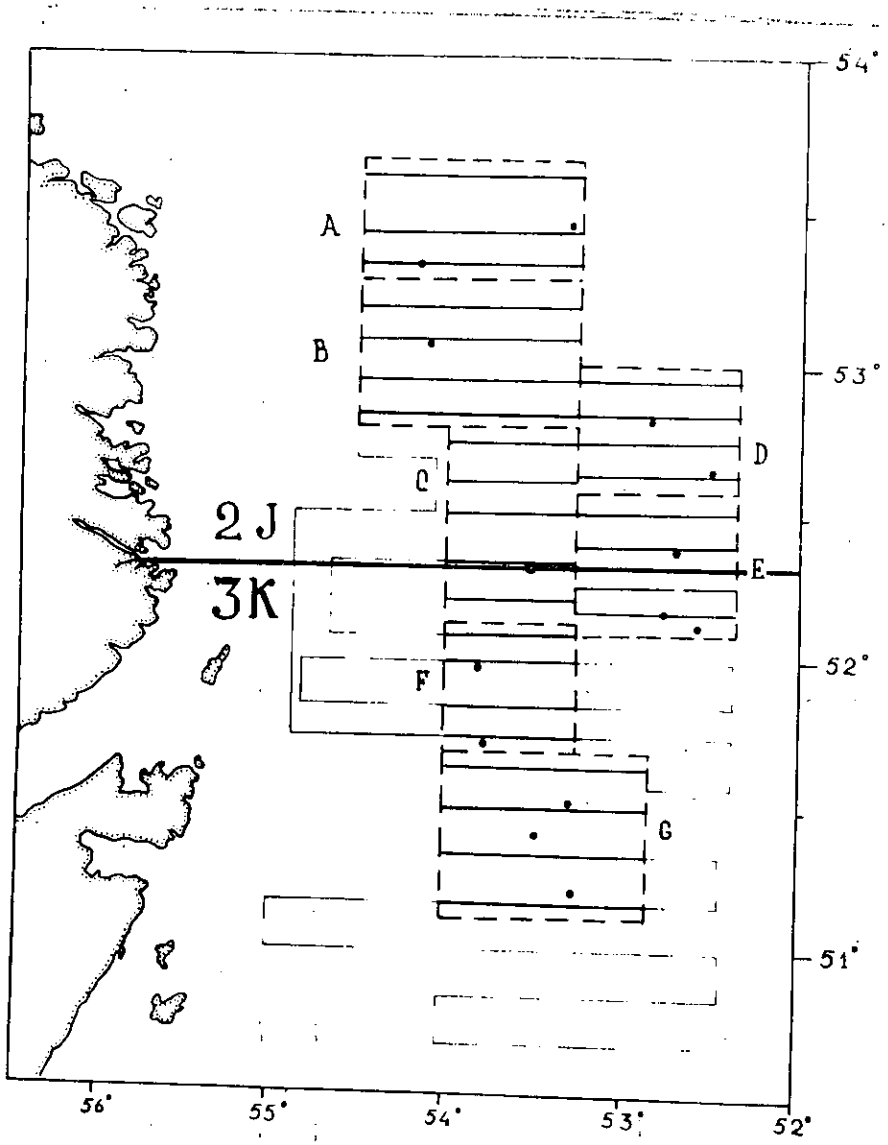

Fig.2. Route of the capelin survey, strata and check haulings in November 1990