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Estimates of Capelin (Mallotus villosus) Biomass from Hydroacoustic Surveys in Divisions 3LNO in 1985 and 1986

by

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Introduction

This paper presents the results of three capelin hydroacoustic surveys carried out in 1985 and 1986. Biomass estimates are provided for NAFO Division 3L for all three surveys and for Division 3N for the June-July 1985 survey only. Preliminary results from the 1985 surveys were presented at the special session on biological surveys in September 1985 (Miller 1985).

These surveys are part of a continuing program of hydroacoustic assessments carried out by Canada on capelin stocks in the Newfoundland-Labrador area since 1977.

Materials and Methods

Data were collected using a custom designed hydroacoustic data acquisition system (Stevens et al. 1985). The system consists of a Simrad EK400 echosounder operating at 49 kHz, with a time varied gain of 20 logR + 2αC R. A custom designed data acquisition computer samples the returned echo signals at a 15 kHz sampling rate, digitizes the signal levels and writes the results to 9-track computer tape. Subsequent analysis is by echo integration (Miller 1985).

In previous years, all data were corrected to an ideal 20 logR + 2αC R time varied gain where the attenuation coefficient αC was assumed to be 0.0175dB/meter. An examination of the literature on attenuation of sound in seawater suggests a more realistic estimate is 0.0120dB/meter for the hydrographic conditions encountered during capelin surveys (Foote 1981; Fisher and Simmons 1977). Consequently, all historical survey data were corrected for this change in the estimate of the attenuation coefficient. The results of the 1985 survey as presented at the survey symposium were also adjusted accordingly.

Fishing sets were made throughout the survey to provide biological samples of capelin and to provide an estimate of mixing with other species.

Results

Cruise tracks for each survey, GADUS 109 (May 1985), GADUS 111 (June-July 1985) and GADUS 124 (May 1986) are shown in Figures 1, 2, and 3. Location of fishing sets made during each survey are also shown in each figure. Age and length composition of capelin are shown for each survey in Figures 4, 5, and 6. Tables 1, 2, and 3 give a summary of the hydroacoustic biomass estimates from each of the three surveys. Division 3L capelin biomass was estimated at 3,426,000 t from the May 1985 survey, 1,001,253 tons from the June-July 1985 survey, and 3,697,499 tons from the May 1986 survey. Division 3NO capelin biomass was estimated at 213,088 tons from the June-July 1985 survey. Coefficients of variation due to sampling and the relative contribution of inter-transect versus intra-transect variance (the delta parameter) were calculated using a cluster sampling model (Nakashima 1981). Inter-transect variance comprised the major component of the sampling variance.

Sampling data from the surveys indicated the presence of a very strong 1983 year-class (Fig. 1, 2, and 3). Examination of maturity stages from samples taken during the 1986 May survey indicate that only 38% of the 1983 year-class will spawn in 1986. An examination of length weight data from the samples indicate that for the 1983 year-class there is a reduction

of mean weight at length of about 7.5% compared to the historical data for three-year-old capelin sampled in May. This reduction in condition factor may explain the low maturation rate for the 1983 year-class.

Tables 4, 5, and 6 give the historical acoustic biomass estimates for Divisions 3L and 3NO corresponding to the survey period (spring-April/May, summer-June/July).

References

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Nakashima, B. S. 1981. Sampling variation and survey design for capelin, Mallotus villosus, from an acoustic survey in Division 3LNO, 1980. NAFO SCR Doc. 81/14, Ser. No. N278.

Stevens, C. R., J. E. Carscadden, D. B. Atkinson, W. H. Lear, D. S. Miller, and B. S. Nakashima. 1985. A summary of hydroacoustic research in the Newfoundland Region. CAFSAC Res. Doc. 85/35.

Table 1. Acoustic survey results for GADUS Cruise 109 (3L - May 1985).

	Block A	Block B	Block C	Block D	Block E	Block F
Mean density	63.8	153.8	215.2	43.6	28.4	24.1
Area (sq. km)	5162	4562	5464	6817	23345	10770
Total biomass	329291	701479	1175668	296885	662773	259944
# of transects	15	5	4	4	12	8
# of estimates	179	116	140	178	526	228
Delta	.90	.94	.97	.97	.97	.96
Lw limit delta	-.09	-.05	-.03	-.02	-.02	-.04
C of variation	19.4	24.5	31.1	22.2	25.3	36.1
Min. density	13.0	41.3	79.4	19.4	6.8	2.5
Max. density	189.3	287.5	395.2	70.4	77.6	74.4

Block A			Block B			Block C			Block D			Block E			Block F		
T#	#Ds	Mean D	T#	#Ds	Mean D	T#	#Ds	Mean D	T#	#Ds	Mean D	T#	#Ds	Mean D	T#	#Ds	Mean D
1	17	57.0	1	23	92.1	1	34	79.4	1	45	19.4	1	42	77.6	1	29	4.4
2	11	39.5	2	23	287.5	2	37	88.0	2	48	32.5	2	44	63.7	2	31	2.5
3	12	105.8	3	24	139.5	3	36	309.0	3	44	70.4	3	42	23.2	3	28	4.1
4	11	189.3	4	23	41.3	4	33	395.2	4	41	54.2	4	43	33.0	4	29	5.7
5	11	155.5	5	23	208.9							5	43	71.3	5	27	74.4
6	11	112.2										6	45	15.6	6	29	55.4
7	12	37.7										7	44	15.3	7	28	30.3
8	12	37.5										8	42	9.7	8	27	20.5
9	12	47.8										9	46	6.8			
10	12	96.8										10	45	13.1			
11	12	16.2										11	44	7.9			
12	11	13.0										12	46	8.2			
13	12	16.9															
14	12	27.1															
15	11	19.8															

Total biomass for GADUS 109 is 3,426,040 tons.

(Mature - 935,344 tons, immature - 2,490,696 tons)

Table 2. Acoustic survey results for GADUS Cruise 111 (Block A - Division 3L, Block E - Division 3N).

	Block A	Block B	Block C	Block D	Block E
Mean density	27.5	22.3	10.7	3.3	8.4
Area (sq. km)	10433	18542	19468	24788	25368
Total biomass	287308	413812	208473	91660	213088
# of transects	30	7	7	9	7
# of estimates	358	251	254	324	388
Delta	.91	.97	.97	.96	.98
Lw limit delta	-.09	-.03	-.03	-.03	-.02
C of variation	16.5	32.0	24.3	22.7	28.4
Min. density	2.2	7.1	4.8	.7	2.9
Max. density	110.7	69.4	28.4	9.4	22.8

Block A			Block B			Block C			Block D			Block E		
T#	#Ds	Mean D	T#	#Ds	Mean D	T#	#Ds	Mean D	T#	#Ds	Mean D	T#	#Ds	Mean D
1	13	12.9	1	35	15.1	1	36	8.6	1	36	.7	1	56	7.5
3	12	22.0	2	35	19.0	2	36	5.1	2	36	3.8	2	56	22.8
4	12	6.0	3	36	7.1	3	34	12.7	3	36	6.5	3	53	9.8
5	12	2.9	4	37	19.8	4	41	9.2	4	36	2.8	4	57	7.5
6	12	9.6	5	36	13.0	5	36	4.8	5	36	3.0	5	56	3.2
7	12	28.7	6	37	14.1	6	38	8.1	6	37	1.8	6	55	2.9
8	11	9.7	7	35	69.4	8	33	28.4	7	36	2.4	8	55	5.0
9	12	2.2							8	34	2.7			
10	12	5.9							9	37	9.4			
11	12	5.3												
12	12	6.8												
13	12	7.7												
14	12	8.8												
15	11	11.8												
16	12	56.4												
17	12	110.7												
18	12	62.1												
19	12	83.4												
20	12	63.9												
21	12	19.8												
22	12	12.3												
23	12	60.9												
24	11	27.4												
25	12	19.2												
26	12	36.7												
27	12	26.9												
28	12	21.7												
29	12	26.4												
30	12	33.3												
31	12	23.1												

Total biomass for GADUS 111 Division 3L is 1,001,253 tons
(Mature - 210,297 tons, immature - 790,956 tons)

Total biomass for GADUS 111 Division 3N is 213,088 tons
(Mature - 168,977 tons, immature - 44,111 tons)

Table 3. Acoustic survey results for GADUS Cruise 124 (3L - May 1986).

	Block A	Block B	Block C	Block D
Mean density	139.7	36.5	37.4	23.8
Area (sq. km)	10715	19686	33812	9106
Total biomass	1497304	718349	1265097	216749
# of transects	31	17	13	16
# of estimates	373	667	699	288
Delta	.91	.97	.98	.94
Lw limit delta	-.09	-.03	-.02	-.06
C of variation	15.2	34.8	17.8	18.7
Min. density	11.0	1.6	2.0	1.4
Max. density	510.6	192.7	88.9	56.7

Block A			Block B			Block C			Block D		
T#	#Ds	Mean D	T#	#Ds	Mean D	T#	#Ds	Mean D	T#	#Ds	Mean D
1	12	19.3	1	40	120.3	1	53	6.4	1	18	1.4
2	12	83.9	3	39	102.4	2	53	2.0	2	18	3.3
3	12	16.3	3	39	34.7	3	54	5.7	3	18	4.6
4	12	19.2	4	39	41.1	4	54	88.9	4	18	8.2
5	12	11.0	5	39	45.9	5	53	59.4	5	19	15.3
6	13	14.8	6	40	192.7	6	54	37.7	6	17	17.3
7	12	29.8	7	38	41.5	7	54	66.9	7	18	9.4
8	12	132.6	8	40	8.1	8	54	32.9	8	18	38.6
9	12	121.6	9	39	2.2	9	54	45.1	9	18	44.1
10	13	172.7	10	39	1.6	10	54	25.8	10	18	29.7
11	12	136.6	11	39	3.8	11	54	47.9	11	18	24.2
12	11	174.9	12	40	2.5	12	55	25.5	12	18	10.0
13	12	137.3	13	38	2.7	13	53	41.8	13	18	16.8
14	12	115.2	14	39	3.0				14	18	55.2
15	12	105.8	15	40	5.4				15	18	56.7
16	12	168.1	16	39	5.0				16	18	46.3
17	12	510.6	17	40	4.1						
18	12	362.3									
19	12	292.7									
20	13	113.5									
21	12	99.8									
22	12	69.9									
23	12	121.4									
24	12	208.3									
25	12	301.3									
26	11	296.3									
27	12	379.3									
28	12	56.7									
29	12	44.4									
30	12	29.4									
31	12	12.8									

Total biomass for GADUS 124 is 3,697,499 tons
(Mature - 1,869,265 tons, immature - 1,828,234 tons)

Table 4. Spring (April-May) Division 3L acoustic survey biomass estimates by year-class.

	Age					
Survey year	1	2	3	4	5	6
Numbers (billions)						
1982	<0.1	9.9	16.0	2.4	0.7	0.2
1983	<0.1	3.5	1.9	0.7	<0.1	<0.1
1984	0.1	21.0	6.1	3.2	0.5	<0.1
1985	<0.1	367.4	82.0	4.8	1.8	<0.1
1986	0	63.7	168.1	22.6	0.8	0.4
Weight ('000s tons)						
1982	<1	50	327	61	21	6
1983	<1	27	36	21	2	6
1984	<1	128	117	93	15	<1
1985	<1	1975	1255	136	59	<1
1986	0	392	2649	618	24	14

Table 5. Summer (June-July) Division 3L acoustic survey biomass estimate by year-class.

Survey year	Age 1	2	3	4	5	6
Numbers (billions)						
1981	61.8	19.7	34.9	8.2	1.9	<0.1
1982	23.1	4.1	4.3	0.2	<0.1	<0.1
1983	57.5	2.3	1.7	0.7	<0.1	0
1984	47.5	28.9	3.8	2.8	0.4	<0.1
1985	3.7	84.5	16.3	0.6	0.2	<0.1
Weight ('000s tons)						
1981	150	204	606	195	54	3
1982	35	41	95	5	1	<1
1983	109	20	36	15	<1	0
1984	97	182	86	82	11	<1
1985	5	715	259	16	5	<1

Table 6. Division 3NO acoustic survey biomass estimate broken down by year-class expressed in numbers and weight.

Survey year	Age 1	2	3	4	5	6
Numbers (billions)						
1981	<0.1	0.6	8.3	1.4	0.3	<0.1
1982	0	0.1	16.6	0.7	0.1	<0.1
1983	0	0.2	3.6	3.8	0.5	<0.1
1984	1.6	0.3	2.8	0.9	0.2	<0.1
1985	0.2	5.9	6.5	0.5	<0.1	0
Weight ('000s tons)						
1981	<0.1	4	165	43	11	1
1982	0	1	390	22	5	1
1983	0	2	85	115	17	<1
1984	3	4	48	27	5	<1
1985	<1	59	135	16	2	0

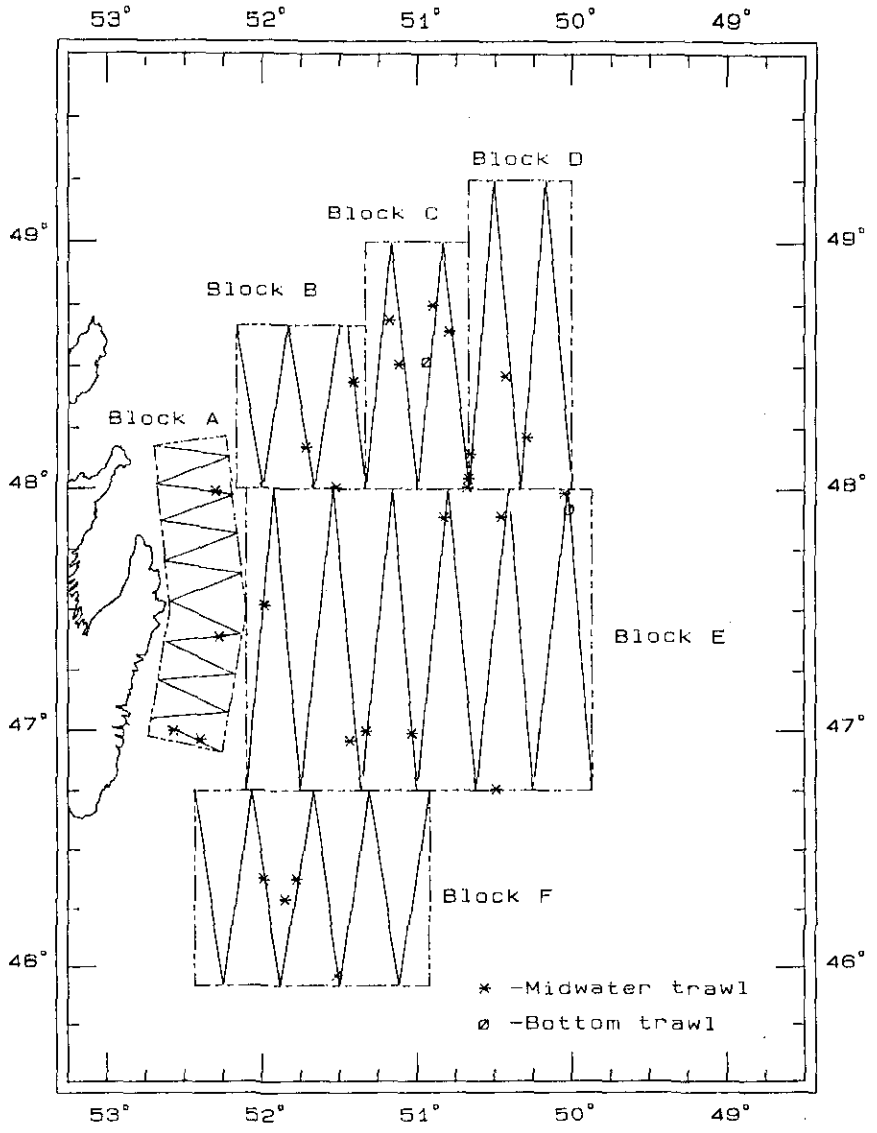

Fig. 1. Cruise track for GADUS 109, NAFO Division 3L, May 1985.

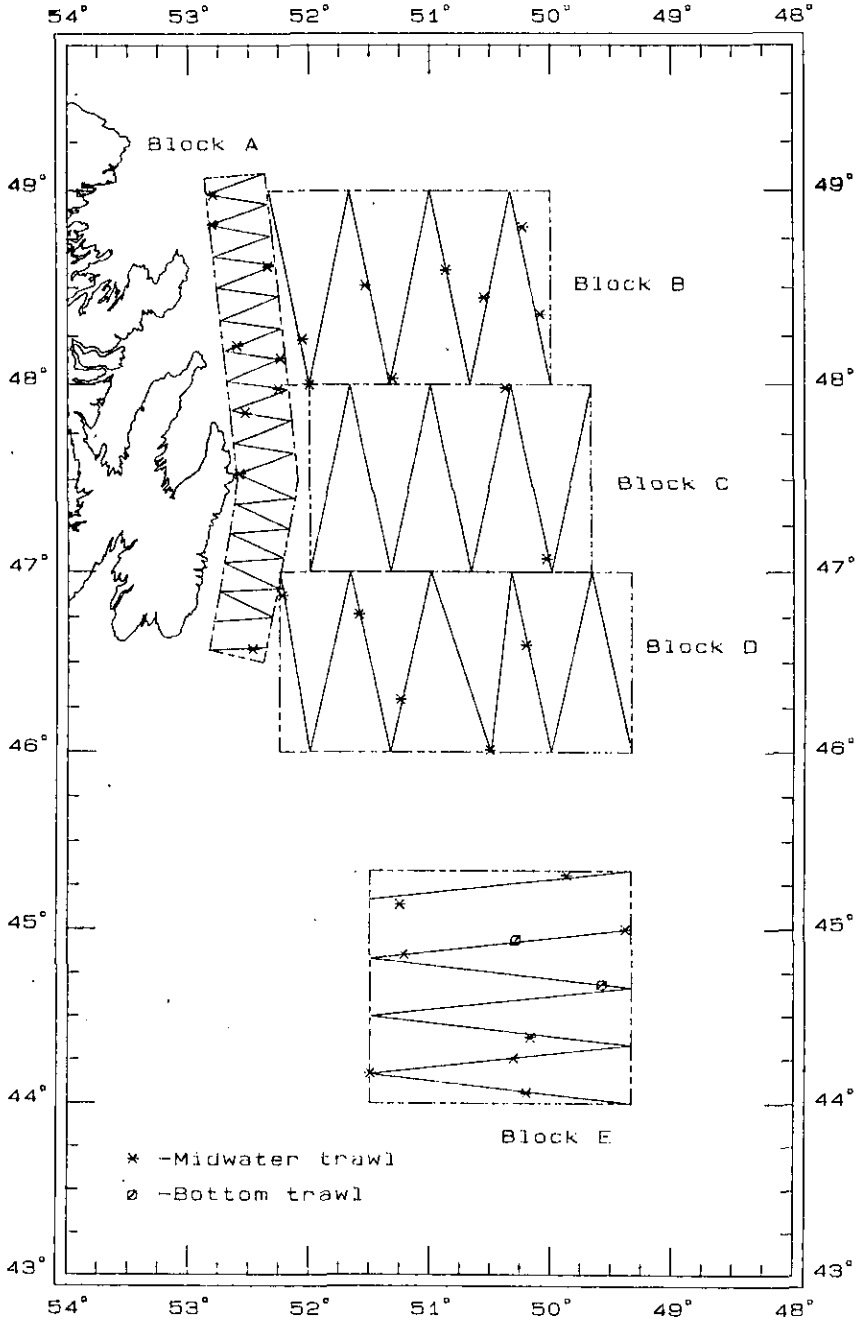

Fig. 2. Cruise track for GADUS 111, NAFO Division 3LN, June-July 1985.

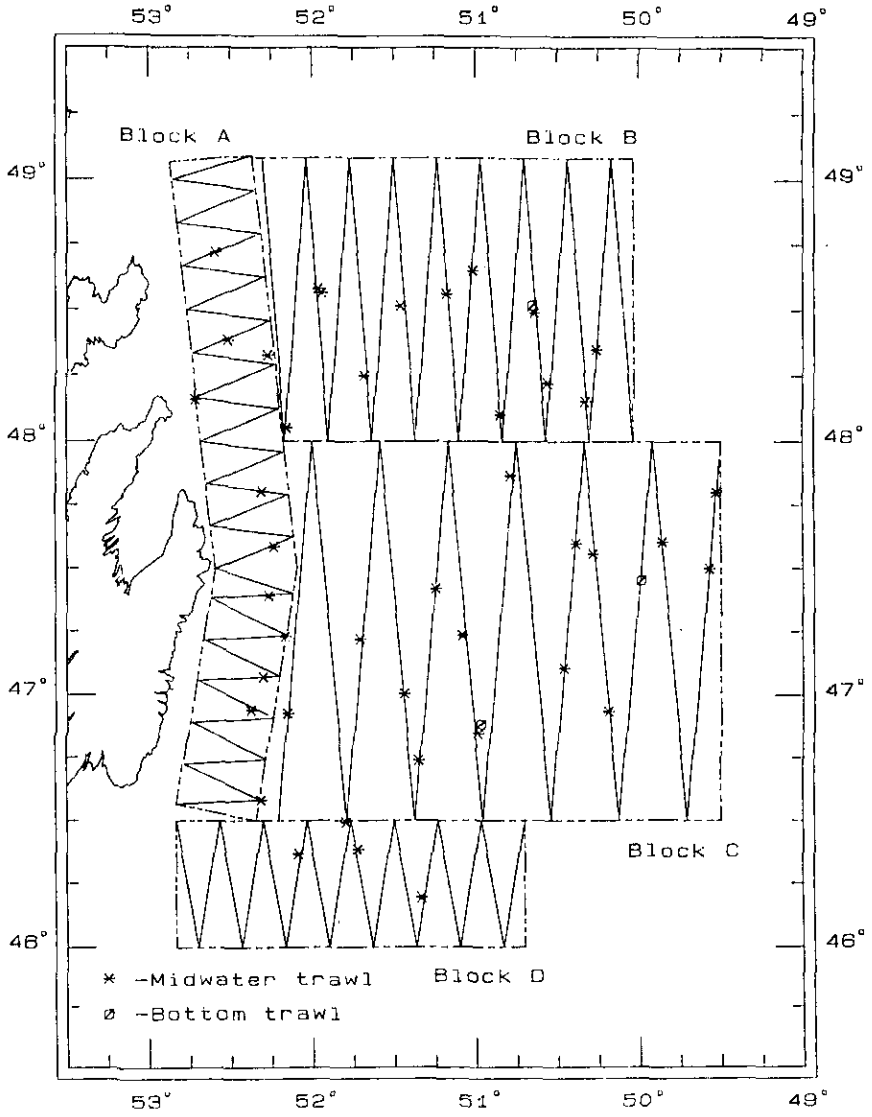

Fig. 3. Cruise track for GADUS 124, NAFO Division 3L, May 1986.

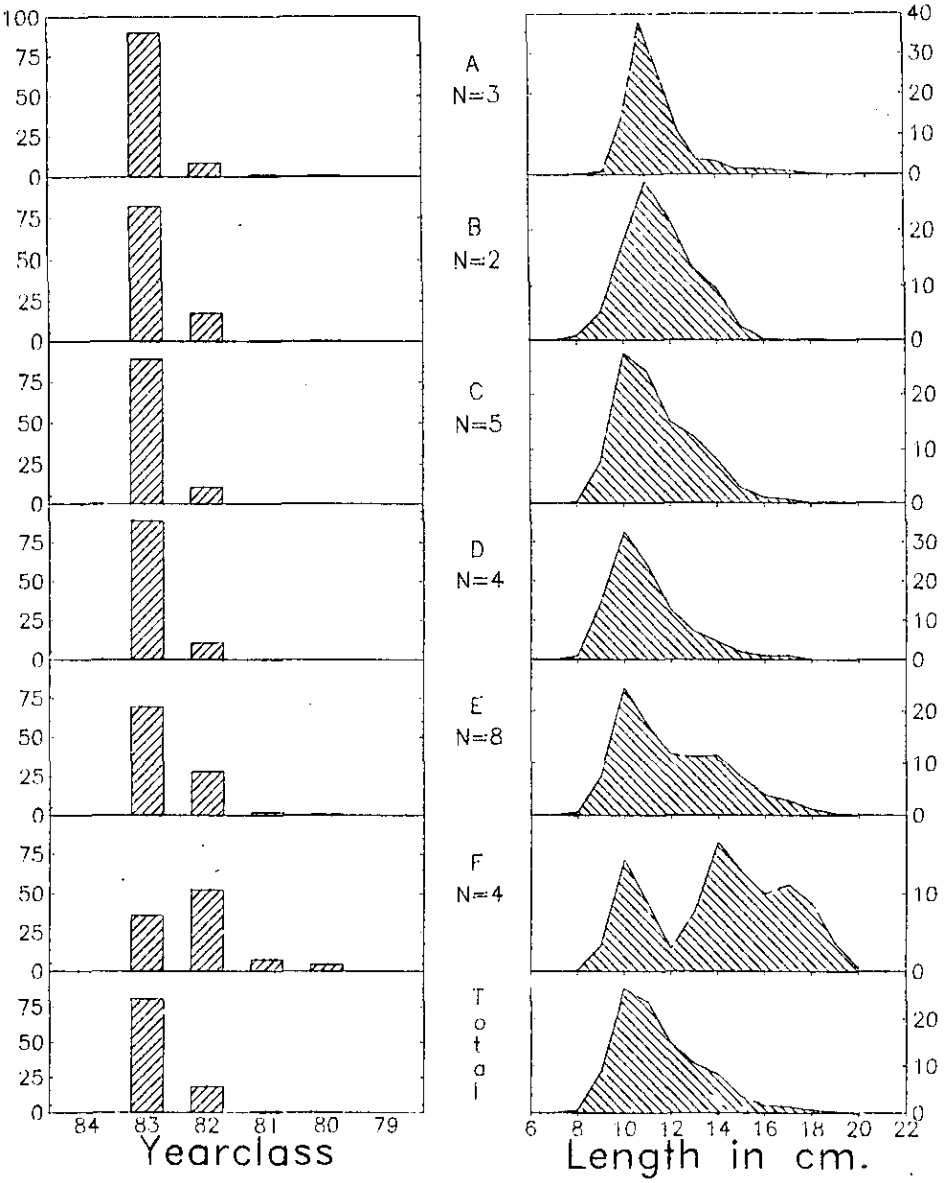

Figure 4. Age and length compositions from Gadus Atlantica Cruise 109

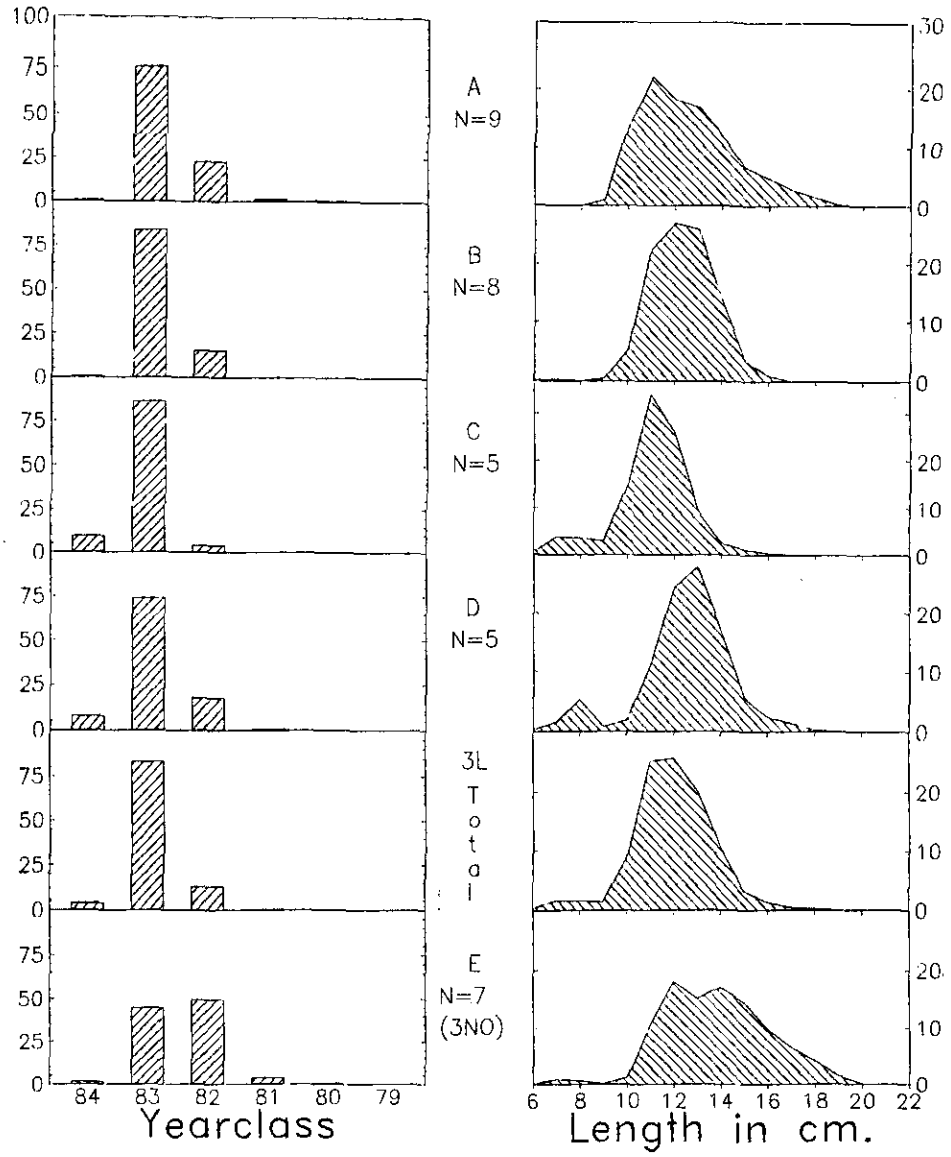

Figure 5. Age and length compositions from Gadus Atlantica Cruise 111

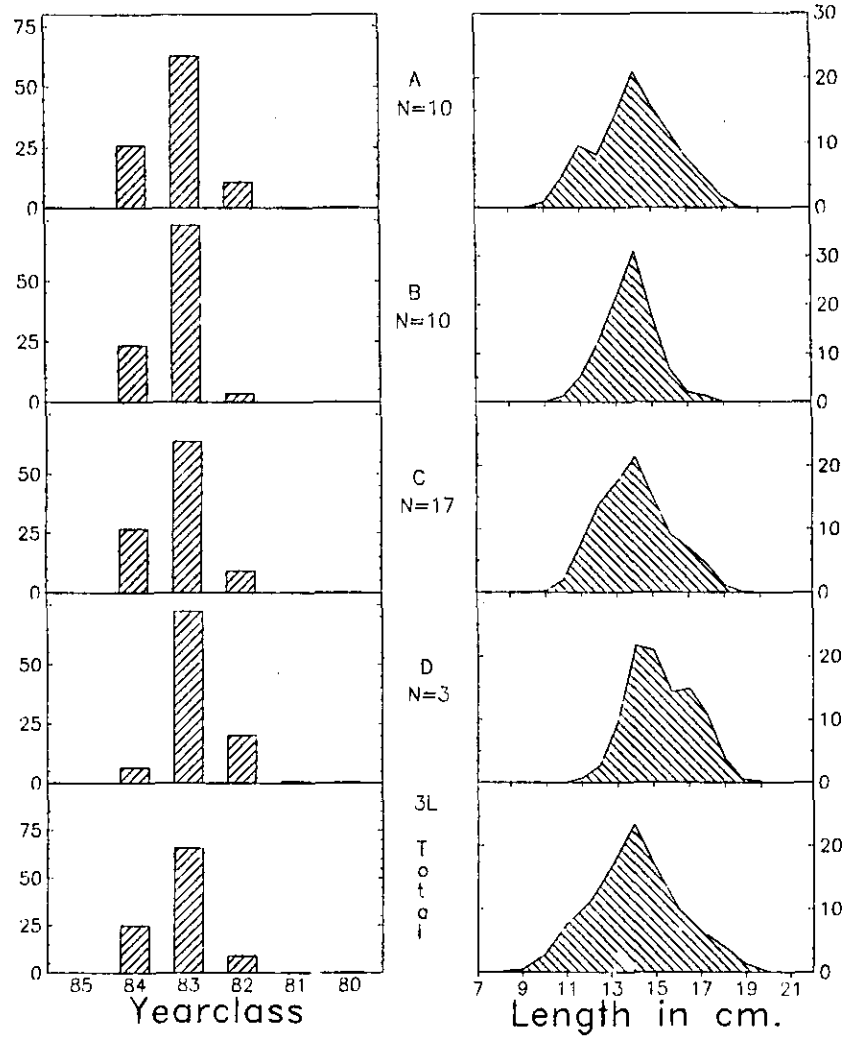

Figure 6. Age and length compositions from Gadus Atlantica Cruise 124