

International Commission for



the Northwest Atlantic Fisheries

Serial No. 5205
(D.c. 9)

ICNAF Res.Doc. 78/VI/43
(Revised)

ANNUAL MEETING - JUNE 1978

An Acoustic Estimate of Capelin (*Mallotus villosus*) Biomass,
ICNAF Divisions 2J and 3K, October and November 1977

by

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An acoustic survey of capelin stocks in ICNAF Divisions 2J and 3K was carried out on the Canadian research vessel "M.V. Gadus Atlantica" in the autumn of 1977. The Division 2J survey was completed during October 29-November 1 and the 3K survey during November 3-7. A capelin biomass of between 507,000 and 635,000 metric tons was estimated.

Introduction

Annual surveys of capelin stocks in the 2J-3K area have been made by U.S.S.R. scientists since 1974 (Serebrov, Bakanev, Kovalev, 1975; Bakanev, Seliverstov, Sevebrov, 1976; Klochtov, Seliverstov, Serebrov, 1977). These surveys were made using a combination of photographic and acoustic techniques to estimate stock abundance. The surveys did not include areas inside Canada's territorial limit. Biomass estimates from the surveys during the period 1974-1976 ranged from 0.98 million tons to 1.33 million tons, and were considered by U.S.S.R. scientists to be underestimates because they did not include areas inside Canada's territorial limit.

This paper presents capelin biomass estimates from a Canadian acoustic survey in Divisions 2J and 3K including areas inside the Canadian territorial limit. The biomass estimates were made using acoustic data only.

Materials and Methods

The acoustic survey was made using the computerized echo counting system developed at the Marine Ecological Laboratory, Dartmouth, N.S. (Dowd, 1974). The acoustic data was analyzed using an echo integration computer program designed for density estimation of schooling fish. Ship speed was maintained at 8 knots throughout the acoustic survey. A target strength value of -50dB/fish was used in the integration program.

The survey track covered 645 kilometers in Division 2J and 1205 kilometers in Division 3K (Fig. 1). Solid line portions of the cruise track represent daytime sampling and dotted line portions represent nighttime sampling. The 12 mile Canadian territorial limit is indicated by the broken line. Fig. 2 shows the areas covered by the cruise in Div. 2J and 3K which were used to calculate the total capelin abundance. Fig. 3 shows mean density estimates at 18.52 kilometer (10 nautical miles) intervals over the cruise track. An abundance estimate was calculated from mean densities for each area derived from the density estimates made every 741 meters (3 min. intervals) over the cruise track.

It was noted in this survey and in previous surveys by the U.S.S.R. (Serebrov, Bakanev, Kovalev, 1975; Bakanev, Seliverstov, Serebrov, 1976; Klochkov, Seliverstov, Serebrov, 1977) that nighttime density estimates were lower than daytime estimates because of diurnal movements of the capelin schools. Estimate densities for day and night periods for Div. 2J and 3K combined are shown in Table 1. Because daytime density estimates were 3.2 times greater than nighttime densities, the nighttime estimates were adjusted by this factor in calculating total abundance (Table 2).

Discussion and Results

Table 2 gives density estimates adjusted for diurnal migration for Div. 2J and Div. 3K and abundance estimates for the entire area shown in Fig. 2.

Sampling data collected during the cruise was used to calculate age composition by sex, and mean weights at age by sex. This data was used to convert the numeric abundance estimates to biomass estimates. These results are shown in Table 3. The calculations indicate a total biomass for Div. 2J and 3K of 4.00 million metric tons.

The target strength value of -50dB/fish used in the integration program for density estimation is significantly lower than the true target strength for capelin. The mean length of capelin during the 1977 survey was about 17 cm. Nakken and Olsen (1977) give a regression of target strength on fish length for herring. This regression predicts a target strength of -40dB at 38 khz for 17 cm fish. Dalen, Raknes and Røttingen (1976) give a regression of target strength on fish length for 4 species of Clupeiformes, including capelin. The regression predicts a target strength of -40.5dB at 38 khz for 17 cm fish. Beamish (pers. comm.) investigated capelin target strength in submerged cage experiments and suggests a value of -42dB/fish at 50 khz. The value of target strength chosen is extremely critical in the calculation of fish density. If the target strength used is 8dB less than its true value, it results in overestimating fish density by 6.3 times. If target strength used is 9dB less than its true value, it results in overestimating fish density by 7.9 times.

Therefore, by using the incorrect value of -50dB as a target strength, it is likely that we have overestimated the biomass by 6.3 to 7.9 times. Taking this into account, the corrected biomass estimate for Div. 2J and 3K capelin is 507 thousand tons if target strength was in error by 9dB and 635 thousand tons if the error in target strength was 8dB.

References

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Table 1. Density estimates for nighttime and daytime, Divisions 2J and 3K combined.

Daytime	Summation of Densities	3927
	Total Intervals	1043
	Mean Density	3.77
Nighttime	Summation of Densities	1706
	Total Intervals	1455
	Mean Density	1.17
Ratio	$\frac{\text{Daytime Density}}{\text{Nighttime Density}}$	$= \frac{3.77}{1.17} = 3.2$

Table 2. Abundance estimates - 2J-3K Capelin.

Area	2J	3K
Total Counts (fish/m ² /interval)	593	5040
Total Counts (adjusted nighttime estimates)	1197	8157
Total Intervals	870	1628
Estimated Density	1.3747	5.03
Area Sampled (m ²)	15568.33 x 10 ⁶	26558.28 x 10 ⁶
Abundance	21.424 x 10 ⁹	133.069 x 10 ⁹

Table 3. Biomass estimation - 2J and 3K Capelin.

Age	2J 21.424 x 10 ⁹ fish			3K 133.069 x 10 ⁹ fish		
	Av. Indiv. Wt. (gm)	% of Stock	Biomass (M.T.)	Av. Indiv. Wt. (gm)	% of Stock	Biomass (M.T.)
♂						
2	-	-	-	19.09	4.6	116,851
3	34.88	17.0	127,036	27.90	20.0	742,514
4	41.40	35.0	310,434	33.24	14.8	654,626
5	52.00	1.0	11,140	-	-	-
Total		53.0	448,610		39.4	1,413,991
♀						
2	35.00	1.0	7,498	13.49	7.4	132,835
3	29.90	10.0	64,058	18.79	25.8	645,085
4	34.32	31.0	227,934	24.96	25.0	830,338
5	38.25	4.0	32,779	27.40	2.0	72,921
6	47.00	1.0	10,069	32.00	0.4	17,033
Total		47.0	342,338		60.6	1,698,212
Total (sexes combined)			790,948	3,212,203		
Total 2J and 3K				4.00 x 10 ⁶ tons		

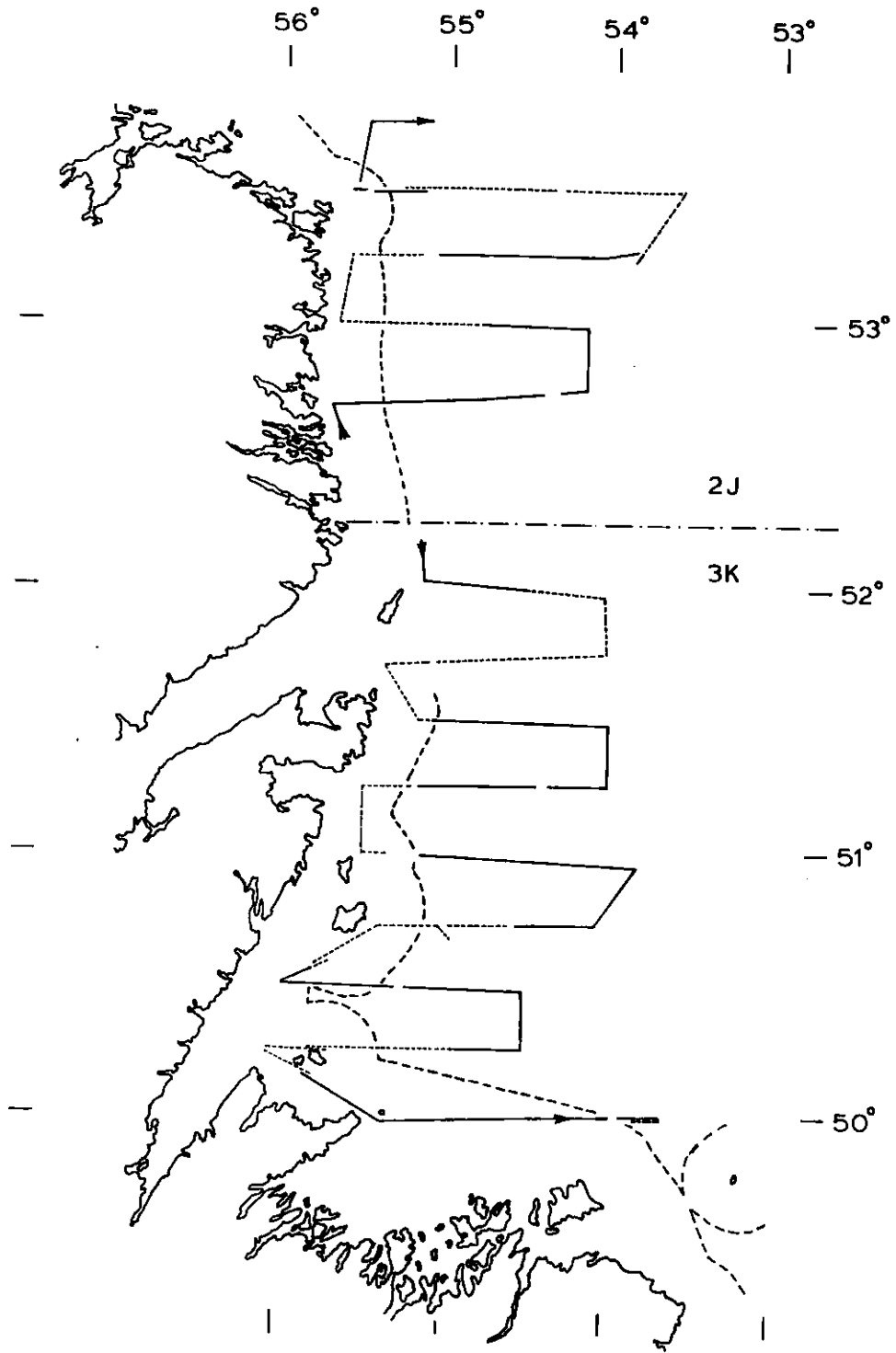


Fig. 1. Acoustic survey track, Div. 2J and 3K, 1977.
(Night - solid line; day - dotted line;
Territorial limit - broken line)

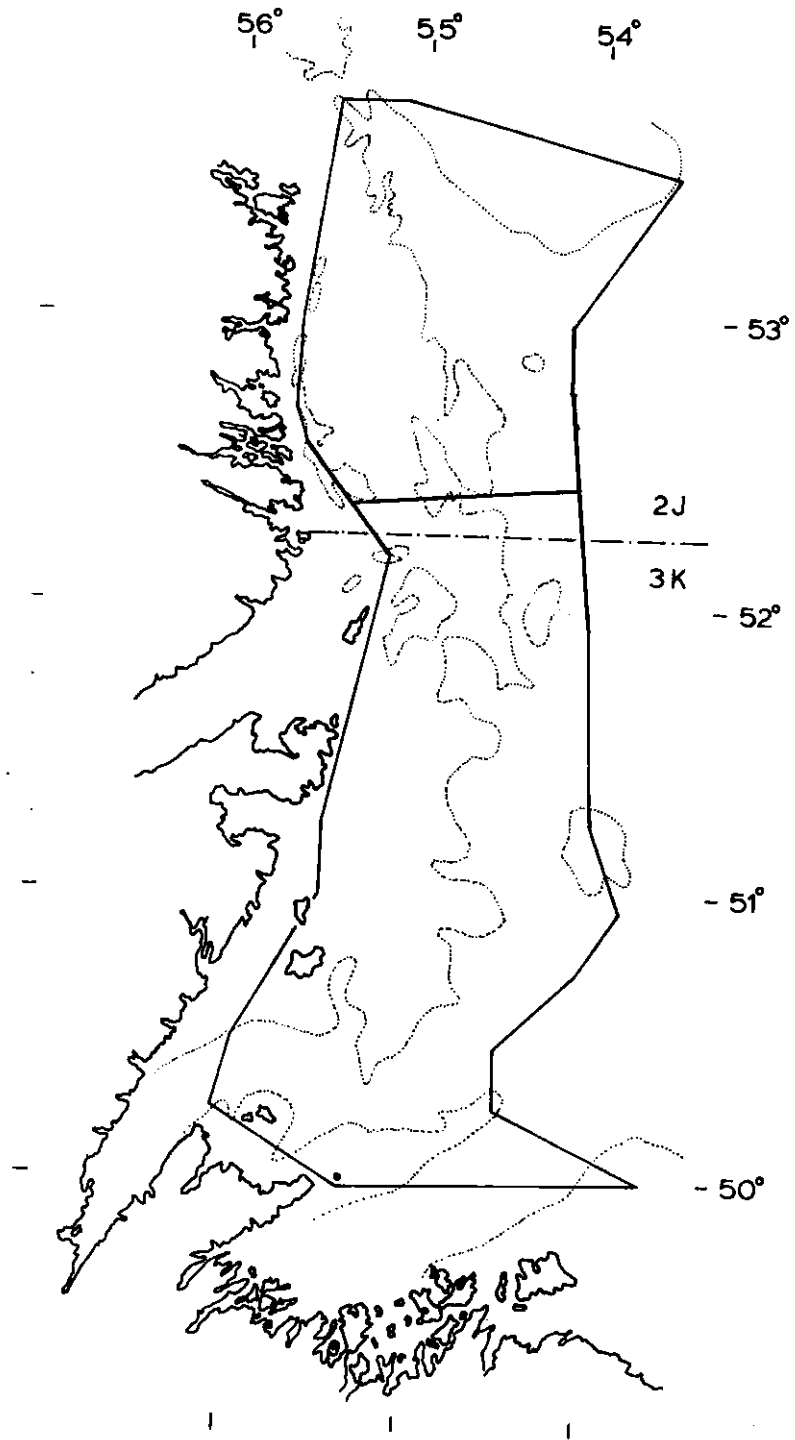


Fig. 2. Area of capelin concentration surveyed.

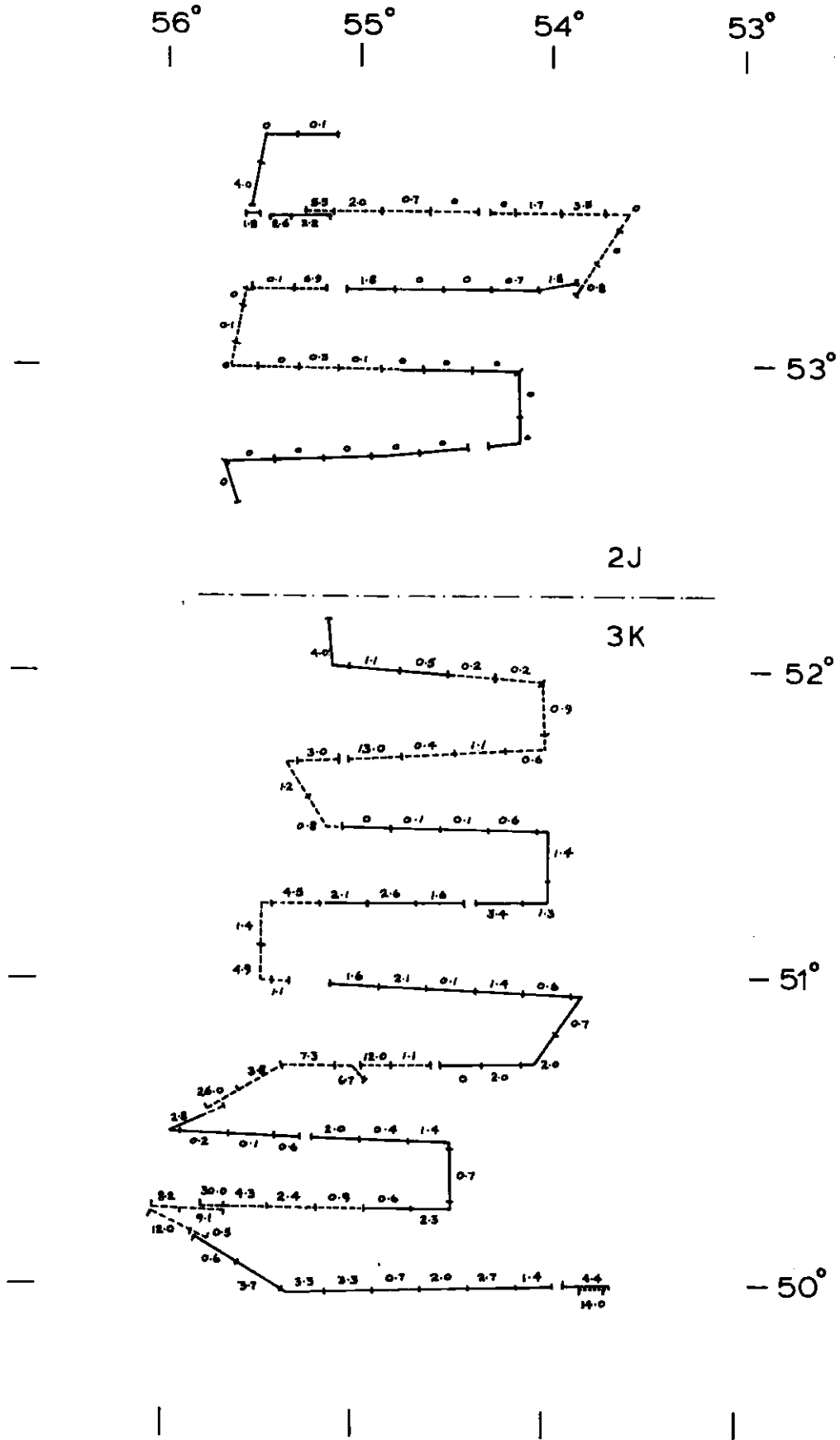


Fig. 3. Average capelin densities (No./M²) over 18.5 kilometer distance. (Night - solid line; day - dotted line)

