Northwest Atlantic Fisheries Organization

Serial No. N2034 NAFO SCR Doc. 92/1

SCIENTIFIC COUNCIL MEETING - MARCH 1992

Results From Acoustic Capelin Surveys in Div. 3LNO and 2J+3KL in 1991

by

V. S. Bakanev

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

ABSTRACT

Results from two acoustic surveys, carried out in Divs.3LNO in June 1991 and Divs. 2J3KL in November 1991 are presented. Data provided by the surveys show almost a 30-time reduction of the stock size compared to the estimates from relevant surveys in 1990, it was found to be at the lowest at record level for the recent 10 years.

The reason for such a drastic drop of the biomass, instead of expected growth, within only one year is not clear, although, it may be guessed, that extremely unfavourable hydrographic conditions are not of the least importance.

INTRODUCTION

Acoustic surveys for Newfoundland capelin, carried out by PINRO since 1974, make it possible to reliably control the dynamics of stock numbers and together with data from similar Canadian surveys provide basis for producing forecasts of the stock size and TAC one or two years in advance.

In 1991 works to provide acoustic estimates of the stock size were continued and had as their important task to cover as vast area of its distribution as possible.

MATERIAL AND METHODS

Acoustic capelin surveys in Divs. 3LNO and 2J3KL were carried out by RV"Vilnius". An acoustic station included echo-sounder EK-400, digital integrator SIORS and "Iskra-226" computer. Operation mode and calibration parameters of instruments in both surveys are given below:

frequency	- 38 kHz,
transmission band width	- 3.3 kHz,
TVG	- 20 lg R-0 dB,
pulse duration	- 1 ms,

receiving and transmitting sensitivity of the echo sounder (SL + VR)	- 130 dB,
directivity diagram	- 19.6 dB,
coefficient of sound attenuation	- 0.009 dB/m,
target strength (T_s)	- 19.1 lg L - 74.4 (dB)

Capelin biomass and standard deviation (σ) were calculated using technique suggested by CAFSAC (O'Boyle and Atkinson, 1989).

RESULTS

Div. 3LNO. In this area the survey fell within 6 June and 6 July, almost one month later, than usual. Later survey times were caused by heavy ice conditions over the northern part of the Grand Newfoundland bank as well as by lack of capelin in areas over the bank, free of ice, that were covered in May during trawl bottom fish survey.

Fig. 1 shows a survey track and positions of check tows. Biomass estimates are presented in Tables 1 and 2.Total biomass was estimated at 118 000 t, almost 30 times below the estimate from the 1990 survey. It should be noted, that the northernmost tack followed the ice edge, where densest concentrations of capelin were found, and it might well be that some fish distributed beneath the ice were not covered.

Immature capelin from the 1989 year class prevailed over northern parts of the survey area (strata A and B, 58% and 63%, respectively), the 1988 year class was second most numerous one (28% and 32%). Pre-spawning fish of the 1988 year class prevailed in the southernmost stratum (47.6%), while 1989 and 1987 year classes were equally represented (Table 3).

An acoustic survey carried out on the spawning grounds of the South-Eastern Shallows in the second half of June (Div.3N) did not find any concentrations of capelin.

Divs. 2J3K. In this area the survey covered the period from 28 October to 15 November. Survey track was designed with account for results from fish-finding works done by a group of commercial trawlers in September-October, besides information from acoustic survey carried out by the Canadian RV"Gadus Atlantica" in October was used. These works did not show any concentrations of capelin in Div. 2J, only Canadian data suggested small concentrations in the southern part of Div. 3K. In view of the above said, it was decided to cover the Div. 2J with big reconnoitring tacks, while to lay special emphasis on Divs. 3K and 3L.

Fig. 2 shows survey tracks in Divs. 2J3K, area, where the capelin were found, strata and positions of check tows. No capelin were found in Div. 2J. Two small patches of capelin with the total area of 1300 sq.miles were observed in the south-east of Div. 3K. Total biomass of capelin in this area was estimated at 19.2 thou.t ± 3.2 thou.t (Tables 4,5).

In check tows 1989 year class prevailed (72.6%), 1988 year class was the second most important (24.2%), while 2-yr-olds (1990) and 5-yr-olds (1987) accounted for 1.5% each (Table 6).

Div. 3L. In this area an acoustic survey for capelin was done from 15 to 30 November concurrent to the trawl 0-group survey, locations with higher densities of capelin received better coverage (extra tacks and check tows).

Fig. 3 shows the survey track and area of capelin occurrence. Capelin were found to be distributed over the area of about 11 000 sq.miles between 47° and 49° N, from the Canada 12-mile zone to the continental slope of the Grand bank. In the west of the above area 1990 year class prevailed, length variation was from 8 to 11 cm. In the east of the distribution range 1988-1990 year class capelin occurred in some concentrations.

In general, 1990 year class accounted for 94.4% in numbers, that were estimated at 3.8×10^9 fish, which corresponded to the biomass of about 11 000 t (Tables 7,8).

Besides, two-year olds (1990 year class) occurred in a research trawl for fry almost everywhere during the trawl 0-group survey in Divs.3LNO. Their numbers in catch varied from single individuals to several thousands per 30 min. tow in depth 0-60 m.

DISCUSSION

Strength of individual year classes of capelin, a species with a short life cycle and considerable fluctuations of numbers, is important for the development of the commercial stock.

Before 1990, a correlation between the forecasted recruitment, estimated from data provided by acoustic surveys, and later actual numbers of these year classes was quite satisfactory, which allowed to control the dynamics of stock numbers.

However, in 1990 this relation was disrupted, unexpectedly stock numbers dropped drastically instead of increasing at the expense of recruitment from successive 1987-1989 year classes of higher strength (Bakanev, 1991) (Table 9).

For instance, the capelin stock in Divs. 3LNO estimated by Canadian and Soviet acoustic surveys in summer 1990 at 7 and 3.7 mill.t was only about 120 thou.t in 1991, as shown by similar surveys(Table 9). This reduction of stock size was noted as early as autumn 1990, when a Canadian survey done in October 1990 in Divs. 2J3K provided an estimate of only about 100 thou.t against 1.7 mill.t in 1989 (Miller, 1991), and Soviet acoustic survey in November 1990 gave an estimate of about 600 thou.t (Bakanev and Zubov, 1991). It was hypothesized, that abnormally low temperatures of waters over the Grand bank (3LNO) and in feeding areas (2J3K) (Borovkov and Tevs, 1991) exerted notable influence on the distribution of fish, and a great part of them did not migrate northwards to leave the Grand bank, and therefore, was not covered by the autumn survey.

However, results from two Soviet surveys by RV"Vilnius" in 1991 and similar acoustic surveys by Canadian RV"Gadus Atlantica" (Carscadden, personal communication) showed that the stock continued to decline, and a hypothesis, that the stock had been underestimated by surveys because of specific distribution appeared to be hardly probable.

Fragmentary capelin research during a year, makes it difficult now to suggest with certainty any reasons behind unexpected collapse of the stock, although extremely unfavourable hydrologic conditions during 1990-1991 are unlikely to be of the least importance. These conditions might well produce adverse effects on the natural mortality of capelin through food supply (zooplankton) or through stronger pressure from predators due to longer overlapping of the distribution ranges of prey and predators. However, to confirm these assumptions actual or indirect observations are required, that are not presently available, although, slower growth rate of capelin, as indicated by data from recent survey on the Grand bank (3L), compared to the growth rate of capelin from Div. 3K (Table 6), may serve as an indirect proof of scanty food supply for capelin.

REFERENCES

Bakanev V.S., 1991. Trawl survey for the 1990 year class of capelin stock assessment in Divs. 3LNO. SCR Doc. No. 91/10, Ser.No. N1882, 8 p.

Bakanev V.S. and Zubov V.I., 1991. Acoustic assessment of capelin stock in NAFO Divs. 3LNO and 2J + 3K in 1990. SCR Doc. No. 91/09, Ser No.1181,10p.

Borovkov V.A. and Tevs I.I., 1991. Oceanographic conditions in NAFO SA 0,1,2 and 3 in 1990. SCR Doc. No.91/11, Ser.No. N1183, 20 p.

Miller D.S., 1991. Estimates of biomass from an acoustic survey for capelin (Mallotus villosus) in Div. 3L, May 1990. SCR Doc. No. 91//37, Ser.No. N 1917, 14 p.

O'Boyle and Atkinson D.B., 1989. Hydroacoustic survey. Methodologies for pelagic fish as recommended by CAFSAC. CAFSAC Res.Doc. No. N89/72, 12 p.

Table 1. Results from acoustic capelin survey in Divs.3LO in June 1991

Stratum	Biomass thou.t	Number of tacks (act.)	Number of possible tacks	Stratum area, sq.mile	Mean biomass along tack in stratum, t	Standard deviation, t
A	23,5	6	70	8960	335,I	705,9
B	I3,I	8	70	3360	I87,5	373,I
C	38,7	4	50	4200	774,6	502,3
D	43,I	3	40	3400	I076,7	I647,2
Total	II8,4	2I	230	I9920	5I4,6	I9I,I
R.m.s. deviation (σ)	±44,0					

Table 2. Some indices from acoustic capelin survey in Divs 3LO in June 1991.

Stratum	Tack No.	Tack length	$\bar{s}$ t/mile^2	Biomass along tack, t	Number of tows	Length measurem. individ.	Age samples, individ.
A	I	I28	I3,80	I773,3	2	400	94
	2	I28	0,88	II2,0	-	-	-
	3	I28	0,54	69,3	-	-	-
	4	I28	-	-	-	-	-
	5	I28	0,44	56,0	I	200	58
	6	I28	-	-	5	263	-
B	I	48	-	-	-	-	-
	2	48	0,25	I2,0	-	-	-
	3	48	4,45	2I2,7	-	-	-
	4	48	-	-	-	-	-
	5	48	I,04	50,I	-	-	-
	6	48	22,70	I09I,5	I	200	58
	7	48	2,70	I29,3	-	-	-
	8	48	0,I0	4,2	2	353	40
C	I	84	I2,00	I009,6	3	3II	29
	2	84	I6,I0	I355,3	-	-	-
	3	84	2,90	240,7	3	236	54
	4	84	5,90	492,6	I	56	2I
D	I	85	35,00	2974,I	3	532	92
	2	85	2,90	243,4	-	-	-
	3	85	0,I5	I2,5	3	I7I	38

Table 3. Age composition (%), mean length (L, mm) and weight (W, g) of capelin in Divs.3LO as suggested by the acoustic survey in June 1991.

Stratum	Index	Age, years 2	3	4	5	Total
A	%	63,0	27,7	8,8	0,5	I00,0
	L	I0,6	I4,I	I5,6	I6,5	I2,0
	W	5,6	I7,3	25,0	29,8	I0,6
B	%	57,6	32,5	9,5	0,4	I00,0
	L	II,6	I3,9	I5,6	I6,4	I2,7
	W	7,5	I6,0	24,9	29,5	I2,8
C	%	40,7	36,8	2I,I	I,3	I00,0
	L	9,6	I4,5	I6,0	I6,8	I2,9
	W	4,6	I9,3	27,I	30,7	I5,I
D	%	24,2	47,6	26,3	I,9	I00,0
	L	I0,7	I4,8	I5,9	I6,9	I4,I
	W	5,8	20,3	26,9	3I,8	I8,8
Total	%	44,4	36,8	I7,7	I,I	I00,0
	L	I0,5	I4,5	I5,9	I6,8	I3,0
	W	5,7	I8,7	26,5	32,0	I4,5

Table 4. Results from acoustic capelin survey in Div.3K in November 1991.

Stratum	Biomass t	Number of tacks actual	possible	Stratum area, sq.mile	Mean biomass along tack, t	Standard deviation, t
A	407I	6	28	896	I45	I90
B	4I52	5	34	8I6	I22	I30
C	2875	3	I5	285	I92	I62
D	8I22	4	2I	672	387	I42
Total	I9220	I8	98	2669	I96	33
Standard deviation (σ)	3236					

Table 5. Some indices from acoustic capelin survey in November 1991.

Stratum	Tack No.	Tack length mile	Mean density M/sq. mile	Mean density T/sq. mile	Mean density G/sq. mile	Biomass t	Number of tows	Length measur. indiv.	Age sample indiv.
A	1	32	1,0	0,3	0,1	8			
	2	32	61,9	16,1	4,7	514	2	400	76
	3	32	18,4	4,8	1,4	153	2	400	74
	4	32	16,4	4,3	1,2	136			
	5	32	3,5	0,9	0,3	29			
	6	32	3,8	1,0	0,3	32			
B	1	24	48,0	12,5	3,6	299	1	200	35
	2	24	1,0	0,3	0,1	6			
	3	24	35,0	9,1	2,6	218	1	200	37
	4	24	12,0	3,1	0,9	75	1	200	32
	5	24	2,0	0,5	0,2	13			
C	1	19	85,3	19,9	5,8	378	1	200	39
	2	19	25,4	5,9	1,7	113			
	3	19	19,0	4,4	1,3	84	1	200	44
D	1	32	56,3	13,1	3,8	420			
	2	32	42,1	9,8	2,9	314	1	200	44
	3	32	32,5	7,6	2,2	243			
	4	32	76,3	17,8	5,2	570	1	200	40

Table 6. Age composition (A, %), mean length (L, mm) and mean weight (W, g) of capelin in Divs. 3K and 3L as suggested by acoustic survey in November 1991.

Stratum	Index	Age 1	Age 2	Age 3	Age 4	Age 5	Total
			Div. 3K				
A + B	A		65,0	31,5	3,4	0,1	100,0
	L		13,7	14,8	15,9	17,2	14,2
	W		16,3	20,6	25,4	35,4	18,0
C + D	A	2,5	77,3	19,6	0,5	0,1	100,0
	L	11,1	13,5	14,8	16,4	16,5	13,7
	W	6,7	14,4	20,4	29,9	31,0	15,5
Total	A	1,5	72,6	24,2	1,6	0,1	100,0
	L	11,1	13,6	14,8	16,0	16,8	13,9
	W	6,7	15,1	20,5	26,2	32,6	16,5
			Div. 3L				
A	A	89,2	10,6	0,2			100,0
	L	9,2	11,6	13,2			9,5
	W	3,5	7,4	11,8			3,9
B	A	85,4	14,1	0,5			100,0
	L	8,8	11,9	13,8			93,0
	W	3,0	8,3	14,9			3,8
C	A	100,0					100,0
	L	84,0					8,4
	W	2,6					2,6
Total	A	94,4	5,4	0,2			100,0
	L	8,6	11,8	13,7			8,8
	W	2,8	8,1	14,4			3,1

Table 7. Results from acoustic capelin survey in Div. 3L in November 1991.

Stratum	Numbers bill. fish	Biomass in stratum, t	Number of tacks	Stratum area, sq.mile	Mean density in Stratum, g/sq.m	Disp. of total density, g/sq.m	L cm	$\bar{W}$ g
A	0,598	I763	5	2314	0,22	0,I0	8,80	2,95
B	0,877	3332	6	6422	0,I5	0,06	9,30	3,80
C	2,294	5965	4	2209	0,79	0,40	8,60	2,60
Total	3,768	II059	I5					
σ	I,375							
Area	I0945 sq.miles							

Table 8. Some indices from acoustic capelin survey in Div. 3L in November 1991

Stratum	Tack No.	Length mile	Density m/sq.mile	Density g/sq.mile	Numbers, mill. fish	Biomass, t
A	I	60,0	2,8	0,08	2,638	7,8
	2	25,0	2I,0	0,57	8,245	24,3
	3	I5,0	5,0	0,I4	I,I78	3,5
	4	25,0	8,8	0,24	3,455	I0,2
	5	20,0	I0,2	0,27	3,204	9,5
B	I	90,0	3,7	0,II	4,706	I7,9
	2	28,0	I3,7	0,43	5,42I	20,6
	3	64,0	2,0	0,06	I,809	6,9
	4	92,0	I,5	0,05	I,950	7,4
	5	47,0	I3,4	0,42	8,900	33,8
	6	50,0	3,6	0,II	2,544	9,7
C	I	22,0	II,2	0,28	4,043	I0,5
	2	I6,0	86,0	2,I4	22,579	58,7
	3	23,0	I8,0	0,45	6,794	I7,7
	4	5,0	I0,4	0,26	0,853	2,2

Table 9. Numbers and biomass of Newfoundland capelin as provided by Soviet acoustic surveys for 1982-1991.

Year	Numbers, bill.fish					Biomass, thou.t
	Age				Total	
	2	3	4	5		
			3LNO			
1982	11.6	19,1	4,7	0,9	36,3	610
1983	0,7	4,3	6,4	1,9	13,3	346
1984	123,6	50,2	16,2	1,7	191,7	2280
1985	230,7	53,3	4,4	0,9	289,3	2200
1986	18,4	70,9	5,9	-	95,2	1492
1987	45,7	30,9	30,0	0,6	107,2	2161
1988	177,5	91,7	34,1	7,6	310,9	3951
1989	78,8	96,5	10,8	1,5	187,6	2458
1990	156,0	105,9	35,5	2,5	299,9	3752
1991	3,6	3,0	1,5	0,1	8,2	118
			2J3K			
1982	11,6	19,1	4,7	0,9	36,3	611
1983	20,5	16,2	2,5	-	39,2	852
1984	19.3	3.8	1.4	0.2	24.7	480
1985	83,8	18,1	2,6	0,2	104,7	1540
1986	19,0	44,6	3,6	0,2	67,4	1491
1987	44,6	6,9	7,0	0,2	58,7	1164
1990	14,9	13,1	2,7	0,1	30,8	631
1991*	4,3	0,5	0,2	+	5,0	30

* Stock estimate for 3KL.

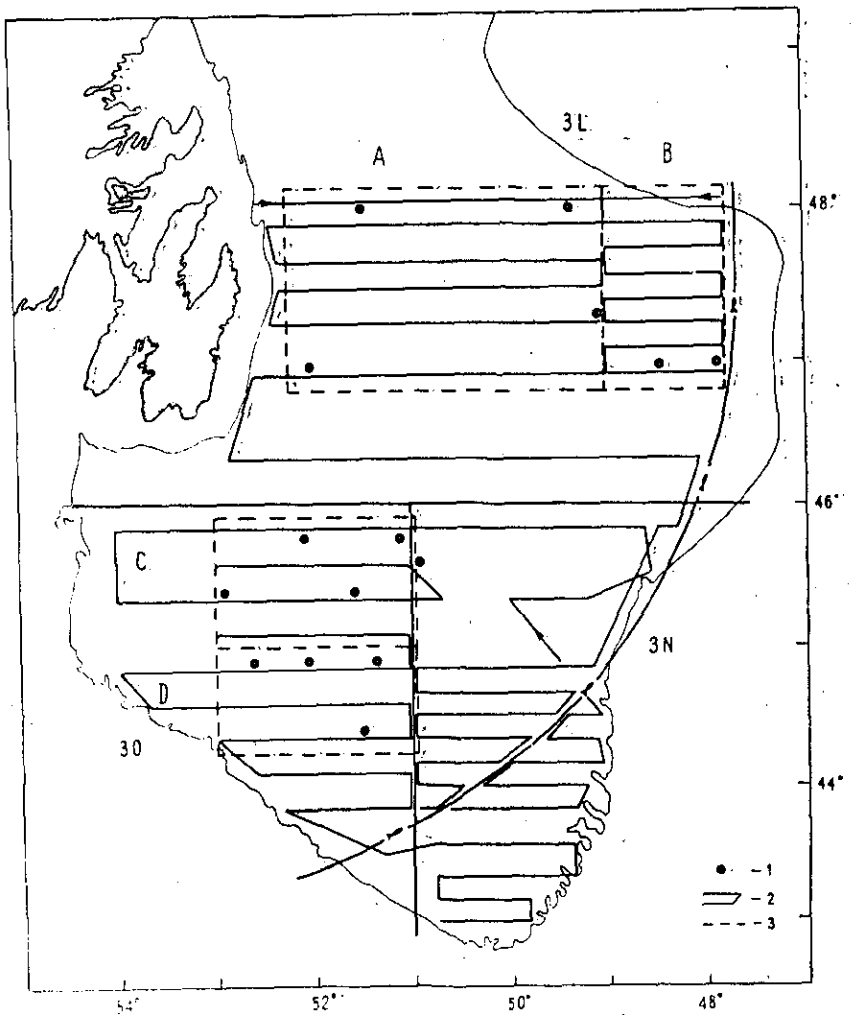

Fig. 1 Capelin survey track, strata and check tows in June 1991.
1 - check tows;
2 - track;
3 - strata boundaries.

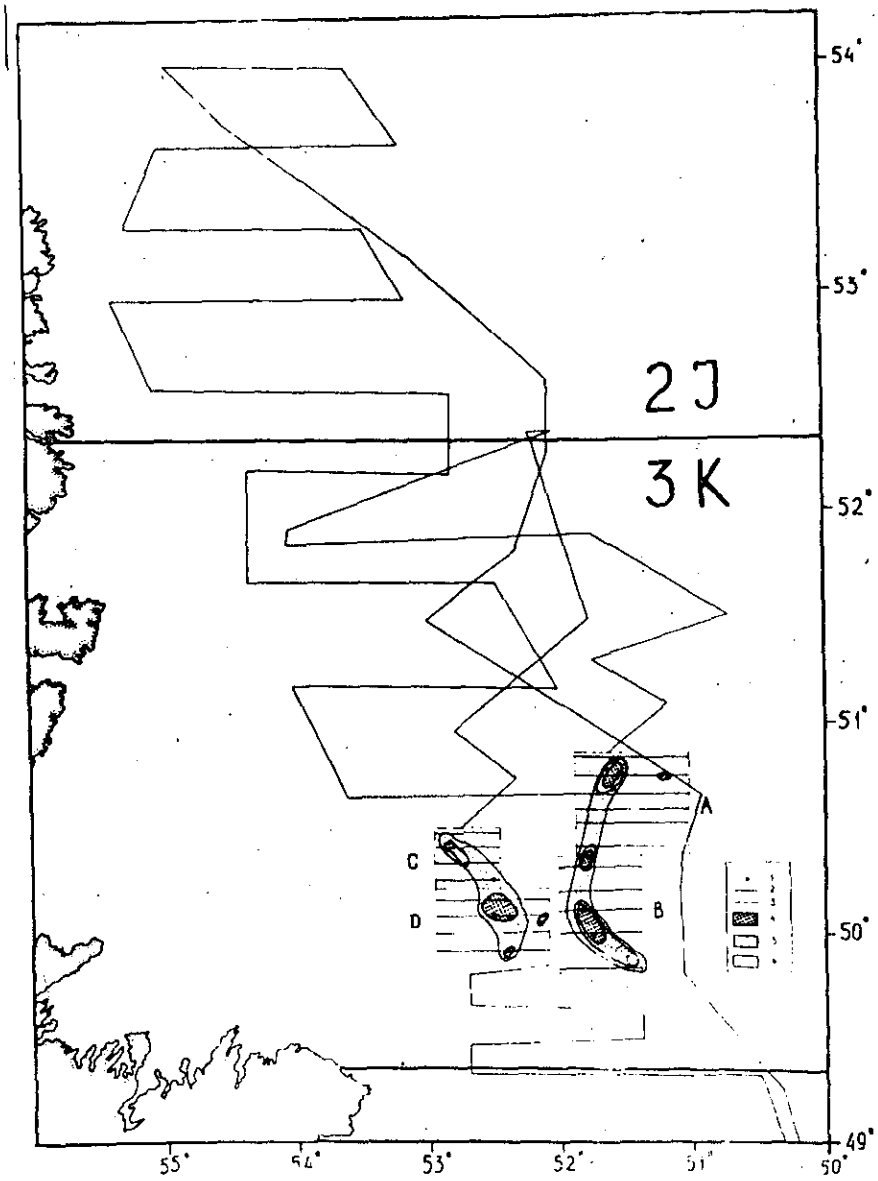

Fig. 2 Track of acoustic capelin survey in Divs.2J3K in November 1991.
1 - check tows; 2 - survey track; 3 - boundaries of strata.
Density areas: 4 - 100 m; 5 - 11-100 m;
6 - 1 - 10 m

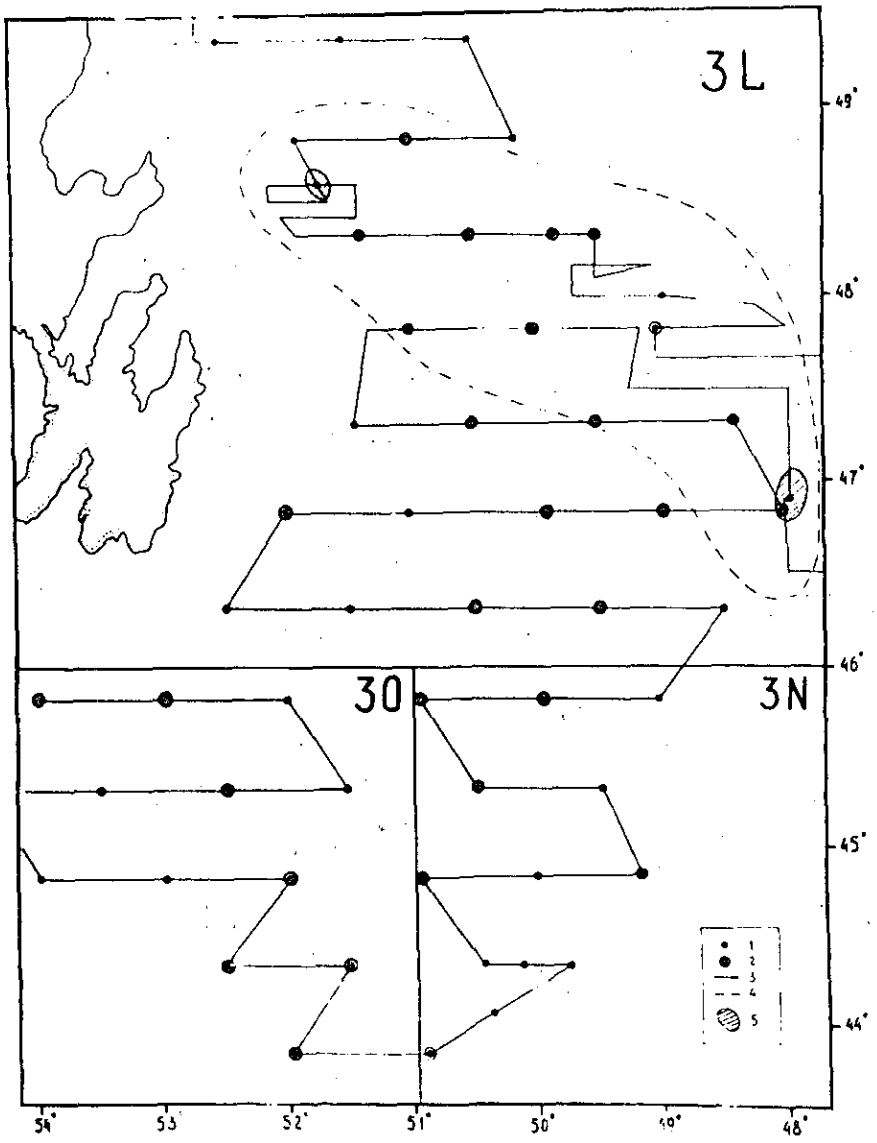

Fig. 3 Survey track and positions of trawl stations (0-group capelin)
1 - trawl stations; 2 - catches containing two-yr-olds (1+); 3 - survey track.
Areas with density of capelin: 4 - 1-25 $\bar{m}$ (echo intensity); 5 - < 25 $\bar{m}$.