Northwest Atlantic Fisheries Organization

Serial No. N977 NAFO SCR Doc. 85/27

SCIENTIFIC COUNCIL MEETING - JUNE 1985

Biological Characteristics and Biomass Estimates of the Squid (Illex illecebrosus) on the Scotian Shelf (Div. 4VWX) in 1984

by

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Introduction

This report describes the distribution, biomass levels and biological characteristics of the short-finned squid stock on the Scotian Shelf (Div.4VWX) as derived from five bottom trawl surveys conducted between March and October 1984. The French R/V Cryos (stern trawler Class 5) conducted a survey from 29 August to September 30. Other surveys were conducted by the Canadian R/V Alfred Needler as follows: 2 - 27 March; 10 July - 2 August; 17 September - 2 October; and 9 October - 2 November.

The September Cryos survey was a continuation of the annual assessment survey conducted by France since 1980 (Dupouy, 1981; Dupouy & Minet, 1982; Dupouy & Derible, 1983; and Poulard et al, 1984). The September Needler squid survey was, in part, designed to complement that of the Cryos by providing additional bottom trawl coverage. The cruise also involved offshore tagging of squid, the results of which are not reported here.

The Needler surveys of March, July and October comprise the spring, summer and fall groundfish surveys (Halliday & Kohler, 1971), the summer survey having been conducted regularly by Canada since 1970 and the other two since 1978 (Halliday & Koeller, 1981). Squid distribution and abundance have been described from groundfish surveys (Scott,1976; Dufour,1979;Koeller,1980; Mohn ,1981; and Rowell & Young,1984), and Rowell et al (1984) have documented both seasonal an interannual variability in distribution.

Methods

Cryos

The gear used was a Lofoten trawl with the following specifications: 31.2 m headrope, 17.7 m footrope, and 50mm stretched mesh in the codend. Of the 126 tows made during the survey, 121 were used to estimate biomass, the remaining sets being either outside of the strata or incomplete because the trawl was damaged on the bottom. All tows were conducted during daylight hours. Tows were of standard duration (30-minutes) and the area swept by the trawl which is assumed to be constant has been calculated on the basis of a horizontal opening of 13.5 meters at the wings, with a vessel speed of 3.5 - 4 knots. This results in a areal coverage per standard tow of 0.015 square nautical miles (0.05 km2). After each tow an XBT was cast. Additionally, three hydrographic sections were made normal to the Shelf edge.

The stations were distributed randomly using the stratification scheme proposed by Halliday and Kohler (1971) and recommended by NAFO for Divisions 4VWX (Fig.1A). The 22 strata surveyed were limited to depths ranging from 50 fathoms (92m) to 200 fathoms (366m). Area surveyed and distribution of catches are shown in Figure 2A. Those for the concurrent Needler survey are shown in Figure 2B.

After each tow, the catch was sorted by species, the total quantity of squid was weighed, and where numbers were sufficient, a representative subsample (200 individuals per set) was analyzed. Detailed morphometrics, by sex, were carried out on 50 individuals (maturity stage, mantle length to the half-centimeter, weight, stomach and caecum fullness, food type, and parasite type and location). An additional 150 individuals were analyzed by sex for only maturity stage, mantle length, and weight. Maturity scales were as defined by Amaratunga and Durward (1979).

Alfred Needler

The gear used was a Western IIA bottom trawl with the following specifications: 22.7m headrope, 32.6m footrope and 90mm stretched mesh codend with a 19mm stretched mesh codend liner. Thirty-minute tows were conducted in all surveys. Tow distance was determined for each trawl with electronic navigation (LORAN-C) aids. Area swept by the trawl is the product of tow distance and trawl wing spread (10.4m). Squid catch weights from night-time tows (i.e.20:00-07:59h) include a correction factor of 2.4 (Rowell & Young, 1984).

Groundfish Survey - 1984. The groundfish survey program for 1984 consisted of three cruises conducted on board the Needler. Halliday and Kohler (1971) have described the stratified random sampling design used in the surveys. The March (Fig.3A), July (Fig.3B) and October (Fig.3C) consisted of 132 , 140 and 157 random stratified bottom trawl stations, respectively. In each survey period most of the 48 Scotian Shelf strata (Fig.1A) were sampled. The depth range coverage in the program is 11-200 fathoms (20-366m). The groundfish survey is therefore more extensive than the Cryos survey, covering much more of the Shelf, including depths in the 11-50 fathom range and the Bay of Fundy. In March the survey also included a series of tows on Georges Bank. Data from the October survey are only preliminary.

The catch was sorted by species, total squid weight and number recorded either on the basis of total squid caught or a sub-sample, and where numbers were sufficient, unsexed mantle length (ML) measurements to the nearest cm were taken on up to 200 squid. Observations made in conjunction with each tow included bottom depth and temperature.

Squid Survey - September 1984. The Needler squid survey in September was designed to complement the coverage of the Cryos survey program. The area to be surveyed was divided into five longitudinal bins (<59° W ; 59-61° W; 61-63° W ; 63-65° W ; and >65 W°) and four depth strata as follows:

Stratum	Depth Range (m)	(fm)
I	20-92	11-50
II	92-183	51-100
III	183-366	101-200
IV	366-915	201-500

In the central area of the Shelf (i.e. 61-65° W) emphasis was placed on Strata I and IV and in other areas equal emphasis was given to all longitude bin/depth stratum cells. An XBT was cast at each bottom trawl station. In total 118 bottom trawl stations (Fig.2B) were completed of which 66 were within groundfish strata. A total of 27 groundfish strata were surveyed by the Needler. The September Needler and Cryos cruises combined surveyed 38 groundfish strata. Trawls outside of groundfish strata were either on Georges Bank or at depths greater than 200 fathoms along the Shelf edge.

The processing of the catch at each station consisted of the following: after sorting, the catch was weighed by species, detailed morphometrics were done on a sample of 50 *Illex*, and length measurements by sex were made on other species in the catch.

Biomass Estimates

Biomass estimates were developed separately for each sampling period and vessel by areal expansion (Table 1). That is, mean catch per stratum has been multiplied by a stratum areal expansion factor and stratum biomass estimates are summed over all strata. Assumption of 100% trawl efficiency is likely an overestimate and, as a result, calculated abundance and biomass are minimum estimates of stock size. Mean lengths include expansion factors and therefore are estimates of mean lengths for the entire Scotian Shelf. Mean numbers or weights per tow and mean bottom temperatures are overall means without regard for the survey stratification scheme. Mean catch rates and biomass estimates by stratum for each of the four survey periods are presented in Appendix 1.1 - 1.4.

Biomass estimates for September have been based principally on data from the Cryos survey. To avoid the assumption of comparability between the vessels and respective trawl gear, in strata surveyed by both vessels, only the Cryos data was used. Strata surveyed only by the Needler were included to complement the Cryos results (Table 1).

There was sufficient overlap between the September Cryos and Needler surveys to draw approximate comparisons (Appendix 2). In five of the strata both vessels performed trawl stations with replicates. There is no obvious relationship between the vessel/gear combinations and computed squid densities. Any possible relationship would undoubtedly be masked by temporal differences in squid distribution. However, the results are consistent to the extent of distinquishing squid presence (strata 50,52,53 & 81) and absence (strata 47).

Results and Discussion

Distribution

Figures 2(A,B) & 3(A-C) illustrates the changes in squid distribution as indicated by catch rates during the period March to October which includes most of the on-Shelf residency period.

In March (Fig.3A) squid were virtually absent from the Scotian Shelf, although a small aggregation was present on the northeast corner of Georges Bank.

In July (Fig.3B) squid appear to have migrated to the western and central areas of the Scotian Shelf and were more widely dispersed than during the same period in 1983 (Rowell et al, 1984). This may be a reflection of the early arrival of squid immigrating to the Shelf. Commercial sampling data suggest that in 1984 squid began arriving on the Shelf one or two months earlier than in 1983 (Rowell and Budden, 1985). However, the general distribution was very similar to that seen in most previous years, although catch rates were lower than in the period 1976-81 when squid distribution and abundance reached a peak and distributions often extended into the Bay of Fundy and eastern parts of the Shelf (Rowell and Young, 1984).

By September (Fig.2 A&B) the squid occupied the western half of the Shelf around Browns Bank and the areas around LaHave and Emerald Basins as well as extending along the Shelf edge to Banquereau Bank (58 W) and the Sable Island/Gully area. At depths greater than 200 fathoms squid appeared to be in very low abundance, and there was no indication of aggregation in the Bay of Fundy.

In October (Fig.3C) the squid distribution was similar to that in September, with the exception of the appearance of squid in the Bay of Fundy. In the period 1981-1983 squid distribution became contracted by October (Rowell et al, 1984) whereas in 1984, as in 1980, the population appeared to continue increasing in distribution. Catch rates were lower (i.e. no catches >10kg) than in July and September.

Geographic distribution relative to hydrographic conditions

Rowell et al (1984) related squid density and bottom temperature patterns that had been observed during the summer and fall groundfish surveys between 1980 and 83. Their conclusion was that temperature is not likely limiting but that there appears to be a preference for temperatures >6° C. Figures 4(A-C) illustrate bottom temperature patterns during the July, September and October 1984 survey periods and Figures 5(A-C) depict observed squid density patterns for the same periods.

The March squid density was very low (Table 2 and App.1.1). The bottom temperature and squid density patterns for this period are described without illustrations. The March mean bottom temperature for the Scotian Shelf was 5.4°C. The areas with >8°C (i.e. strata 53,54,61,65,71,77,78,82 & 84) and >6°C (i.e. strata 46,52,62,64,66,70,72, & 83) bottom temperatures were more restricted than in the other survey periods. Squid density exceeded 100 squid/n.mi.2 only in strata 72 and 51 (App.1.1).

In July the mean bottom temperature (7.3°C) was the highest in the groundfish survey time series (1970-1984). Trites and Drinkwater (1985) observed anomalously high sea surface temperatures on the Scotian Shelf in July 1984. The 1984 bottom temperature pattern has been described in the same manner as that employed by Rowell et al (1984) for the 1980-83 period. The extent of the area having bottom temperatures >8°C and >6°C in 1984 (Fig.4A and App.3A)) exceeded those of the previous four years. Squid density (Fig.5A) reached peak in July with strata 53, 72 and 57 having the greatest densities, respectively (App. 1.2). These strata and others with significant squid densities (i.e. >500 squid/n.mile2) were found in the areas with >6°C bottom temperatures most being within the >8 C bottom temperature strata.

During the Cryos survey in September 530kg of squid were caught. The mean catch per tow was 4.4kg or 31 individuals. *Illex illecebrosus* were found in 106 of the 121 tows (87%). Although squid were captured throughout the area surveyed, the yields were generally low with only one station resulting in a catch of more than 50kg (Fig.2A). This occurred in the western part of the Shelf edge, south of Baccaro Bank in an area having unusually cold bottom temperature (3.7°C).

As in previous September surveys (Dupouy, 1981; Dupouy and Minet, 1982; Dupouy and Derible, 1983; and Poulard et al, 1984), the three-layered structure of water masses on the Scotian Shelf described by Sigaev (1979) and Gomez (1979) was observed during the period of this survey.

- **surface water** (0-30m depth, Fig.6A) was generally in the range of 15-20°C with cooler temperatures at depths over Roseway Bank, LaHave and Emerald Basins, and the Gully; salinities ranged from 29-32 ‰.

- **intermediate water** (30-100m depth, Fig.6B) covered most of the shallower strata and low temperatures (2-5°C) and with salinities generally in the range of 30-33‰. In the deeper water (60-100m) temperatures over most of the inner Shelf were in the 4-7°C range, while over the outer Shelf they ranged from 2-8°C. Temperatures were generally cooler in the near-shore areas and in the areas to the east of Emerald Bank; and

- **slope water**, generally at depths greater than 100 and 300m (Fig.6C), and characterized by warmer temperatures (7-11°C) and higher salinities (33-34‰),stretching primarily along the Shelf edge west of Western Bank and entering into the centre of the Shelf in the LaHave Basin area.

The analysis of broad squid density patterns versus bottom temperatures suggests that there was no significant relationship between these parameters (Figs. 4B & 5B, and App.3B). Although 3 of the 4 best catches were obtained with bottom temperatures between 8 and 11°C this preference for warmer temperatures is only a general trend and the highest density was encountered in one of the lowest bottom temperatures (3.7°C). In the September 1982 survey the generally low catch levels were related to a lower mean bottom temperature (6.6°C). There is no similar relation in 1984; the mean bottom temperature was 7.7° C being even warmer than that observed in 1980 (7.6°C) when catch rates were much higher.

The mean bottom temperature also appeared anomalously high in October, but this may be attributed largely to missing data from the cooler strata of the eastern Shelf areas (Fig.4C) resulting in undue weight to the warmer strata and producing a spurious overall mean. There was only a minor change in the distribution of bottom temperatures from those observed in July. Warming to above 6°C occured in stratum 75, and to above 8°C in strata 56, 58, 63, 83, 91 and 92. Stratum 62 cooled to below 8°C and strata 57 and 73 cooled to below 6°C. However, the distribution of squid density changed dramatically between July and October (Fig.5C & App.3C). Densities greater than 5,000 squid/n.mile2 were no longer present in October (App.1.4). No significant concentrations were present east of Western Bank, although moderate concentrations were found around Browns Bank and in the approaches to the

Bay of Fundy. In the eastern areas, especially stratum 57, changes may be interpreted as a response to adverse bottom temperatures but migration to the western areas is likely mitigated by factors other than bottom temperature.

Biomass levels

Statistics relevant to biomass levels for the four survey periods are given in Table 1. The March survey indicates low levels of squid stock on the Shelf prior to the the late spring/early summer period of immigration to the Shelf. These low levels are generally seen throughout the late winter (Amaratunga et al. 1980). Scotian Shelf biomass was highest in July at about 10,000 t representing 74 million squid. The September biomass (5,700 t ML) was lower due to a reduction in stock size. despite an increase in individual squid size (i.e. from 17 to 19cm ML) .. In October the biomass (1,700 t) and stock size (16 million squid) were lower. This decrease in biomass is a combined reflection of fishery removals. natural mortality and emigration.

In Table 2 depth stratified biomass and stock size estimates are presented for the group of eighteen strata (Fig.1A) which have been surveyed consistently by France, each September from 1980-84. In 1984 the bulk of the Scotian Shelf population was contained within this subset of strata (Table 2(i)). That is, 100% of the March, 84% of the July, 97% of the September, and 66% of the October biomass were found in these strata. There were consistently greater amounts of squid in the depth range of 50-100 fathoms; largely because of the greater total area of strata within this range as compared with that in the 101-200 fathom range (Fig.1B).

The July biomass levels in 1984 show a continuance of the low abundance levels seen in the previous two years (Rowell and Young, 1984). The September biomass levels in 1984 (Table 2(ii)) also reflect continuance of this period of low abundance being considerably lower than abundances seen in 1980-81 (Poulard _et al_, 1984). Assuming comparability between the Cryos and Needler results, there appears to be a decrease in abundance and biomass between July and September which is the converse of the 1980-83 pattern (Rowell _et al_, 1984).

Biological Characteristics

Length Frequency

Length frequency distributions for each survey period are presented in Figure 7. The distributions are based on all squid measured during the surveys with no areal expansion. March, July and October distributions are based on unsexed squid measured to the nearest centimeter, whereas the September distribution is based on squid measured to the nearest 0.5 centimeter with males and females distinquished.

As noted in previously reported surveys (Amaratunga 1980, 1981 and Rowell _et al_, 1984) , there was in 1984 a general progression in mantle lengths throughout the period of on-Shelf residency. The relatively flat March distribution, based largely on observations from Georges Bank (Fig. 3A), appears to represent residuals from the second cohort of the previous year as well as 1984 arrivals. Two modes are seen in July with peaks at 11cm and 18cm. By September there is a single mode between 18 and 21 cm and a peak at 19cm. A wide range of both smaller and larger squid are evident around the mode. In October squid lengths between 5 and 30 cm were observed with modal peaks at 11-12 cm and 21-23 cm.

The July bimodality seen in 1984 has not been regularly observed (eg. 1970 & 1982, Rowell and Young, 1984). In September 1984, the bimodal pattern regularly seen since 1981 is absent and the length frequency distribution is almost identical to that of 1982, being quite symmetrical and displaced to the left (Rowell _et al_, 1984). The October length frequency distribution shows a reduction in relative importance of the larger mode and the complementary increased importance of the smaller mode; likely as a result of emigration by squid of larger size.

Maturation

The progression of sexual maturation from July through October is presented in Table 3. For both males and females, the drop in percentage of stage I and increased percentages of stages II and III animals is most evident from the July and October data. The September data indicate a progression from stage I to II for females, but males show a higher percentage of stage I's and a lower percentage of stage II's than seen in the July data. The reason for this inconsistency is unclear, but may result from the continued input to the population of smaller squid and the more rapid growth of the female component. Maturation patterns for both males and females have been noted to vary widely from year to year, particularly in the late summer (Rowell et al, 1984) and the relationship between mantle length and maturity stage has been clearly demonstrated (Amaratunga, 1980).

When compared with the September maturities for the period 1980-83, as reported by Rowell et al (1984), both male and female maturities in 1984 were much less advanced (except when compared to female maturities in 1982, which were essentially the same as those observed for 1984). Interestingly, the length frequency pattern for females in September 1984 was very similar to that observed in 1983 when female maturities were much advanced over those seen in 1984, indicating that the relation between reproductive state and somatic growth may vary considerably from year to year.

Acknowledgements

The authors would like to thank the captains and crews of the research vessels A. Needler and Cryos ; the scientific personnel involved in the conduct of the surveys; and the personnel of the groundfish survey programme for their respective cooperation. In particular F. Budden and J.C. Mahe are acknowleged for their significant contribution.

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Table 1. Bottom trawl survey statistics for squid Illex illecebrosus from the Scotian Shelf, 1984.

Month	Julian1 Date	Vessel	Bottom Temp.	No. Tows	% tows with squid	Squid No. /tow	kg. /tow	Biomass Est.(t)	Stock Size (millions)	Length (cm)
March	72.8	Needler	5.4	132	7.6	0.1	0.03	99	0.22	20.2
July	206.4	Needler	7.3	140	40.7	13.5	1.59	10,025	74	16.9
September	258.6	Cryos	7.6	121	87.6	30.7	4.38	5,478	39	18.9
	269.5	Needler2	6.5	42	4.8	0.3	0.05	194	2	20.0
	262.4	Combined	7.2	163	65.0	22.9	3.6	5,672	41	19.0
October	293.4	Needler	9.0	157	45.9	3.1	0.41	1,664	16	15.1

1 - mean Julian calendar date of trawl stations from each survey.
2 - only strata not surveyed by Cryos were included (i.e. additional strata)

Table 2. Stock size and biomass estimates for the 18 strata surveyed: (i) in common by the four 1984 bottom trawl surveys (excluding September Needler survey); and (ii) consistently by IFREMER in September, 1980-84.

Depth Level		51-100 fms.		101-200 fms.		Overall 51-200 fms.	
Year	Period	Stock Size (millions)	Weight (t)	Stock Size (millions)	Weight (t)	Stock Size (millions)	Weight (t)
(i)1984	March	0.15	75	0.07	24	0.22	99
	July	52	8,061	6	521	58	8,582
	September	30	4,171	6	1,044	36	5,215
	October	14	941	1	151	15	1,092
(ii) 1980-1984							
1980	September	447	108,014	180	43,706	657	151,720
1981	September	164	39,135	40	9,941	204	49,076
1982	September	49	3,667	5	905	54	4,572
1983	September	82	11,819	8	1,239	90	13,058
1984	September	30	4,171	6	1,044	36	5,215

Table 3. Maturity stage frequencies squid from bottom trawl cruises, 1984.

Period	Sex	Maturity Stage I	II	III	IV	V
July	male	0.70 (174)	0.29 (72)	0.01 (4)	--	
	female	0.53 (121)	0.29 (66)	0.16 (37)	0.02 (5)	0.0 (1)
September	male	0.83 (846)	0.16 (158)	0.01 (17)	--	
	female	0.45 (471)	0.46 (481)	0.08 (83)	0.0 (3)	--
October	male	0.55 (108)	0.42 (82)	0.03 (5)	--	
	female	0.21 (36)	0.37 (65)	0.42 (74)	0.0 (1)	--

N.B. computed relative frequencies are followed by absolute frequencies in parenthesis.

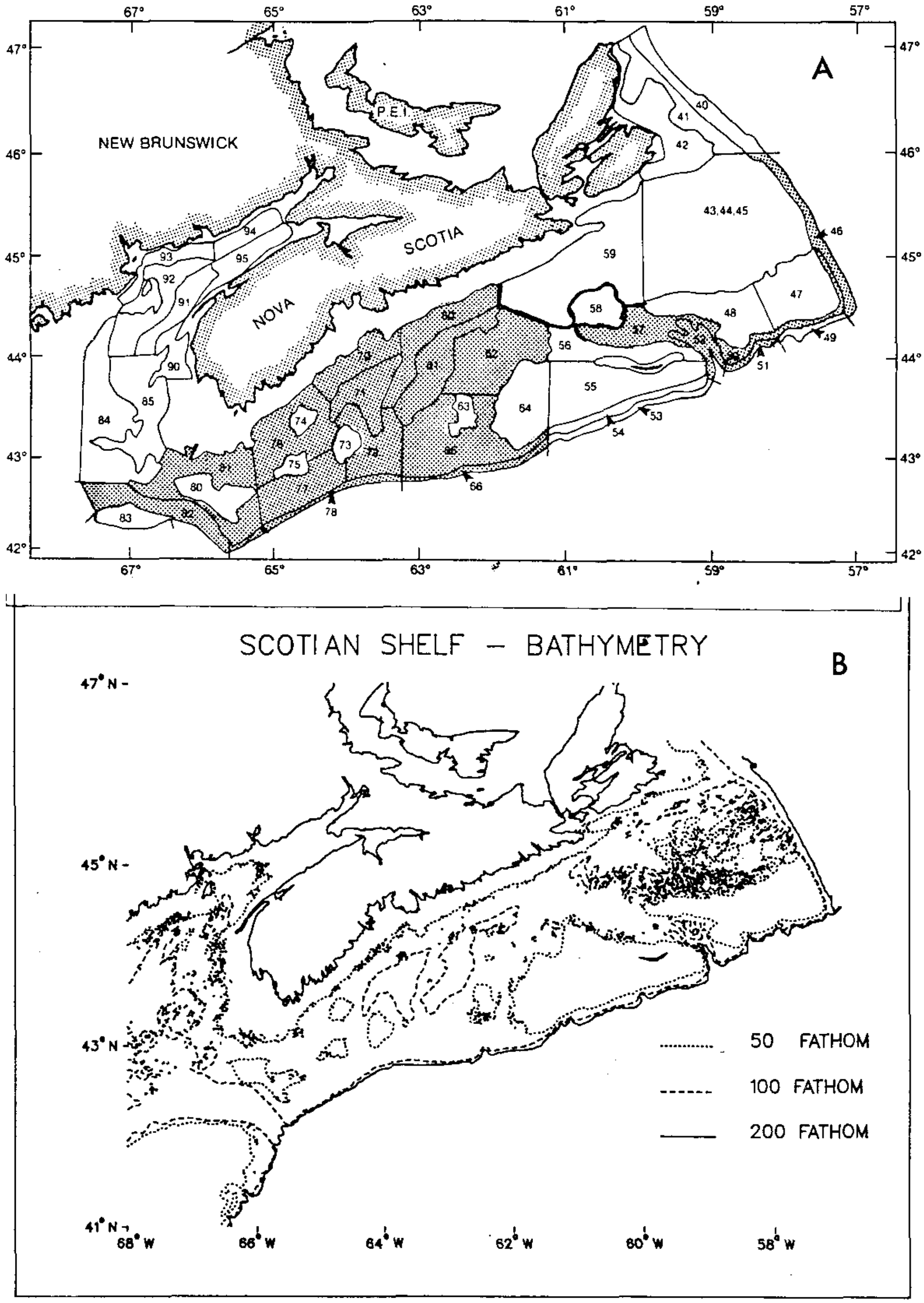
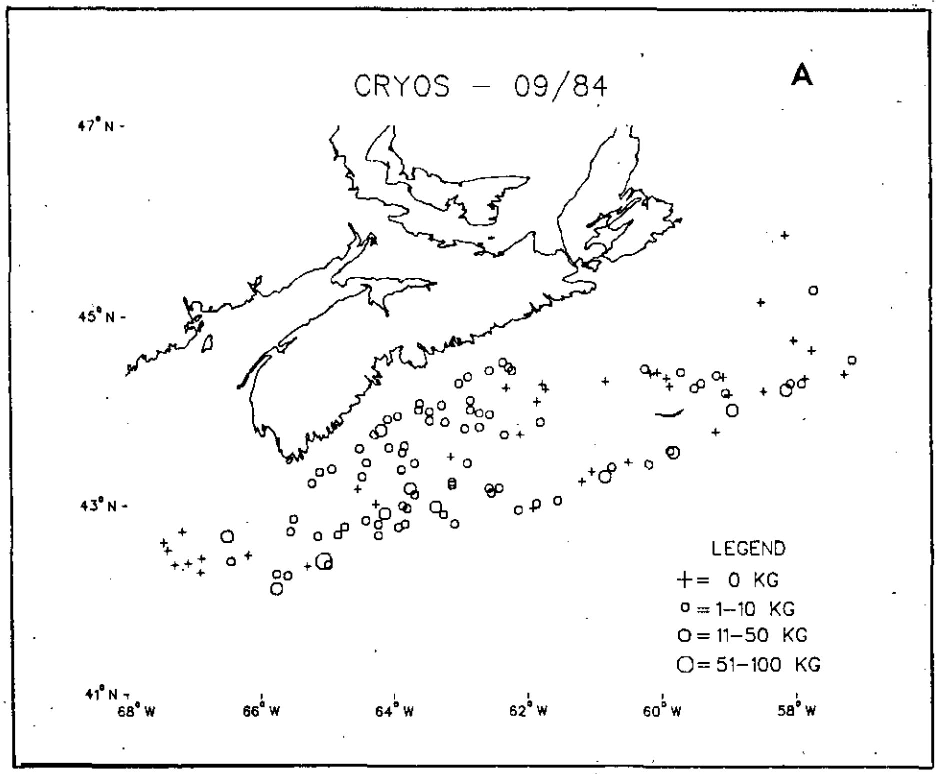


Fig. 1. Scotian Shelf: A, groundfish survey strata, redrawn from Halliday and Kohler (1971); B, bathymetry within the 50, 100 and 200-fath contours. (The shaded area in A represents the 18 strata surveyed consistently by IFREMER in September, 1980-84.)



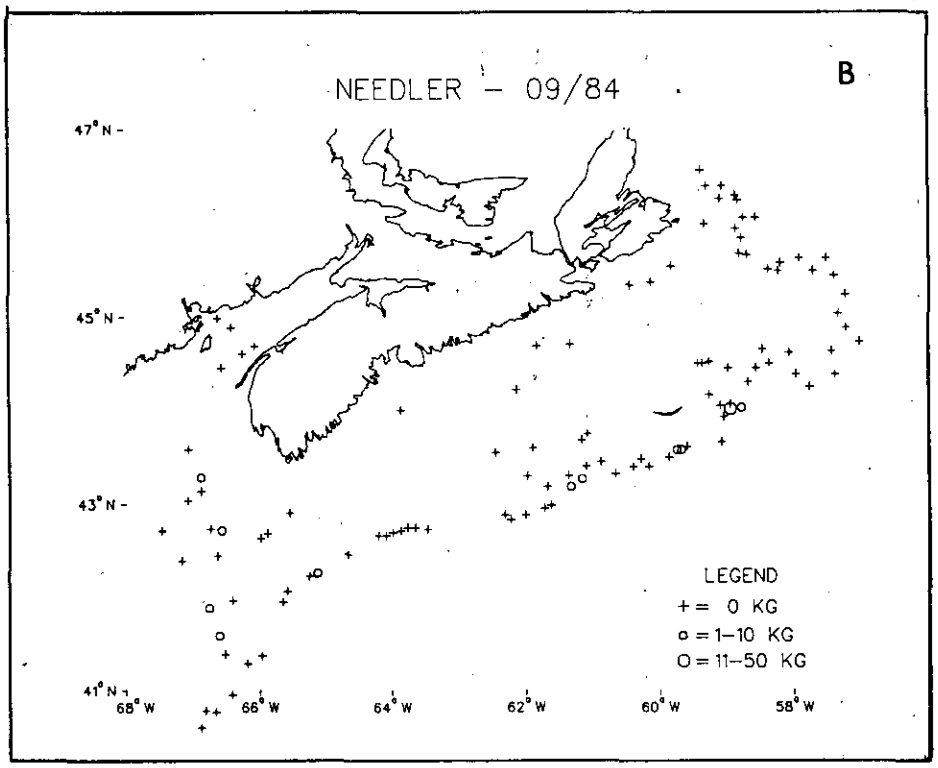


Fig. 2. Squid distribution on the Scotian Shelf from (A) *Cryos* and (B) *Needler* surveys in September 1984.

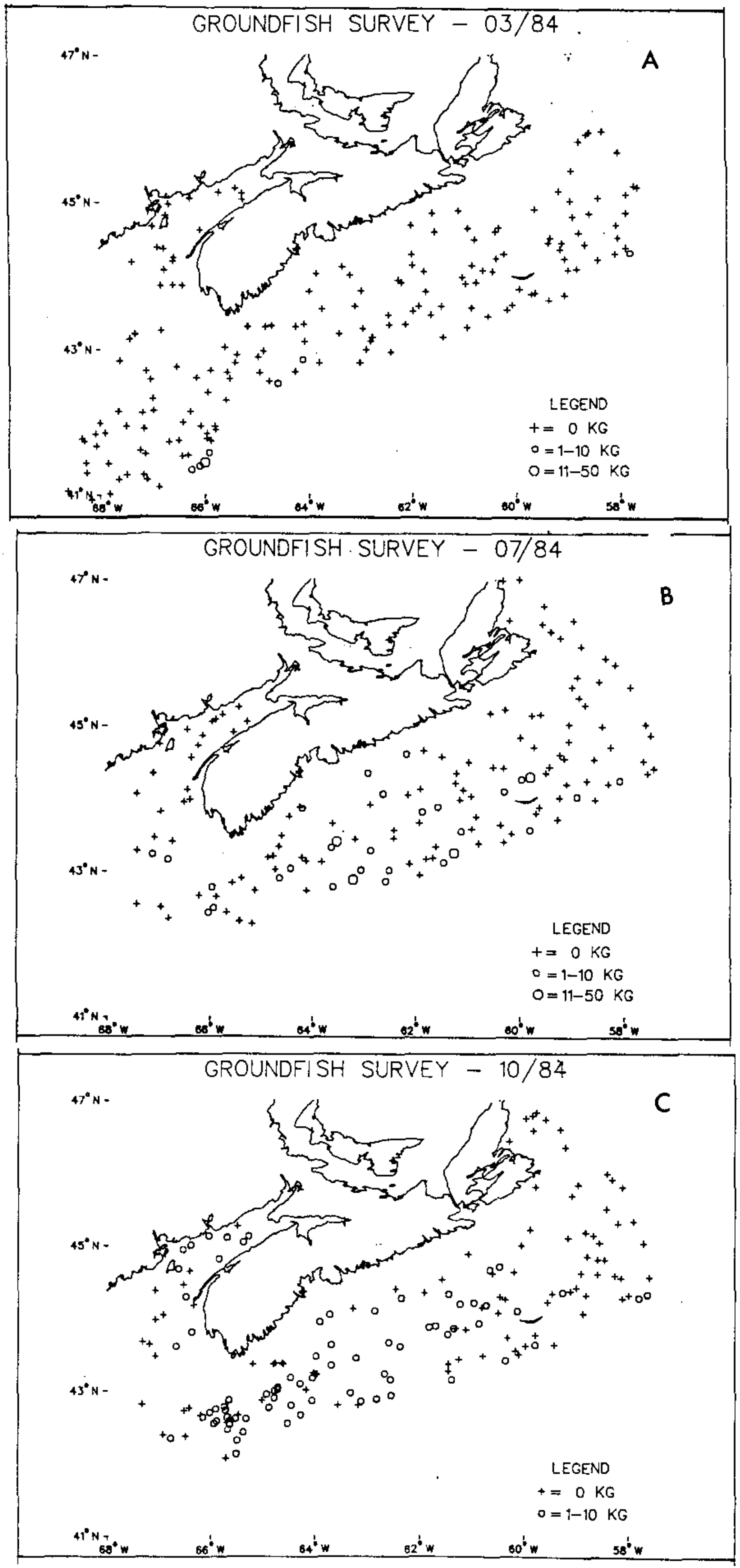


Fig. 3. Squid distribution on the Scotian Shelf from 1984 groundfish surveys in (A) March, (B) July, and (C) October.

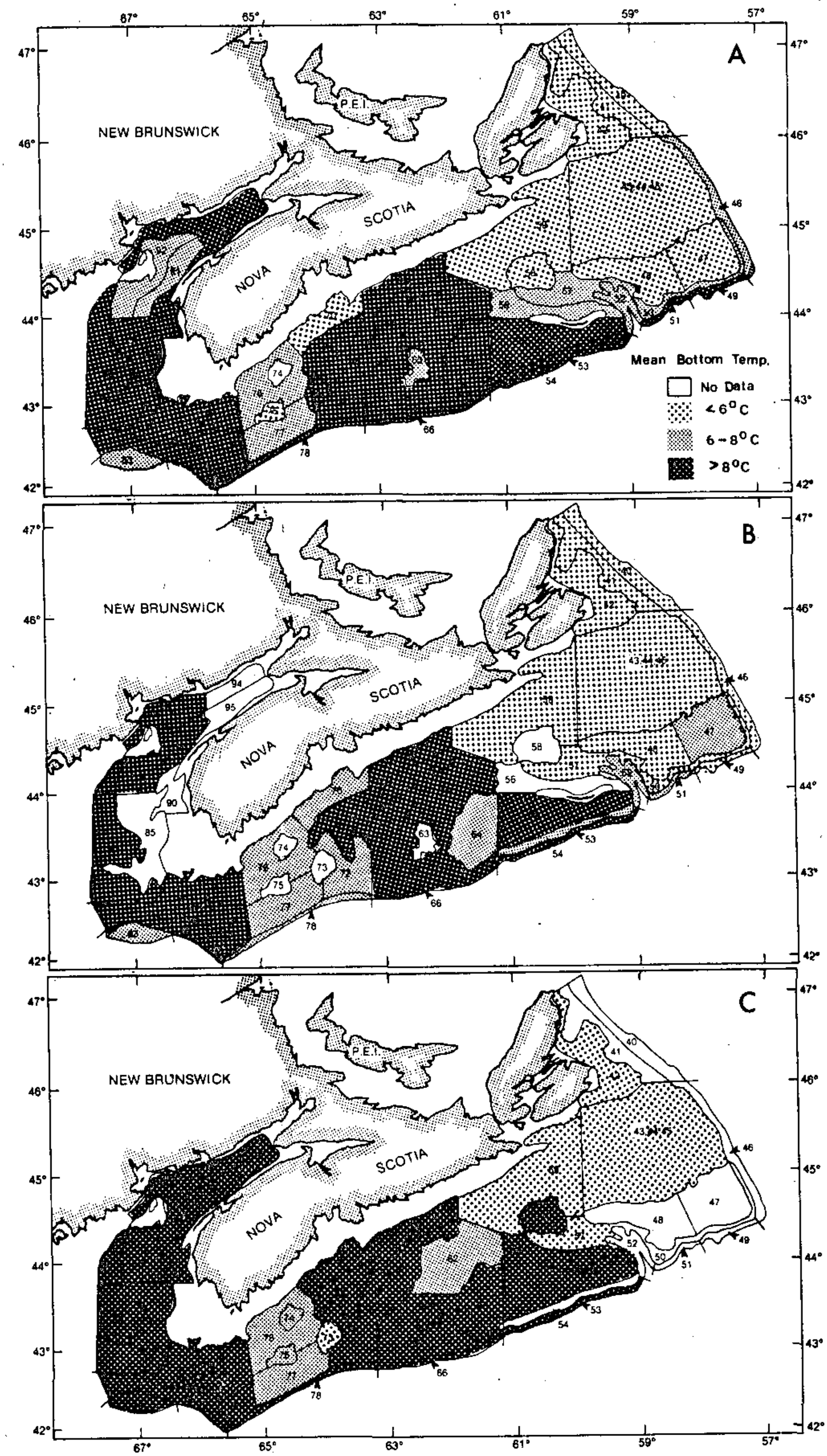


Fig. 4. Distribution of bottom temperature on the Scotian Shelf in relation to strata sampled during the 1984 surveys in (A) July, (B) September, and (C) October.

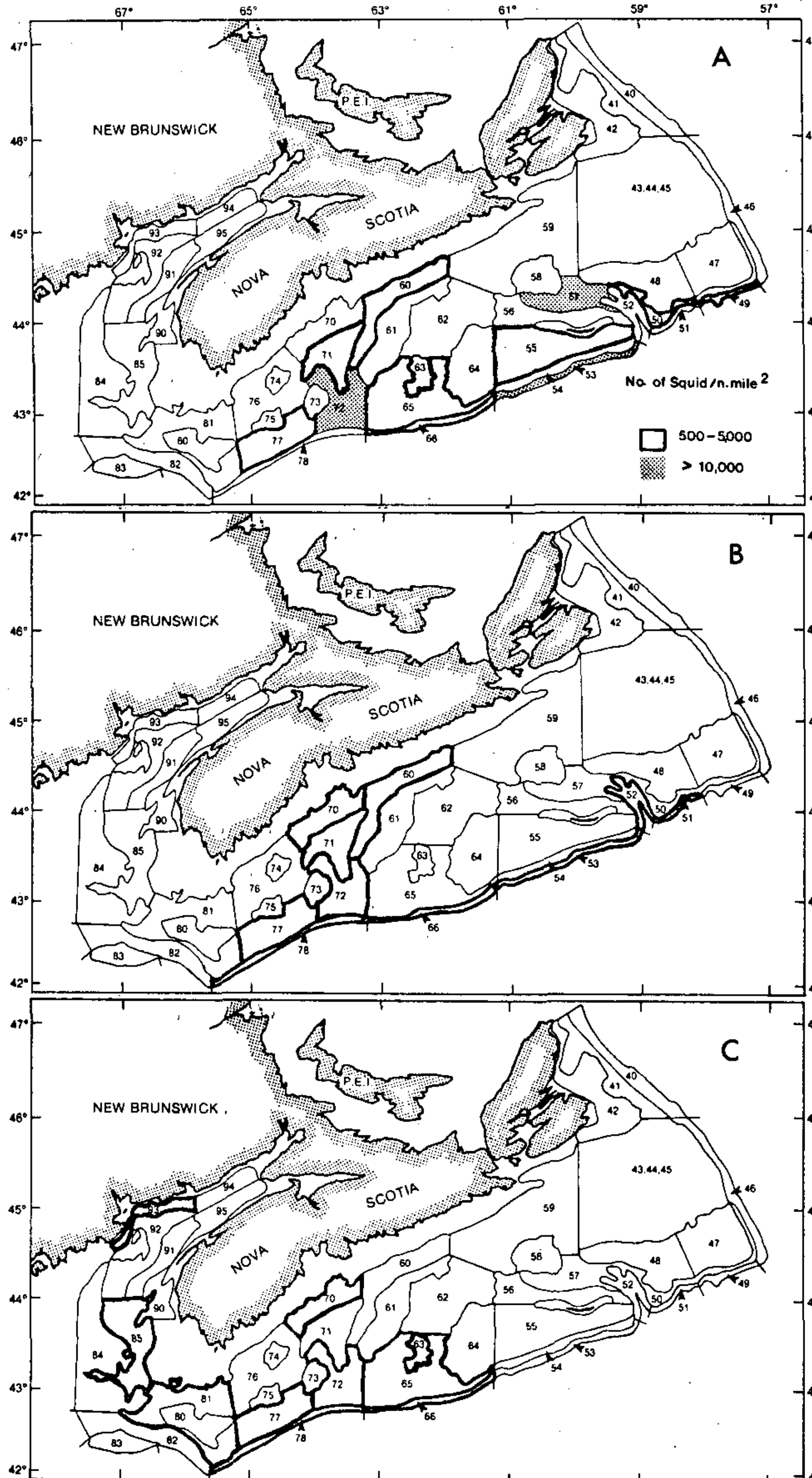


Fig. 5. Squid density by strata on the Scotian Shelf from 1984 surveys in (A) July, (B) September, and (C) October. (No area had squid density in the 5,001-10,000 range.)

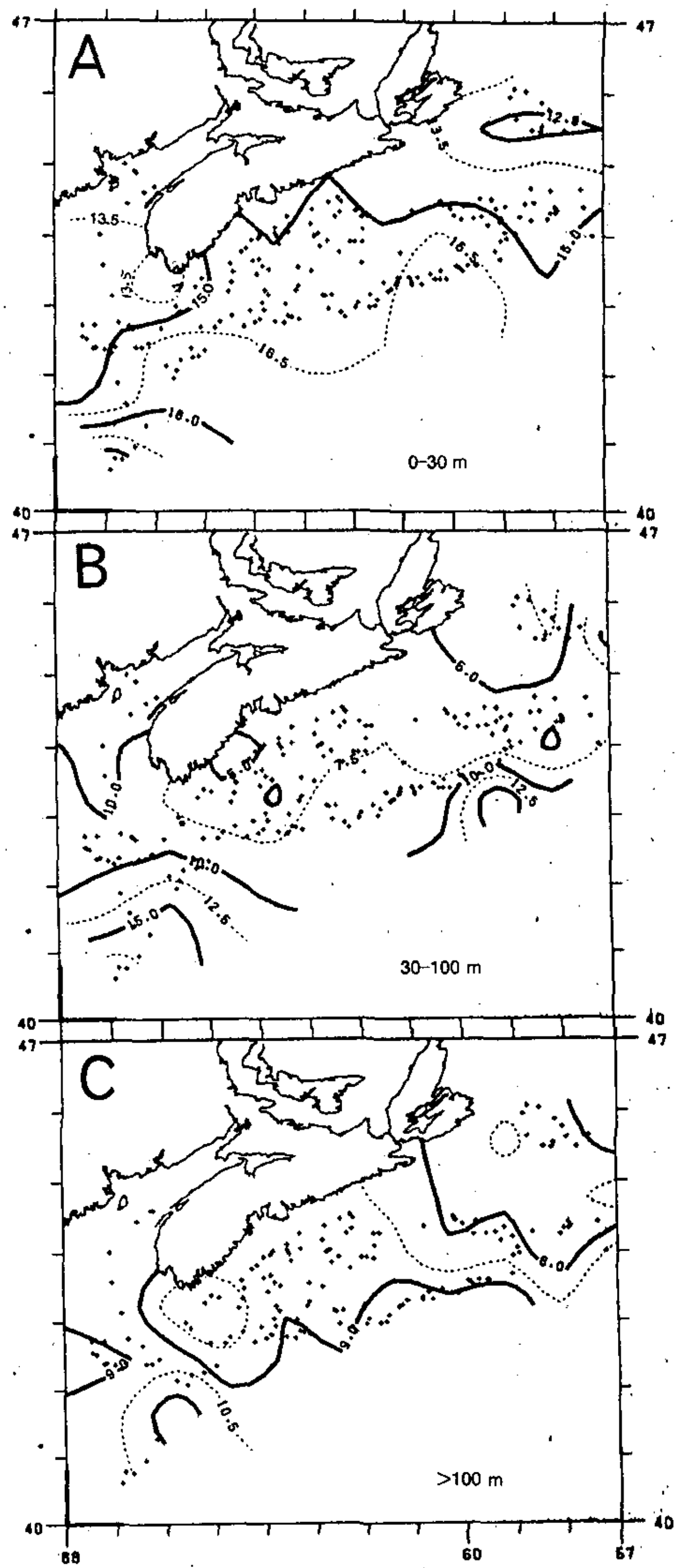


Fig. 6. Horizontal temperature distribution by depth range on the Scotian Shelf from squid surveys in September 1984.

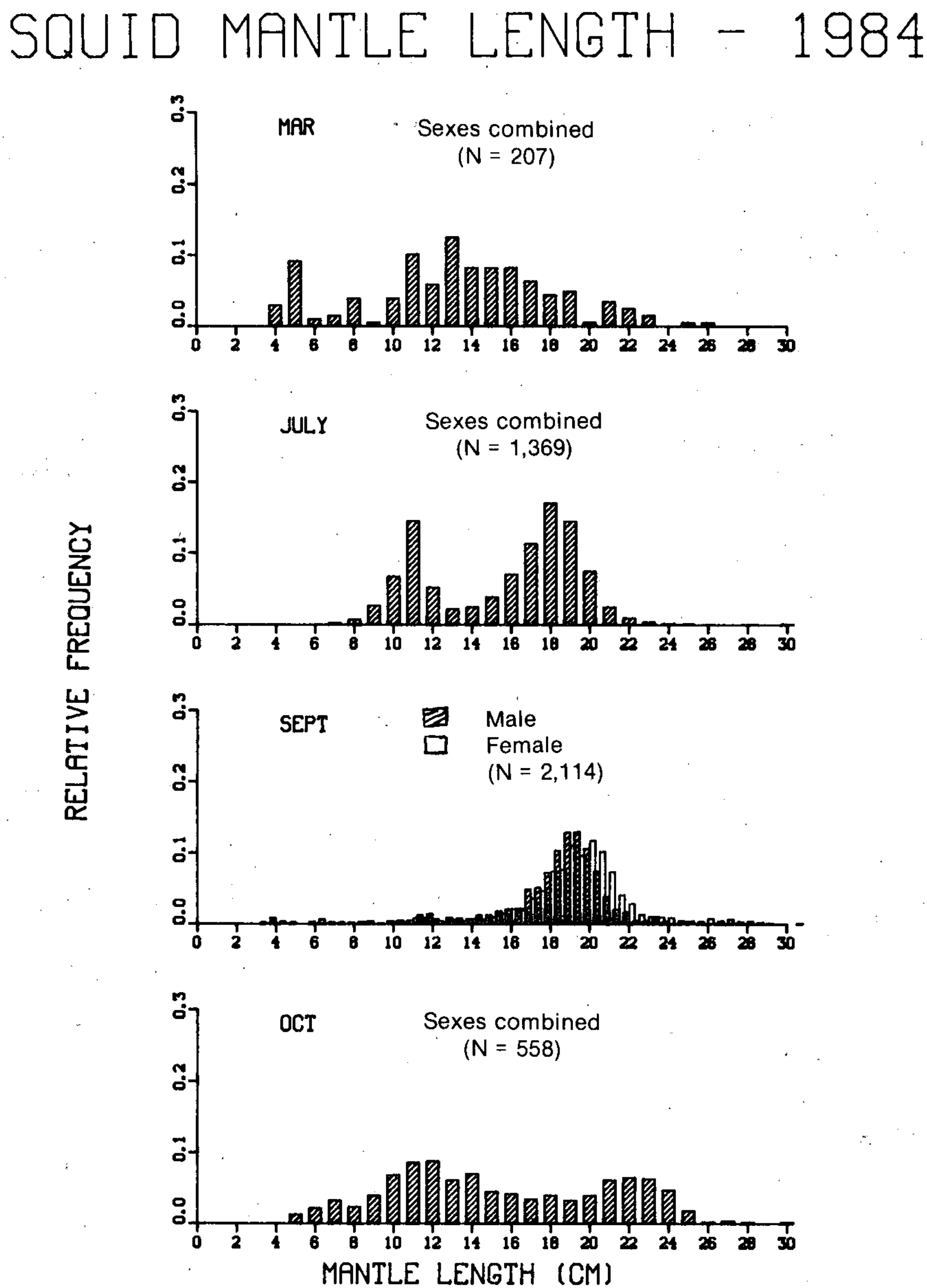


Fig. 7. Length distributions of squid (I. illecebrosus) on the Scotian Shelf for the four survey periods in September 1984.

APPENDIX I

Appendix 1.1. Mean Catch Rate and Biomass Estimates of Squid by Stratum from Groundfish Survey, March 1984.

Depth range	Stratum No.	Area n.mi2	No.of tows	Mean yield/n.mi2 No.	Mean yield/n.mi2 Wt.(kg)	Biomass Nx103	Biomass Wt.(t)
11-50 fms	43	1318	4	28	--	36.8	--
total		1318	4	28	--	36.8	--
51-100 fms	54	499	3	35	--	17.5	--
	65	2383	5	20	--	47.4	--
	72	1249	2	119	59.6	149	74.5
	81	1875	4	30	--	55.9	--
total		6006	14	40.2	8.5	269.8	74.5
101-200 fms	46	491	3	80	--	39	--
	51	147	2	112	112	16.4	16.4
	53	259	3	33	--	8.6	--
	78	233	3	244	33.1	57	7.7
total		1130	11	117.7	29.4	121	24.1
overall		8454	29	71.9	15.3	427.6	98.6

Appendix 1.2. Mean Catch Rate and Biomass Estimates of Squid by Stratum from Groundfish Survey, July 1984.

Depth range	Stratum No.	Area n.mi.2	No.of tows	Mean yield/n.mi2 No.	Mean yield/n.mi2 Wt.(kg)	Biomass Nx103	Biomass Wt.(t)
11-50 fms	48	1449	4	124	--	180.2	--
	55	2122	7	907	32	192.5	67.8
	56	955	6	140	35	134	33.5
	58	658	3	66	--	43.6	--
	64	1297	5	442	21	573.2	27.3
	75	156	2	424	47.1	66.1	7.3
	80	655	4	374	49.7	245.1	32.5
	90	601	3	37	--	22.4	--
	94	417	2	53	--	21.9	--
total		7652	36	409	29.3	1479	168.4
51-100 fms	41	1000	3	307	--	306.6	--
	44	3925	4	12.4	--	487.6	--
	49	144	2	3236	199	466	28.6
	50	383	2	2348	74.5	899	28.5
	54	499	3	246	--	122.5	--
	57	811	2	11312	1210	9174	981.4
	60	1344	2	1774	360	2385	483.2
	62	2116	4	395	105	835	222.7
	65	2383	5	3951	1221	9487	2910
	70	920	2	224	55.9	205.7	51.4
	72	1249	2	21825	2624	27260	3277
	77	1232	2	1684	105.2	2074	129.6
	81	1875	4	79	26.3	148	49.3
	85	1582	3	484	74.5	766.5	118
total		19463	40	2752	403	52997	8280
101-200 fms	45	1023	4	25	--	25.4	--
	51	147	2	615	--	90.4	--
	52	345	2	112	--	38.6	--
	53	259	2	45498	378.7	117800	981
	61	1154	2	263	--	303.6	--
	66	226	3	1167	203.5	263.7	46
	71	1004	2	4114	417.4	4131	419
	82	1042	2	497	49.7	517.8	51.8
	84	2264	3	316	35.1	714.7	79.4
total		1764	22	4881	419	17865	1577
overall		34579	98	2471	269.3	72341	10025

N.B. only strata with squid catches are shown above. The other strata were surveyed without any squid catch.

Appendix 1.3. Mean catch rates and biomass estimates of squid by stratum from Cryos survey, September 1984.

Depth range	Stratum n°	Area of stratum (square miles)	Number of hauls	Mean yield per haul		Biomass		Standard error	
				Number	kg	N. thousands	W. tons	N. thousands	W. tons
	49	144	3	1.67	0.33	16	3	15	3
	50	383	4	4.50	0.57	115	15	76	12
	54	499	5	9.00	0.64	299	21	171	13
	57	811	7	6.29	0.74	340	40	187	25
	60	1 344	7	15.14	2.29	1 357	202	263	38
51-100 faths	62	2 116	8	4.62	0.66	652	93	235	38
(93-183 m)	65	2 383	8	13.62	2.12	2 164	337	437	86
	70	920	6	78.17	10.50	4 794	644	2 663	347
	72	1 249	7	75.14	11.43	6 257	951	2 625	389
	76	1 478	7	9.14	1.43	901	141	230	36
	77	1 232	7	100.25	14.16	8 234	1 163	6 861	998
	81	1 875	6	40.00	4.68	5 000	585	1 953	244
Total		14 434	75	31.35	4.38	30 129	4 195	8 082	1 158
	46	491	4	2.37	0.62	78	20	54	12
	51	147	3	102.00	16.70	1 000	164	992	156
	52	345	4	25.25	4.00	581	92	377	59
	53	259	4	116.50	13.75	2 012	237	849	91
101-200 faths	61	1 154	7	10.86	2.01	835	155	232	36
(185-366 m)	66	226	4	16.25	2.75	245	41	178	25
	71	1 004	6	15.67	2.83	1 049	189	278	50
	78	233	4	16.54	3.11	257	48	112	18
	82	1 042	5	35.00	4.82	2 431	335	2 551	356
	83	532	5	1.20	0.06	43	2	4	0
Total		5 433	46	29.57	4.38	8 531	1 283	2 921	410
Overall		19 867	121	30.67	4.38	38 660	5 478	8 594	1 229

- Mean Catch and Biomass estimates of Illex illecebrosus per stratum in NAFO Div. 4 V, W, X
(R/V Cryos survey : Aug. 30 - Sept. 30, 1984).

Appendix 1.4. Mean Catch Rate and Biomass Estimates of Squid by Stratum from Groundfish Survey, October 1984.

Depth range	Stratum No.	Area n.mi2	No.of tows	Mean yield/n.mi2 No.	Wt.(kg)	Biomass Nx103	Wt.(t)
11-50 fms	55	2122	7	15	--	32	--
	56	955	10	184	19.9	175.4	19.0
	58	658	5	84	--	55.6	--
	63	302	2	658	204.6	198.6	61.8
	64	1297	5	61	--	78.9	--
	75	156	2	410	--	63.9	--
	80	655	4	199	--	130.5	--
	90	601	3	145	--	87.1	--
	93	533	3	1629	438.7	868.1	233.8
	94	417	2	52	--	21.9	--
	95	584	2	161	--	94.1	--
total		8280	45	241	42.8	1751	314.6
51-100 fms	50	383	4	168	55.9	64.2	21.4
	54	499	4	53	--	26.3	--
	62	2116	6	159	--	336.8	--
	65	2383	5	1123	79.8	2677	190.1
	70	920	2	2315	368.3	2130	338.8
	72	1249	2	707	105.2	882.5	131.4
	76	1478	2	50	--	73.4	--
	77	1232	2	5367	210.5	6612	259.3
	81	1875	4	585	--	1096	--
	85	1582	3	807	105.2	1276	166.5
total		13717	34	856	59.0	15175	1107.5
101-200 fms	51	147	4	417	59.6	61.4	8.8
	53	259	3	149	74.5	38.6	19.3
	61	1154	2	298	--	344.6	--
	66	226	3	506	159.7	114.3	36.1
	71	1004	2	161	--	162.1	--
	78	233	3	1543	456	360	106.2
	83	532	3	35	--	18.7	--
total		3555	21	442.1	99.3	1100	170.4
overall		25552	100	492.3	60.2	18026	1592.5

N.B. only strata with squid catches are shown. The other strata were surveyed without any squid catch.

APPENDIX 2

Appendix 2. Comparison of September Cryos and Needler squid catches from strata with more than one bottom trawl station.

Stratum	Vessel	No. of tows	Squid density (kg/n.mi.2)
47	Cryos	2	0
	Needler	2	0
50	Cryos	4	34.2
	Needler	2	198.8
52	Cryos	4	274
	Needler	4	422.4
53	Cryos	4	633.6
	Needler	2	105.2
81	Cryos	6	319.6
	Needler	4	23.5

APPENDIX 3

Appendix 3. Contoured bottom temperature plots from (A) July, (B) September, and (C) October 1984 survey periods (prepared by MEDS).