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Capelin in Division 3L and Their Occurrence in the NAFO Regulatory Area

by

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Introduction

This paper has been prepared in response to a question posed by the Fisheries Commission of NAFO, specifically, "for capelin in Div. 3L, what proportion of the biomass of capelin is available, on average, seasonally and annually, in the Regulatory Area".

Data Sources

The only quantitative surveys designed to estimate capelin abundance in the NAFO area are acoustic surveys conducted by USSR and Canada. During the 1970's, acoustic surveys in Div. 3LNO were conducted annually by the USSR but most of the survey effort was concentrated on the spawning stock in Div. 3NO. During the 1980's, the survey coverage was expanded to cover portions of Div. 3L as well as Div. 3NO. Canada began acoustic surveys in the late 1970's and began routine surveys in Div. 3L during the early 1980's. The Soviet and Canadian surveys normally are conducted within the 200-mile fishing zone and thus there are no estimates of abundance available to address the question posed by the Fisheries Commission.

Two other sources of data are available which, although qualitative in nature, do provide insight into the occurrence of capelin in the 200-mile fishing zone and in the Regulatory Area. Capelin have been caught during stratified-random bottom trawl surveys conducted over a number of years by personnel from Fisheries Research Branch, St. John's. Also, during some of these groundfish surveys, stomachs were collected from Atlantic cod (Gadus morhua) and American plaice (Hippoglossoides platessoides), and the occurrence of capelin in these stomachs provide a second indication of capelin distribution.

By-catch of Capelin in Stratified-random Bottom Trawl Surveys

The distribution of capelin in Div. 3L was examined using the geographic stratification given in the Manual of Groundfish Surveys in the Northwest Atlantic (Doubleday 1981) and shown in Figure 1. Six strata are entirely within the Regulatory Area and 7 strata are partially (5-99%) within the Area (Table 1). From the area of each stratum (Doubleday 1981) and the estimate of the percentage of each stratum occuring within the Regulatory Area (Table 1), we calculate that only 45% of the total area of these 13 strata occurs within the Regulatory Area.

Because numbers of capelin were not recorded for many catches, only weights were used. The arithmetic mean weight per set was calculated for each stratum using the method of Smith and Somerton (1981). Since the amount of capelin caught per set was generally very low and since capelin are pelagic species and the surveys were directed towards groundfish species, the authors are of the opinion that the results cannot be used in a quantitative manner. Consequently, the results have been presented in ranges of <1 kg/set, 1-10 kg/set, and >10 kg/set. This grouping provides a presence or absence comparison as well as semi-quantitative information about whether capelin were very low or very high in abundance in the catches at any place and time.

Only research vessel surveys that met two criteria were used in this paper. First, only those trips that had capelin recorded as a catch were used in the analysis. While this has the danger of omitting valuable information in a presence or absence study, it was not known whether capelin were not observed or simply not recorded because they were not a species of primary interest. Some surveys which showed only a few sets with capelin present were also

not used. Second, only those trips that had data in a form that could be analyzed by the stratified-random survey data analysis program in St. John's were used. After these criteria were applied a number of surveys were used, including the series of spring groundfish surveys conducted primarily by the A.T. CAMERON, as well as the other seasonal surveys.

Four research vessels were employed in these surveys. The A.T. CAMERON (ATC) was a 51.2 m side trawler which fished a Yankee #41.5 bottom trawl. The GADUS ATLANTICA (GA) is a 73.8 m stern trawler and the WILFRED TEMPLEMAN (WT) and the ALFRED NEEDLER (AN) are 50.3 m stern trawlers. The latter 3 ships fished an Engel-145 trawl. All fishing sets were made at 3.5 knots for 30 minutes. The differences in the trawls may have affected catchability. This was not examined, but any differences are thought to be of minor importance, as will be discussed later.

Occurrence of Capelin in Predator Stomachs

Previous studies in Div. 3L (Lilly and Rice 1983) and on the Flemish Cap (Lilly and Gavaris 1982) have shown that the examination of cod stomachs may reveal the presence of small pelagic or semi-pelagic fish at more locations than can the trawling itself. Thus, a predator may be a useful collecting device if the target species tends to be relatively inaccessible to the trawl or is in low abundance. However, distribution patterns of prey inferred from their occurrence in stomachs of predators may be suspect, for it is possible that the predator may move a considerable distance before digestion renders the prey unrecognizable. In addition, if the quantity of prey in the predator's stomach is to be used as a quantitative index of relative prey density, one should determine the relationship between prey density and predation rate, including the influence of the relative sizes of prey and predator, the availability of other prey, appetite of the predator, and the distance from the bottom to the depth zone inhabited by the prey. These factors have not been examined with respect to predation by Atlantic cod and American plaice on capelin in Div. 3L, but the authors opine that the data should be useful in a semi-quantitative sense.

The quantity of capelin in the stomachs of all specimens of a given predator species, collected from a specific stratum during a specific survey, was expressed as a mean partial fullness index (PFI_c).

$$PFI_c = \frac{1}{n} \sum_{i=1}^{n} \frac{W_i}{L_i^3} \times 10^4$$

where W_i is the weight of capelin in fish i, L_i is the length of fish i, and n is the number of fish collected. These mean PFI_c values have been presented in the following ranges: for Atlantic cod, < 0.20, 0.20-0.99, > 1.0; for American plaice, < 0.10, 0.10-0.49, > 0.50. Only cod in the length range 36-71 cm were used, but American plaice of all sizes were used. The data are presented only for those strata for which $n > 4$.

Results

Winter Surveys

Results from only two winter surveys are available and coverage was much more extensive in 1985 than in 1984 (Table 2). In the 1985 survey, capelin were more prevalent in the northwest strata than in all other areas. Capelin occurred in only one of the 13 strata that were outside or overlapped the 200-mile line.

Spring Surveys

The spring surveys constitute the longest series, running from 1972-85 (Table 3). Many strata were not covered in 1972 and 1973 but generally the coverage improved after that. There was no survey in 1983 and coverage in 1984 was poor. In many years, depths greater than 200 fathoms (366 m) were not surveyed.

Four different research vessels were used in this series. We examined the influence of different vessels on our perception of capelin distribution by comparing the catches of the A. T. CAMERON and the GADUS ATLANTICA in May-June 1979, when the two vessels fished side-by-side at most positions in a comparative fishing experiment. The catch categories were in agreement in 23 (82%) of the 28 strata fished jointly. In the five other strata the GADUS ATLANTICA catches were one category higher than the A. T. CAMERON catches. This very close agreement, not only on presence or absence but also on semi-quantitative abundance, supports direct comparison of the results from all surveys.

Another concern is how well the grouping of strata into geographic areas will allow one to gain an accurate impression of the distribution of capelin within the division. From examination of Table 4 we conclude that in May-June 1979 capelin were widely distributed, but

highest densities were in the central and southwestern areas, and lowest density was in the area outside and overlapping the 200-mile zone. This is the same pattern we perceive from examination of the catches plotted on a set-by-set basis (Fig. 2). We conclude that although it would be preferable to examine distribution on a set-by-set basis, particularly for the area adjacent to the 200-mile line, the use of the stratification scheme permits a quick and fairly accurate interpretation of capelin distribution.

There appears to be no consistent pattern of capelin distribution within the 200-mile zone. The central area seems to be important in most years. Other areas were of moderate to high importance in some years but not others. Few capelin were taken anywhere in 1978.

Capelin occurred in strata outside and overlapping the zone in 11 of the 12 years when there was coverage. In only five (42%) of the 12 years (1974-76, 1982, 1985) was the catch rate intermediate or high in at least one stratum. In 1979, capelin were common in sets inside the zone but in strata overlapping and outside the zone, capelin did not appear in A. T. CAMERON sets and appeared in only small amounts in GADUS ATLANTICA sets. In 1985, when all strata were covered, capelin were less prevalent in deeper strata (729-736).

Results of stomach analysis were available for cod from five surveys (1978-82) and for American plaice from two surveys (1981 and 1982) (Table 4). To what extent are results from stomach analysis comparable to information from trawl catches? A comparison between the two methods is available on a set-by-set basis for the 1979 survey (Fig. 2 and 3). On a presence or absence basis, there was agreement in 80 (73%) of the 110 cases. Of the 30 instances of disagreement, cod stomachs revealed capelin presence in 22 (73%) of the cases. As stated above, largest capelin catches during these surveys tended to be in the central and southwestern areas. Most high PFI values also came from the central area, but from north of the largest capelin catches. This difference is probably due to the intensive predation on other prey, notably euphausiids and crabs, by cod in the southern part of the central area (Lilly and Rice 1983). We conclude from this comparison that the two methods of deducing capelin distribution yield similar results and are complementary.

A similar comparison between catches and stomach examinations may be made on a stratum-by-stratum basis for 1978-82 surveys (Table 4). In a comparison between catches and cod stomachs there was agreement on a presence-absence basis in 72 (75%) of the 96 cases. In 14 cases (58% of the disagreements) capelin were identified in cod stomachs but not recorded in the catch, and in ten instances capelin appeared in the catch (always <1 kg) but not in cod stomachs. In a comparison between catches and American plaice stomachs, there was agreement in 36 (71%) of the 51 cases, and in 12 (80%) of the disagreements capelin were caught in the trawl but were not identified in stomachs. In a comparison between cod stomachs and American plaice stomachs, there was agreement in 23 (68%) of the 34 cases, and in nine (82%) of the disagreements capelin were identified in cod stomachs but not in American plaice stomachs. We conclude that examination of stomachs from cod and American plaice yields information similar and complementary to that from the trawl survey. It is useful to use both predators because information will often be available from one but not the other.

The information from stomach examinations supports several conclusions derived from examination of catches alone. In 1978 capelin abundance was low to moderate in the west and very low elsewhere. In 1979 capelin were present in most strata inside the zone, being particularly abundant in the southwestern and central areas, but were in very low abundance in strata outside and overlapping the zone. In 1980 capelin were in low to moderate abundance in most areas inside the zone. In 1981 capelin appeared to be concentrated in the northwest, whereas in 1982 they were distributed to a much greater extent in the central and eastern areas, including the strata outside and overlapping the zone.

Summer Surveys

Results are available from three summer surveys, but coverage was good in only the 1984 and 1985 surveys (Table 5). In these two surveys, capelin occurred in approximately the same proportion of the strata (56% in 1984 and 63% in 1985). In 47% of the strata capelin occurred in both years. In strata outside and overlapping the zone, capelin occurrence was similar in the two years, with capelin being less prevalent in deeper strata.

The results of examination of stomachs from cod and American plaice were available for only the 1984 survey (Table 6). In a comparison of the occurrence of capelin in trawl catches and cod stomachs, there was agreement in 18 (60%) of 30 cases and in 11 (92%) of the disagreements capelin were identified in cod stomachs but not caught in the trawl. In a comparison between catches and American plaice stomachs, there was agreement in 19 (68%) of the 28 cases, and in seven (78%) of the disagreements capelin were found in stomachs but not caught in the trawl. In a comparison between cod and American plaice stomachs, there was agreement in 22 (81%) of the 27 cases, and in four (80%) of the disagreements capelin were identified in cod stomachs but not in American plaice stomachs. The impression from the examination of predator stomachs was that in 1984 capelin were more abundant and more widely distributed than deduced from catches alone.

Autumn Surveys

Catches are available from four regular surveys and one survey restricted to depths >183 m (Table 7). Capelin appear to be most prevalent in the north and east, including the strata outside and overlapping the 200-mile zone. As in other seasons, catches were low in strata deeper than 366 m.

The results of analysis of stomachs of cod and American plaice are available from three surveys (1981-83) (Table 8). In a comparison between trawl catches and cod stomachs, there was agreement in 41 (67%) of 61 cases, and in 11 (55%) of the disagreements capelin were found in cod but not in the trawl. In a comparison between trawl catches and American plaice, there was agreement in 38 (60%) of 63 cases, and in just three (12%) of the disagreements capelin were found in stomachs but not in the trawl. In a comparison between cod and American plaice stomachs, there was agreement in 32 (59%) of 54 cases, and in 21 (95%) of the disagreements capelin were found in cod but not in American plaice. Our impression of the results from examination of predator stomachs is that the presence of capelin in a few additional strata has been revealed, but that the conclusion that capelin are distributed primarily in the north and east remains unchanged.

Discussion

The results from the comparison of occurrence of capelin in trawl catches and in predator stomachs from the same strata indicate that the sources complement each other. There were cases in all seasons considered where each sampling source provided information on the occurrence of capelin when the other did not. However, one sampling source was not consistently "better" than the other.

The data presented here indicate that capelin occur in strata inside the 200-mile zone as well as in strata outside and overlapping the zone in all seasons of the year. Only in 1985 were surveys made during all seasons. In the winter of 1985 capelin catches were highest in the northwest, and nil or low elsewhere. In spring the capelin were broadly distributed, with low catches in the central area. In summer the capelin were distributed primarily in the north and east, with nil catches in many strata in the central and southwestern areas. By autumn the tendency toward concentration in the north and east was most pronounced. No capelin were caught in most strata in the central and southwestern areas. (These seasonal differences are more apparent in plots than in tables.) Stomachs were collected from cod and American plaice during the 1985 surveys, but analyses have not been completed, so we do not know if the stomachs will reveal the same patterns.

Was 1985 a typical year? There are insufficient data from other winters to permit a comparison. The spring distribution was similar to some other years, but very different from others. For example, in 1979 capelin were most abundant in the central and southwestern areas, and in very low abundance in the east. The summer and autumn distributions in 1985 were similar to other years, but there were only a few surveys available for comparison.

It will be important to determine why capelin distribution in spring varies so much among years. The 1985 surveys were conducted at a time when 2-year-old fish were very abundant in Div. 3L (Miller 1985) and the perceived distribution may be strongly influenced by the distribution of juvenile fish. A more detailed study of capelin distribution should attempt to determine distribution by age-group, and by degree of maturity for those age-groups which are at least partially mature. A more detailed analysis should be done on a set-by-set basis.

The data presented here are not adequate for determining "what proportion of the biomass of capelin is available, on average, seasonally and annually, in the Regulatory Area". However, it is clear that capelin may be found in strata outside and overlapping the Canadian 200-mile zone in any season. In spring, the season for which we have the longest time series, there are years when capelin density appears to be moderately high in this area, and other years when it is very low. There were few surveys in which depths greater than 366 m were fished, but our impression is that capelin are more prevalent in depths <366 m.

References

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Table 1. Percent area of individual strata in Div. 3L situated within the NAFO Regulatory Area. Strata not listed in this table occur completely within the 200-mile fishing zone.

Strata	Depth zone (fathoms)	% Area in NAFO Regulatory Area
385	51-100	5
390	51-100	55
389	101-150	62
391	101-150	100
387	151-200	37
388	151-200	99
392	151-200	100
729	201-300	100
731	201-300	100
733	201-300	50
730	301-400	100
732	301-400	100
734	301-400	67

Table 2. Average weight (kg) of capelin per 30-minute tow from winter surveys in Div. 3L, by strata inside Canada's 200-mile fishing zone and outside and overlapping the zone (* = <1 kg; ** = 1-10 kg, *** = >10 kg).

	Strata No.	WT 11, 12 Jan.-Feb. 1984	WT 22, 23, 24 Jan.-Feb. 1985
Inside			
Northwest	344	*	**
	345	**	***
	346	-	*
	347	*	**
	348	*	*
Southwest	328	-	*
	341	0	*
	342	0	*
	343	*	0
	349	0	0
Central	350	-	*
	363	-	0
	364	0	0
	371	-	0
	372	-	0
	384	-	0
Northeast	365	0	0
	366	-	**
	368	-	0
	369	-	0
	370	-	*
	386	-	0
	735	-	0
	736	-	-
Outside and overlapping			
	385	-	0
	387	-	0
	388	-	0
	389	-	0
	390	-	0
	391	-	0
	392	-	*
	729	-	0
	730	-	0
	731	-	0
	732	-	0
	733	-	0
	734	-	0

Table 3. Average weights (kg) of capelin per 30-minute tow from spring surveys in Div. 3L, by strata inside Canada's 200-mile fishing zone and outside and overlapping the zone (* = <1 kg, ** = 1-10 kg, *** = >10 kg).

Strata No.	ATC 199 May 1972	ATC 209 Apr.-May 1973	ATC 222 May 1974	ATC 233 May 1975	ATC 246 Apr.-May 1976	ATC 262 May 1977	ATC 276 May 1978	ATC[a] 290 May-June 1979	GA[a] 21 May-June 1979	ATC 304, 305 May-June 1980	GA[b] 36 Apr.-May 1980	ATC 317, 318 Apr.-May 1981	ATC 329 May 1982	AN 28 May 1984	WT 28, 29, 30 Apr.-May 1985
Inside															
Northwest															
344	-	-	-	-	*	*	*	0	0	0	*	***	*	-	*
345	-	-	-	-	0	0	0	0	-	*	*	*	0	-	0
346	-	-	-	*	0	0	-	0	*	**	*	0	0	-	0
347	-	-	**	*	*	*	*	*	*	*	*	**	*	-	*
348	0	-	***	*	*	**	0	*	*	*	-	**	*	-	*
Southwest															
328	-	-	-	-	-	*	-	**	**	-	-	*	*	**	0
341	-	**	-	-	-	***	0	***	***	*	-	0	*	**	*
342	-	-	-	-	-	0	0	*	*	0	-	-	0	**	*
343	-	-	-	-	-	0	0	0	0	*	-	*	0	-	*
349	**	-	**	**	**	**	*	**	***	**	-	*	*	**	**
Central															
350	0	-	*	***	*	***	0	***	***	*	-	0	*	***	*
363	**	-	**	***	0	0	0	***	***	*	-	0	**	*	0
364	*	-	0	**	***	***	0	*	**	0	-	*	*	**	*
371	0	-	0	-	-	*	0	***	***	0	-	0	**	-	0
372	*	-	0	***	***	0	0	***	***	0	-	0	***	0	*
384	*	0	*	-	-	*	0	0	0	0	-	0	*	-	*
Northeast															
365	0	-	0	**	**	**	0	*	*	*	-	*	*	-	**
366	-	-	0	*	*	*	-	*	*	*	*	0	*	-	*
368	-	-	0	0	0	0	-	*	*	0	*	0	0	-	*
369	-	-	0	**	*	**	0	*	*	0	*	0	*	-	*
370	**	-	**	**	**	*	0	*	*	0	-	0	0	-	*
386	-	-	*	**	**	0	0	0	0	*	*	*	**	-	*
735	-	-	-	-	-	-	-	-	-	-	*	0	-	-	0
736	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Outside and overlapping															
385	*	*	0	*	**	*	0	0	*	0	-	*	**	-	**
387	-	-	0	*	0	*	*	0	0	0	0	*	0	-	*
388	-	0	0	0	*	0	0	0	0	0	0	0	0	-	*
389	*	0	*	**	**	0	0	0	0	0	0	*	**	-	*
390	*	0	***	*	-	0	0	0	*	0	-	0	**	-	**
391	0	0	0	0	-	0	0	0	0	0	0	*	*	-	**
392	-	0	0	0	-	0	*	0	0	0	0	*	0	-	0
729	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
730	-	-	-	-	-	-	-	-	-	-	0	-	-	-	0
731	-	-	-	-	-	-	-	-	-	-	0	-	-	-	*
732	-	-	-	-	-	-	-	-	-	-	0	-	-	-	0
733	-	-	-	-	-	-	-	-	-	-	0	-	-	-	0
734	-	-	-	-	-	-	-	-	-	-	0	-	-	-	0

a The GADUS ATLANTICA and the A.T. CAMERON fished side-by-side at most positions during a comparative fishing experiment

b Only strata in depths >183 m were fished

Table 4. Average weight (kg) of capelin per 30-minute tow from 5 spring bottom trawl surveys in Div. 3L, by strata grouped by broad geographic area and with respect to Canada's 200-mile fishing zone (symbols as in Table 2). Also, partial fullness indices of capelin from stomachs of Atlantic cod and American plaice caught during these surveys (for cod, * 0.01-0.19, ** 0.20-0.99, *** > 1.00; for American plaice, * 0.01-0.09, ** 0.10-0.49, *** > 0.50).

	May 1978 ATC 276		May-June 1979 ATC 290	GA 21		May-June 1980 ATC 304, 305		April-May 1981 ATC 317, 318			May 1982 ATC 329		
Stratum	Trawl	Cod	Trawl	Trawl	Cod	Trawl	Cod	Trawl	Cod	Plaice	Trawl	Cod	Plaice
Inside													
Northwest													
344	*	**	0	0	*	0	*	***	**	**	*	**	0
345	0	**	0	-	-	*	**	*	0	0	0	*	0
346	-	-	0	*	*	**	**	0	0	0	0	0	0
347	*	*	*	*	**	*	*	**	**	**	*	**	0
348	0	**	*	*	**	*	0	**	**	*	*	**	*
Southwest													
328	-	-	**	**	**	-	-	*	-	0	*	-	*
341	0	-	***	***	***	*	-	0	-	**	*	*	*
342	0	-	*	*	*	0	-	-	-	-	0	0	0
343	0	*	0	0	**	*	-	*	-	*	0	*	0
349	*	**	**	***	**	**	-	*	0	*	*	*	0
Central													
350	0	-	***	***	**	*	**	0	0	0	*	**	**
363	0	0	***	***	***	*	**	0	0	0	**	***	***
364	0	0	*	**	***	0	**	*	-	*	*	***	*
371	0	0	***	***	***	0	0	0	-	0	**	-	**
372	0	0	***	***	**	0	*	0	0	0	***	***	**
384	0	-	0	0	0	0	-	0	-	0	*	-	0
Northeast													
365	0	-	*	*	*	*	**	*	***	***	*	*	*
366	-	-	*	*	*	*	*	0	0	0	*	*	0
368	-	-	*	*	*	0	-	0	0	0	0	0	***
369	0	0	*	*	**	0	0	0	**	0	*	**	0
370	0	-	*	*	**	0	*	0	-	0	0	-	***
386	0	-	0	0	0	*	-	*	0	0	**	**	**
735	-	-	-	-	-	-	-	0	-	-	-	-	-
736	-	-	-	-	-	-	-	-	-	-	-	-	-
Outside and overlapping													
385	0	-	0	*	0	0	-	*	-	*	**	-	**
387	*	0	0	0	0	0	-	*	-	-	0	*	-
388	0	0	0	0	0	0	-	0	0	-	0	0	-
389	0	0	0	0	0	0	-	*	-	0	**	***	0
390	0	-	0	*	0	0	-	0	-	0	**	-	**
391	0	0	0	0	0	0	-	*	0	0	*	-	**
392	*	0	0	0	0	0	-	*	0	-	0	**	-
729	-	-	-	-	-	-	-	-	-	-	-	-	-
730	-	-	-	-	-	-	-	-	-	-	-	-	-
731	-	-	-	-	-	-	-	-	-	-	-	-	-
732	-	-	-	-	-	-	-	-	-	-	-	-	-
733	-	-	-	-	-	-	-	-	-	-	-	-	-
734	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 5. Average weight (kg) of capelin per 30-minute tow from summer surveys in Div. 3L, by strata inside Canada's 200-mile fishing zone and outside and overlapping the zone (* = <1 kg, ** = 1-10 kg, *** = >10 kg).

	Strata No.	WT 3, 4 July-Aug. 1983	WT 16, 17, 18 July-Sept. 1984	WT 32, 33, 34 July-Aug. 1985
Inside				
Northwest	344	0	**	0
	345	0	0	*
	346	0	0	0
	347	*	*	*
	348	*	**	**
Southwest	328	-	*	**
	341	-	*	0
	342	-	0	0
	343	*	*	0
	349	*	*	**
Central	350	-	*	*
	363	-	0	0
	364	*	*	*
	371	-	0	*
	372	-	*	*
	384	-	0	*
Northeast	365	*	**	**
	366	0	*	*
	368	-	0	0
	369	0	**	*
	370	-	*	**
	386	-	*	*
	735	-	0	-
	736	-	-	-
Outside and overlapping				
	385	-	*	**
	387	-	0	*
	388	-	*	0
	389	-	**	***
	390	-	0	**
	391	-	*	*
	392	-	0	*
	729	-	0	0
	730	-	*	*
	731	-	0	0
	732	-	0	0
	733	-	0	0
	734	-	0	0

Table 6. Average weight (kg) of capelin per 30-minute tow from 1 summer bottom trawl survey in Div. 3L, by strata grouped by broad geographic area and with respect to Canada's 200-mile fishing zone (symbols as in Table 2). Also, partial fullness indices of capelin from stomachs of Atlantic cod and American plaice caught during these surveys (for cod, * 0.01-0.19, ** 0.20-0.99, ***>1.00; for American plaice, * 0.01-0.09, ** 0.10-0.49, ***>0.50).

		July-September 1984 WT 16, 17, 18		
Stratum		Trawl	Cod	Plaice
Inside				
Northwest	344	**	**	**
	345	0	**	**
	346	0	*	*
	347	*	**	**
	348	**	**	**
Southwest	328	*	***	*
	341	*	***	**
	342	0	**	*
	343	*	**	**
	349	*	**	**
Central	350	*	*	0
	363	0	*	0
	364	*	**	*
	371	0	*	*
	372	*	0	0
	384	0	0	*
Northeast	365	**	**	**
	366	*	**	**
	368	0	**	-
	369	**	***	**
	370	*	**	*
	386	*	***	***
	735	0	-	-
	736	-	-	-
Outside and overlapping				
	385	*	***	*
	387	0	***	0
	388	*	***	-
	389	**	***	***
	390	0	***	*
	391	*	-	***
	392	0	***	0
	729	0	***	***
	730	*	-	-
	731	0	-	-
	732	0	-	-
	733	0	***	-
	734	0	-	-

Table 7. Average weight (kg) of capelin per 30-minute tow from autumn surveys in Div. 3L, by strata inside Canada's 200-mile fishing zone and outside and overlapping the zone (* = <1 kg, ** = 1-10 kg, *** = >10 kg).

Strata No.	GA 55[a] Sept. 1981	ATC 323, 325 Oct.-Nov. 1981	ATC 333, 334 Oct.-Dec. 1982	WT 7, 8, 9 Oct.-Nov. 1983	WT 37, 38, 39 Oct.-Nov. 1985
Inside					
Northwest					
344	0	0	0	*	**
345	*	*	*	*	*
346	0	0	*	*	*
347	*	**	**	*	**
348	-	*	*	*	*
Southwest					
328	-	-	-	-	*
341	-	*	0	0	*
342	-	0	0	*	0
343	-	0	-	*	0
349	-	0	*	*	0
Central					
350	-	0	0	0	0
363	-	0	0	0	0
364	-	*	0	*	*
371	-	0	0	0	0
372	-	0	0	0	0
384	-	-	0	0	*
Northeast					
365	-	0	*	*	**
366	*	*	*	*	*
368	*	**	*	-	*
369	**	**	*	**	*
370	-	0	*	0	*
386	**	0	*	-	*
735	0	-	0	-	0
736	0	-	-	*	*
Outside and overlappping					
385	-	0	*	*	*
387	*	*	**	-	*
388	-	-	*	-	*
389	*	-	**	-	*
390	-	0	*	*	**
391	*	-	*	0	*
392	0	-	**	*	*
729	0	-	-	-	0
730	0	-	-	-	0
731	*	-	-	-	0
732	0	-	-	-	0
733	0	-	-	-	*
734	0	-	-	-	0

a only strata in depths 183 m were fished

Table 8. Average weight (kg) of capelin per 30-minute tow from 3 autumn bottom trawl surveys in Div. 3L, by strata grouped by broad geographic area and with respect to Canada's 200-mile fishing zone (symbols as in Table 2). Also, partial fullness indices of capelin from stomachs of Atlantic cod and American plaice caught during these surveys (for cod, * 0.01-0.19, ** 0.20-0.99, ***>1.00; for American plaice, * 0.01-0.09, ** 0.10-0.49, ***>0.50).

	October-November 1981 ATC 323, 325			October-December 1982 ATC 333, 334			October-November 1983 WT 7, 8, 9		
Stratum	Trawl	Cod	Plaice	Trawl	Cod	Plaice	Trawl	Cod	Plaice
Inside									
Northwest									
344	0	*	0	0	0	0	*	*	**
345	*	*	0	*	*	0	*	*	**
346	0	*	0	*	*	0	*	*	0
347	**	**	0	**	*	0	*	**	*
348	*	*	*	*	*	0	*	*	**
Southwest									
328	-	-	-	-	-	-	-	-	-
341	*	0	0	0	-	0	0	0	-
342	0	0	0	0	**	0	*	0	0
343	0	0	0	-	-	0	*	**	**
349	0	0	0	*	0	*	*	*	0
Central									
350	0	0	0	0	*	0	0	0	0
363	0	**	0	0	0	0	0	0	-
364	*	0	0	0	0	0	*	*	*
371	0	-	0	0	0	0	0	0	0
372	0	*	0	0	0	0	0	0	-
384	-	-	0	0	-	0	0	**	-
Northeast									
365	0	**	*	*	**	**	*	**	*
366	*	*	0	*	**	*	*	**	*
368	**	**	-	*	0	0	-	-	-
369	**	*	0	*	**	0	**	**	*
370	0	**	0	*	**	0	0	**	*
386	0	**	*	*	0	0	-	-	-
735	-	-	-	0	-	0	-	-	-
736	-	-	-	-	-	-	*	-	-
Outside and overlapping									
385	0	-	0	*	-	0	*	-	-
387	*	0	0	**	0	-	-	-	-
388	-	-	-	*	0	-	-	-	-
389	-	-	-	**	**	0	-	-	-
390	0	-	0	*	-	0	*	-	-
391	-	-	-	*	-	*	0	-	-
392	-	-	-	**	**	0	*	-	-
729	-	-	-	-	-	-	-	-	-
730	-	-	-	-	-	-	-	-	-
731	-	-	-	-	-	-	-	-	-
732	-	-	-	-	-	-	-	-	-
733	-	-	-	-	-	-	-	-	-
734	-	-	-	-	-	-	-	-	-

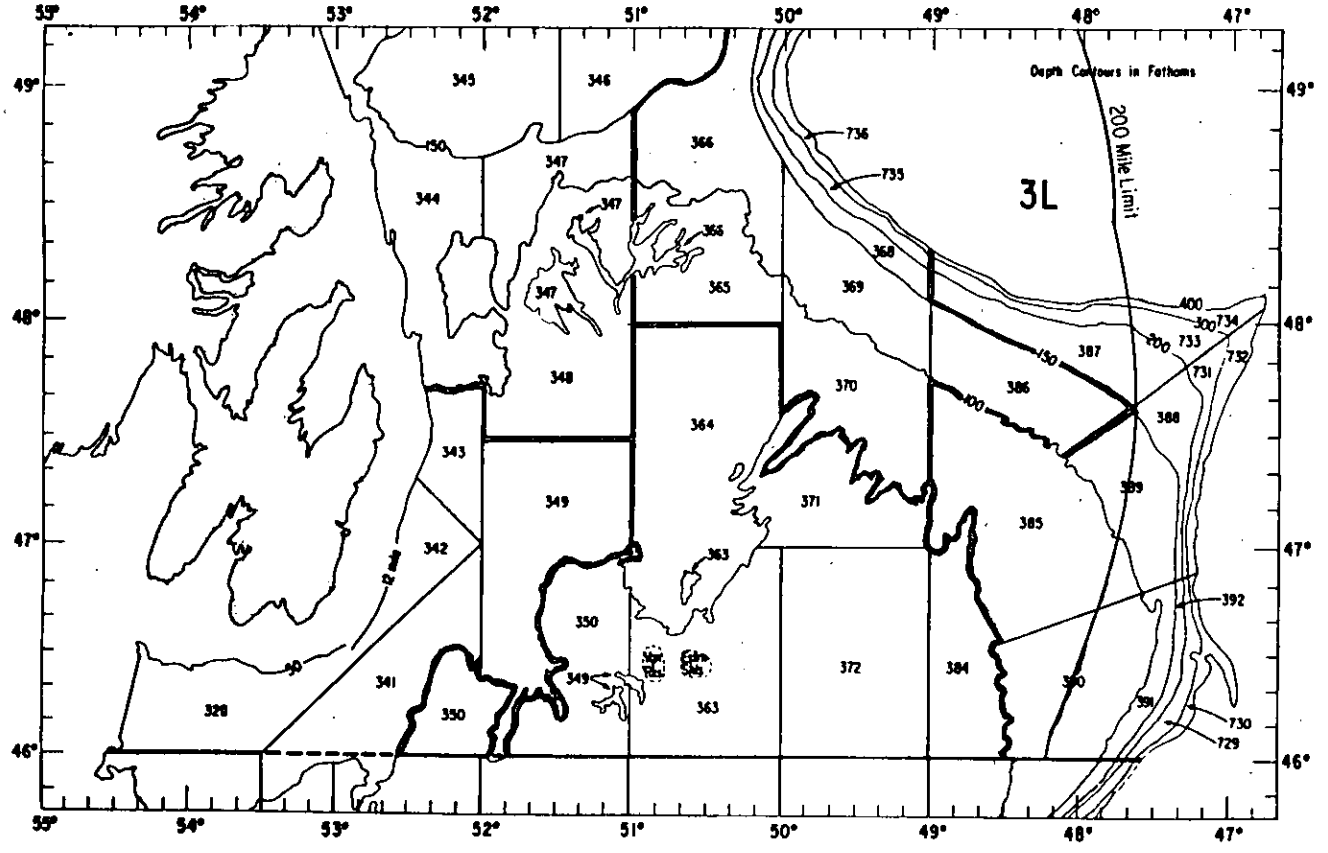

Fig. 1. NAFO Div. 3L showing stratification scheme and the approximate position of the Canadian 200-mile limit.

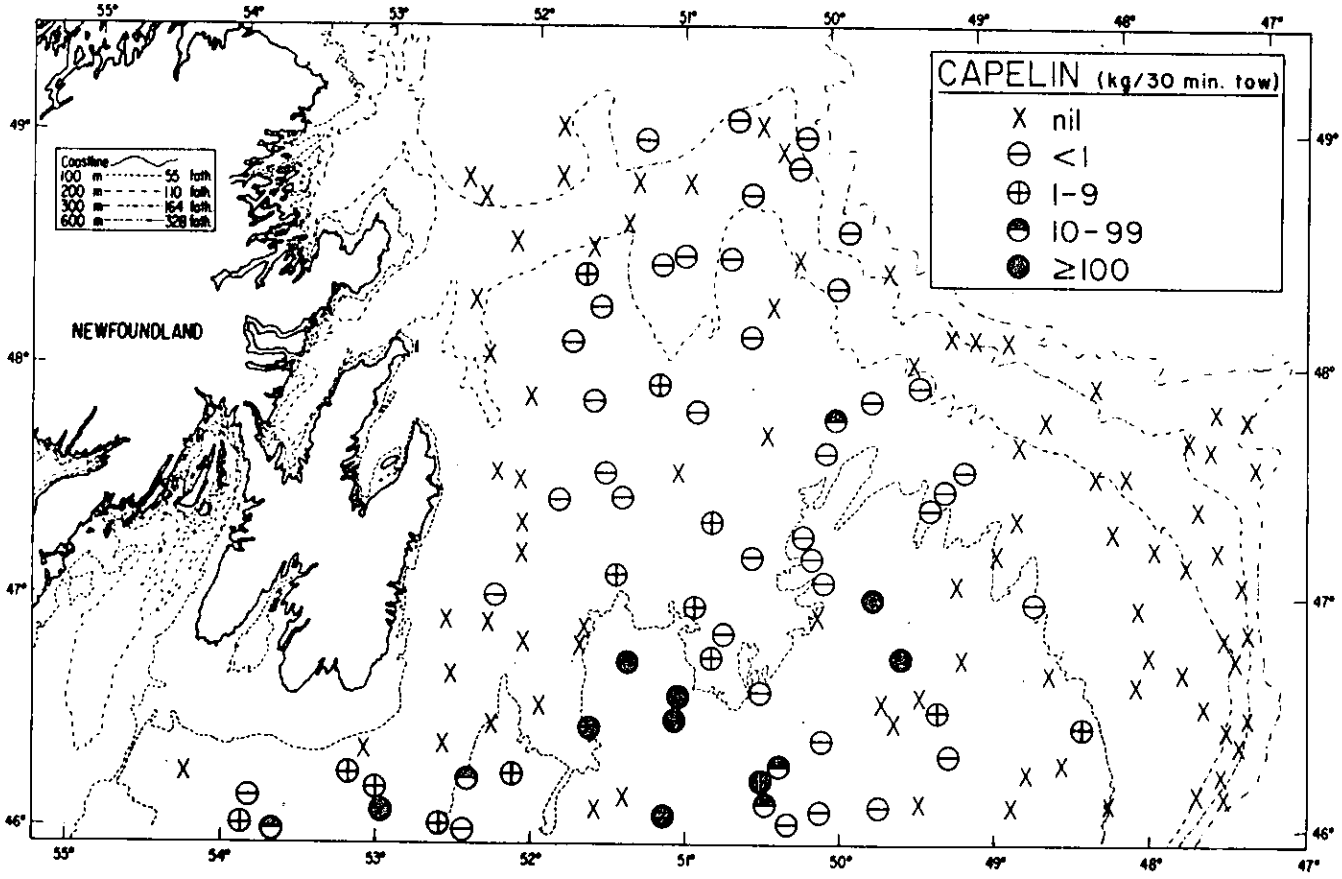

Fig. 2. Capelin catches during a stratified-random bottom trawl survey of NAFO Div. 3L, May-June 1979. The research vessels GADUS ATLANTICA and A.T. CAMERON fished within 1 km of each other at most positions and the larger of the catches is shown. (from Lilly and Rice 1983).

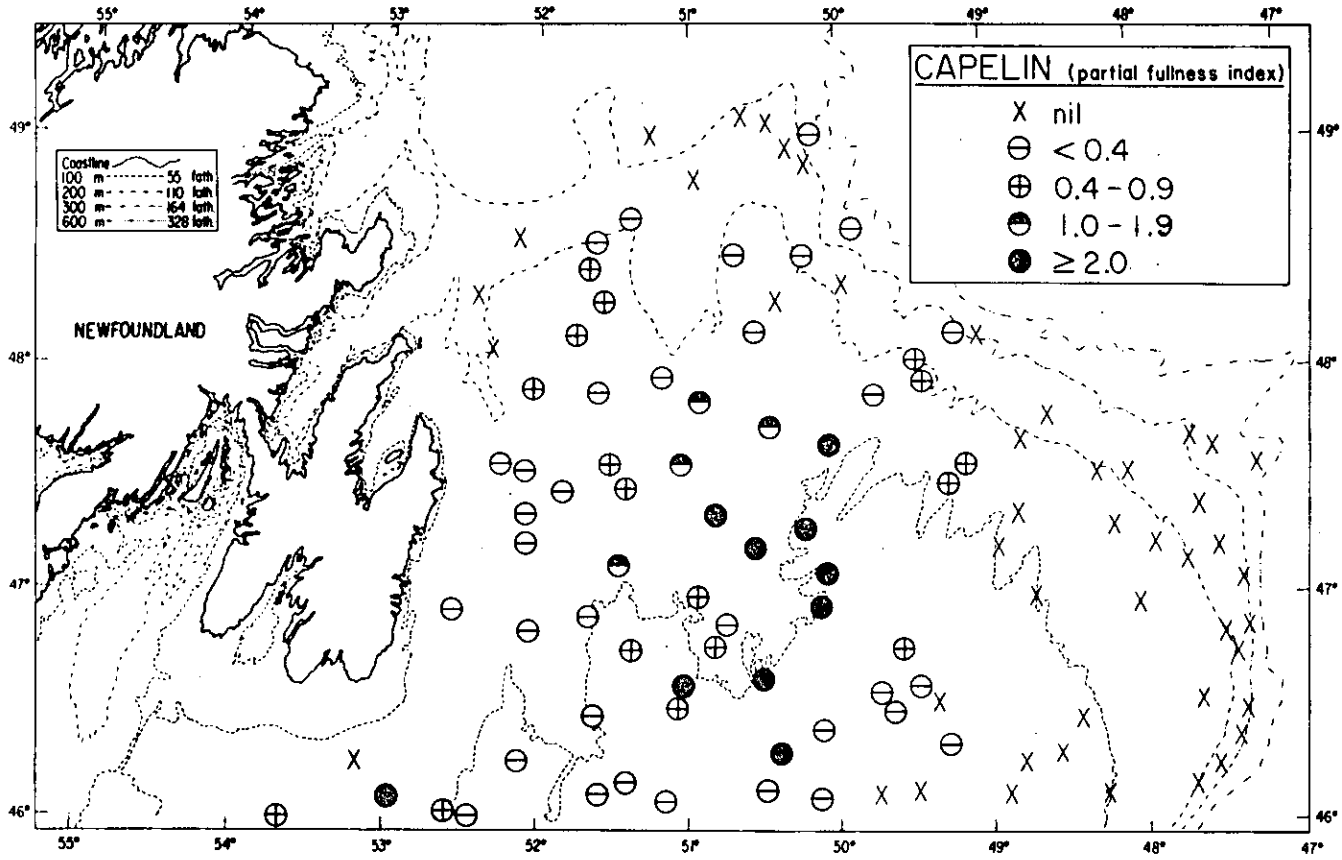

Fig. 3. Partial fullness indices of capelin in stomachs of Atlantic cod caught at individual fishing positions of the R.V. GADUS ATLANTICA during May-June 1979. The indices were calculated using data from all stomachs collected, regardless of predator size, but only sets with 5 or more stomachs were plotted. (from Lilly and Rice 1983).