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Biological Characteristics and Biomass Estimates of the Squid (Illex illecebrosus) on the Scotian Shelf (Div. 4VWX) in 1985

by

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Introduction

This report describes the distribution and biomass levels of the short-finned squid stock on the Scotian Shelf (Div.4VWX) as derived from the spring and summer groundfish survey (Halliday and Kohler,1971) conducted in 1985. These surveys have been conducted regularly since 1978 and 1970,respectively (Halliday and Koeller, 1981). Squid distribution and abundance have been described from groundfish surveys (Scott, 1976; Dufour, 1979; Koeller, 1980; Mohn, 1981a&b; Rowell and Young, 1984; and Rowell *et al*, 1985a&b).

Methods

The groundfish survey program for 1985 consisted of two cruises conducted on board the R/V Alfred Needler using the stratified random sampling design described by Halliday and Kohler, 1971. The March (Fig.1A) and July (Fig.1B) surveys consisted of 64 and 196 bottom trawl stations, respectively. In the March survey only 20 strata (Fig.2A) in the western area of the Scotian Shelf were surveyed, whereas during the July survey all 48 strata were surveyed. The depth range coverage in the program was 11-200 fathoms (20-366m).

The trawl 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 both surveys. Tow distance was determined for each trawl with electronic navigation aids (i.e. Loran-C or SatNav). Area swept by the trawl is the product of the tow distance and the 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).

The catch was sorted by species, total squid weight and number were 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 centimeter were taken on up to 200 squid. Often, when the squid catch consisted of only a few squid, no weight was recorded. This has created some discrepency between stock size and biomass estimates. Observations made in conjunction with each tow included bottom depth and temperature.

Biomass estimates were developed separately for each sampling period by areal expansion (Tables 1, 2 & 3). That is, mean catch per stratum were multiplied by a stratum areal expansion factor and stratum biomass estimates were summed over all strata. The assumed 100% trawl efficiency is unlikely 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, mean weights per tow, and bottom temperatures, are overall means without regards for the survey sampling scheme.

Since the A. Needler is now fully operational it was considered appropriate to update the survey time series for the various vessel/gear combinations using the Needler as a standard. Correction factors of 0.6148 and 2.004 derived from Rowell and Young (1984), have therefore been applied to abundance and biomass estimates for the Lady Hammond and A.T. Cameron, respectively.

Results and Discussion

Distribution

Figure 1 illustrates the 1985 squid distribution, as indicated by catch rates in the western Shelf areas in March and over the entire Shelf in July. In March (Fig.1A) the only occurrences of squid were in the vicinity of LaHave and Browns Banks (Fig.2, strata 72, 78 & 82). In July (Fig.1B) squid appear to have migrated to the western and central areas of the Shelf, similar to that observed for the same period in 1984 (Rowell *et al*, 1985b), and those observed for 1971-74. However, the squid distribution was more restricted than that of July in the period 1976-79 (Rowell & Young, 1984). Commercial sampling data suggest that squid, slightly smaller than normal, began arriving on the Shelf around mid-May (Rowell & Scattolon, 1986).

Figures 3A and 3B, respectively present patterns of July 1985 bottom temperatures and squid abundance levels in relation to groundfish survey strata.

Bottom temperatures of 6°C or greater prevailed over the western end of the Shelf, into the Bay of Fundy, and along the edge of the Laurentian Channel. Highest temperatures (>8°C) were seen along the Shelf-edge from the mouth of the Bay of Fundy to the Gully and over the central area of the Shelf from 61°-64°W. Colder water (<6°C) covered most of the Shelf east of 61°W. This pattern is very similar to that generally seen for July in the period 1980-84 (Rowell *et al*, 1985a&b).

Patterns of July squid abundance were very similar to those seen in 1983 and 1984, and differed from that seen in the 1980-82 period, in that the distribution over the eastern and western extremities of the Shelf was more limited.

Biomass levels

Statistics relevant to biomass levels for March and July 1985 are presented along with those from the period 1980-84 in Table 1. The March survey indicates low levels of squid stock on the Shelf prior to the late spring/early summer immigration to the Shelf. The July biomass was about 20,000 t representing 412 million squid. This abundance is the highest seen in the 1980-85 period, being marginally greater than those of 1981 and 1983. Biomass was less than half that seen in 1981, but higher than the period 1982-84 and roughly the same level as seen in 1980.

In Table 2 depth stratified biomass and stock size estimates are presented for: (i) all strata; and (ii) the 'eighteen' strata (Fig.2A) which have been surveyed in September 1980-84 by France and reported by Rowell *et al*, 1985b. In July 1985, 71% of the Scotian Shelf squid population was contained in this subset of the strata. More than 96% of the squid population and biomass were located in the 51-100 fathom depth range. In the years 1980-85 more than 84% of the squid stock was located in this depth range with the exception of 1982 and 1984, which had 53% and 73% respectively. The exceptional years were ones of low overall stock size and biomass. Conversely, in years of high levels of stock and biomass, the greatest increase was observed in the 51-100 fathom depth range. At least part of the explanation of this is the greater total area in this depth range.

Catch rates, abundance, and biomass estimates for the March and July surveys are presented by stratum in Table 3. More than 89% of the squid stock in July was located in strata 54, 65 and 72 which represent the 51-100 fathom depths of the Shelf edge area between the Gully and LaHave Bank, that is 59°W

and 64°W (see Table 3 and Fig.2). In these strata there were 3, 5 and 2 bottom trawl stations respectively, but a large squid catch was made at only one bottom trawl station in each stratum. The limited data on which the bulk of the estimates are based must be considered in any interpretation of year to year changes in biomass and abundance levels or spatial patterns.

Length frequency

Length frequency distributions for July are presented in Figure 4. The distribution is based on the 1,749 squid measured during the survey with no stratum areal expansion. Modes are seen in the 9-10 and 16-17 centimeter ranges (Fig.4A). A July bimodal length frequency distribution was observed in the previous year as well, but in general secondary components to the squid stock are not observed until later in the on-shelf residency period (Rowell *et al*, 1985a).

In Figure 4B depth stratified length frequency distribution are presented. The number of tows in each depth range was sufficiently large that sampling intensity may be assumed to have no influence on the results (i.e. 29, 29 and 21 tows respectively where squid were caught at 11-50 fm, 51-100 fm, and 101-200 fm). The two modes noted in Fig.4A are clearly seen in the 51-100 depth range, and are much less evident in the other depths. In the shallower strata (<50 fm), this may in part be a reflection of the very small number of squid encountered and measured. The larger sample from depths >100 fm however clearly suggests that in July 1985 smaller squid were concentrated at depths <100 fm. A similar disparity between depth ranges is implied by comparing the stock size and biomass estimates in Table 2. Rowell *et al* (1985a) in considering data from four survey periods in each of the years 1980-83 did not observe a consistent pattern with depth throughout the series. However, in examining data from the August-September period of 1980 Dupouy (1981), 1981 Dupouy & Minet (1982), and 1982 Dupouy & Derible (1983) observed a tendency for secondary (i.e., smaller) length groups to be distributed in the 51-100 fathom depth range.

Acknowledgements

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Table 1. Groundfish survey statistics for squid, *Illex illecebrosus*, from the Scotian Shelf for 1980-85[1].

Period	Julian Day[2]	Vessel	Bottom Temp. (°C)	No. Tows	% tows with squid	Squid No. /tow	Squid kg. /tow	Biomass Est. (t)	Stock Size (millions)	Length (cm)
March:										
1980	76	L. Hammond	5.1	106	3.8	0.06	0.0	0	0.0	18.6
1981	65	L. Hammond	4.6	118	10.2	0.18	0.04	55	0.18	20.3
1982	73	L. Hammond	4.3	130	7.7	3.32	0.2	443	6.15	15.8
1983	--	--	--	--	--	--	--	--	--	--
1984	73	A. Needler	5.4	132	7.6	0.1	0.03	99	0.22	20.2
1985	**64**	**A. Needler**	**6.7**	**47**	**6.4**	**0.2**	**0.02**	**52**	**0.17**	**23.2**
July:										
1980	199	A.T.Cameron	6.2	145	44.1	32.7	2.86	21,595	229.98	16.9
1981	197	A.T.Cameron	6.4	150	52.0	47.9	6.37	54,552	393.41	18.5
1982	202	L. Hammond	5.4	150	50.7	11.1	0.86	6,583	80.46	16.5
1983	198	A. Needler	5.6	145	29.0	57.0	1.57	14,701	392.03	13.1
1984	206	A. Needler	7.3	140	40.7	13.5	1.59	10,025	74.05	16.9
1985	**196**	**A. Needler**	**5.5**	**152**	**28.9**	**69.2**	**2.82**	**19,870**	**411.89**	**11.0**
October:										
1980	286	L. Hammond	6.2	140	57.1	13.8	3.87	18,740	69.8	22.2
1981	285	L. Hammond	7.7	127	58.3	10.6	0.8	3,460	40.98	20.2
1982	282	L. Hammond	6.1	145	46.9	2.6	0.31	1,774	12.38	20.8
1983	289	A. Needler	6.3	175	32.6	2.9	0.5	1,875	11.59	17.6
1984	293	A. Needler	9.0	157	45.9	3.1	0.41	1,664	15.71	15.7
1985	--	--	--	--	--	--	--	--	--	--

1- Squid catch rates, biomass and stock size estimates from L. Hammond and A.T. Cameron surveys have been corrected to values for the A. Needler similar to Rowell and Young, 1984. In this case, as the Needler is now fully operational, it is used as the base whereas values were corrected to those for the Cameron in Rowell and Young,1984.
2- mean survey date from Julian calendar

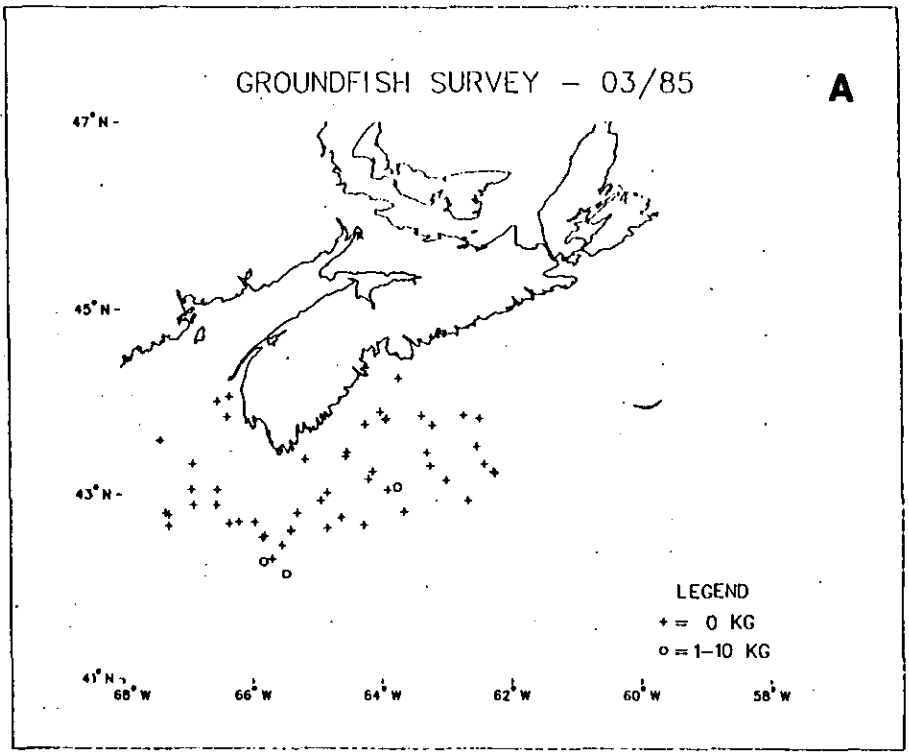
Table 2. Stock size and biomass estimates for squid (from Table 1) with depth stratification for the groundfish surveys in the period 1980-85 as follows: using (i) all strata, and (ii) only 18 strata (see Rowell *et al*, 1985b and Fig.1A).

		Depth Range (fms.) 11-50			51-100		101-200		Overall[1] 11-200	
Period	Year	millions	t		millions	t	millions	t	millions	t
March:										
	1980	--	--	(i)	.07	--[2]	.0	--	.06	--
				(ii)	.06	--	.0	--		
	1981	--	--	(i)	.07	--	.17	--	.18	--
				(ii)	.04	--	.1	--		
	1982	--	--	(i)	3.62	301	2.54	143	6.1	443
				(ii)	3.62	301	2.46	133		
	1983	no survey								
	1984	.04	--	(i)	.27	75	.12	24	.39	99
				(ii)	.25	75	.11	24		
	1985	--	--	**(i)**	**.06**	--	**.11**	**52**	**.17**	**52**
				(ii)	.06		.11	52		
July:										
	1980	19.2	3,681	(i)	177.2	16,607	3.4	659	199.8	20,948
				(ii)	140.7	11,778	1.2	182		
	1981	36.3	6,647	(i)	242.9	39,290	10.2	1,467	289.2	47,405
				(ii)	212.8	34,621	6.8	826		
	1982	2.5	138	(i)	41.5	3,552	34.7	3,036	78.8	6,726
				(ii)	37.2	3,023	10.0	76		
	1983	.9	50	(i)	386.6	14,410	6.1	241	393.6	14,701
				(ii)	380.1	14,200	5.8	241		
	1984	3.2	168	(i)	56.4	8,279	18.1	1,577	77.7	10,024
				(ii)	52.5	8,133	5.3	517		
	1985	**.5**	--	**(i)**	**403.6**	**19,110**	**8.4**	**759**	**412.0**	**19,869**
				(ii)	286.1	17,676	5.0	554		
October:										
	1980	12.9	4,040	(i)	51.8	13,287	4.7	1,257	69.4	18,585
				(ii)	17.0	3,962	4.0	1,024		
	1981	28.	1,104	(i)	8.7	1,409	3.8	609	40.5	3,121
				(ii)	7.7	1,099	2.5	390		
	1982	3.3	419	(i)	8.3	1,155	.8	122	12.3	1,697
				(ii)	7.7	990	.7	122		
	1983	.5	122	(i)	7.6	817	3.5	794	11.6	1,733
				(ii)	6.7	683	0.6	308		
	1984	1.8	315	(i)	15.5	1,180	1.1	170	18.4	1,665
				(ii)	13.9	941	1.0	151		
	1985	no survey								

1 - Overall totals do not include stratum 59 which has variable depth.
2 - Trawl catches of only a few squid are not weighed but the number is recorded, thereby creating a discrepency between estimated stock size and biomass.

Table 3. Mean catch rate and biomass estimates of squid by stratum from groundfish surveys in 1985.

Month	Depth range	Stratum No.	Area ($n.mi^2$)	No. of tows	Mean yield/$n.mi.^2$ No.	Mean yield/$n.mi.^2$ Wt.(kg)	Biomass $nx10^3$	Biomass Wt.(t)
March	51-100	72	1,249	2	50	--	62.0	--
	101-200	78	233	3	232	--	54.0	--
		82	1,042	2	50	49.7	51.8	51.8
July	11-50	55	2,122	7	28	--	60.3	--
		56	955	6	66	--	63.3	--
		58	658	3	66	--	43.6	--
		63	302	2	149	--	45.0	--
		64	1,297	5	61	--	78.9	--
		75	156	2	310	--	48.3	--
		80	655	4	176	--	115.2	--
	51-100	50	383	3	33	--	12.7	--
		54	499	3	123,435	2,876.3	61,590.	1,435.3
		57	811	2	9,448	614.9	7,662.	498.7
		62	2,116	4	998	127.2	2,112.	269.1
		65	2,383	5	117,473	2,588.7	279,000.	6,168.8
		70	920	2	99	--	91.4	--
		72	1,249	2	32,598	8,099.8	40,710.	10,116.6
		76	1,478	2	1,888	49.7	2,791.	73.4
		77	1,232	2	6,814	365.4	8394.	450.2
		81	1,875	4	184	52.6	345.3	98.7
	101-200	51	147	2	3,630	52.6	533.7	7.7
		53	259	3	3,648	210.5	944.8	54.5
		61	1,154	2	2,260	263.1	2,607.	303.6
		66	226	3	199	66.3	44.9	15.
		71	1,004	2	579	52.6	581.1	52.8
		78	233	3	2,153	530.	501.7	123.5
		82	1,042	1	696	49.7	724.9	51.
		83	532	2	53	--	28.0	--
		84	2,264	3	1,060	66.3	2,400.	150.



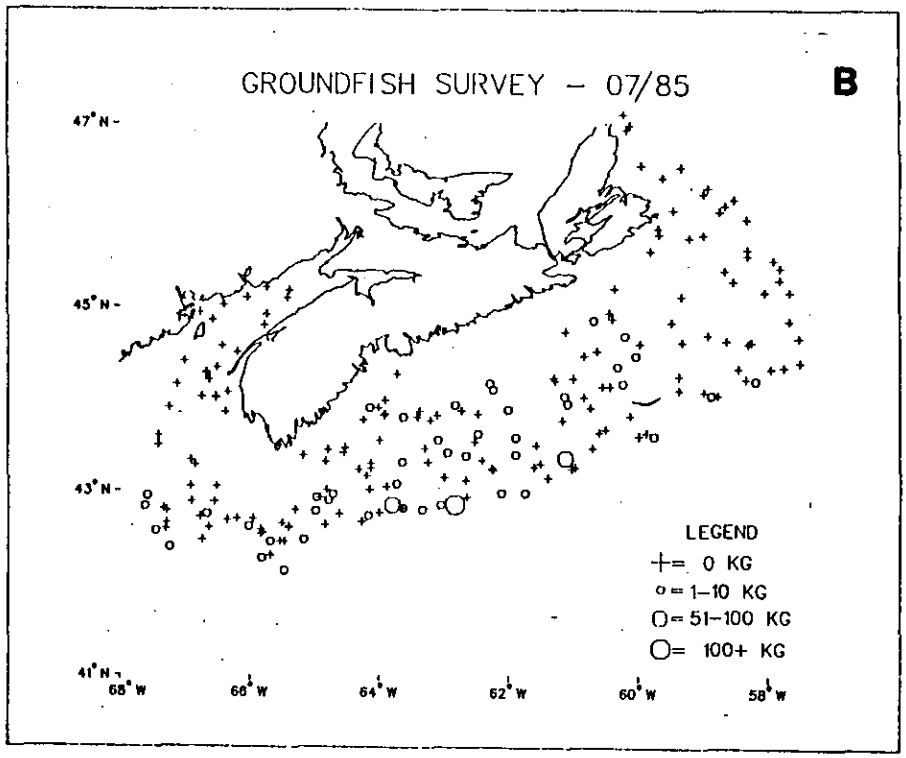


Fig. 1. Distribution of squid catches (kg/tow) on the Scotian Shelf from (A) March and (B) July groundfish surveys in 1985.

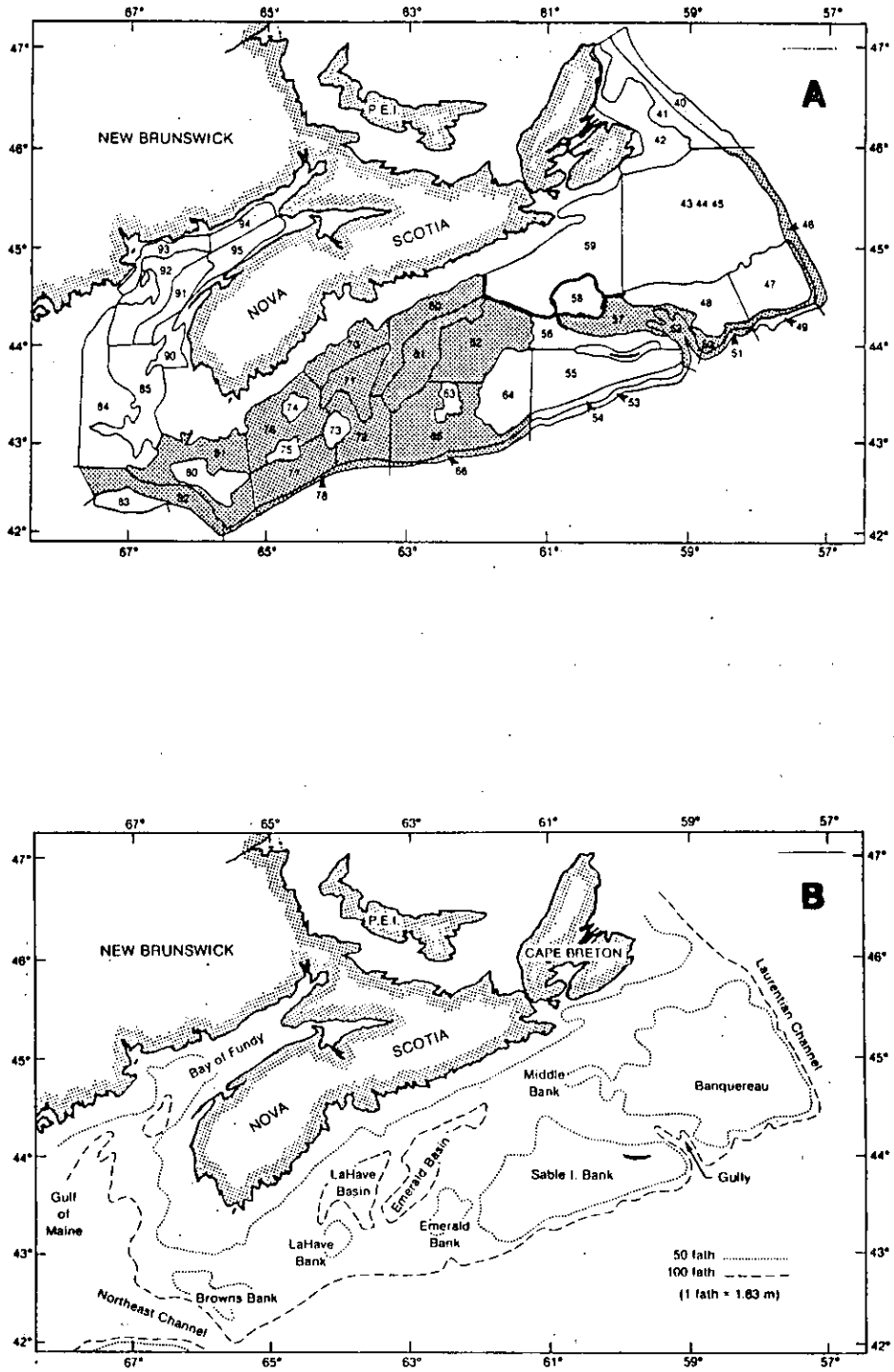


Fig. 2. Scotian Shelf: (A) groundfish survey strata, redrawn from Halliday and Kohler, 1971; (B) with place names mentioned in the text. (The shaded area in (A) represents the '18' strata referred to in Table 2)

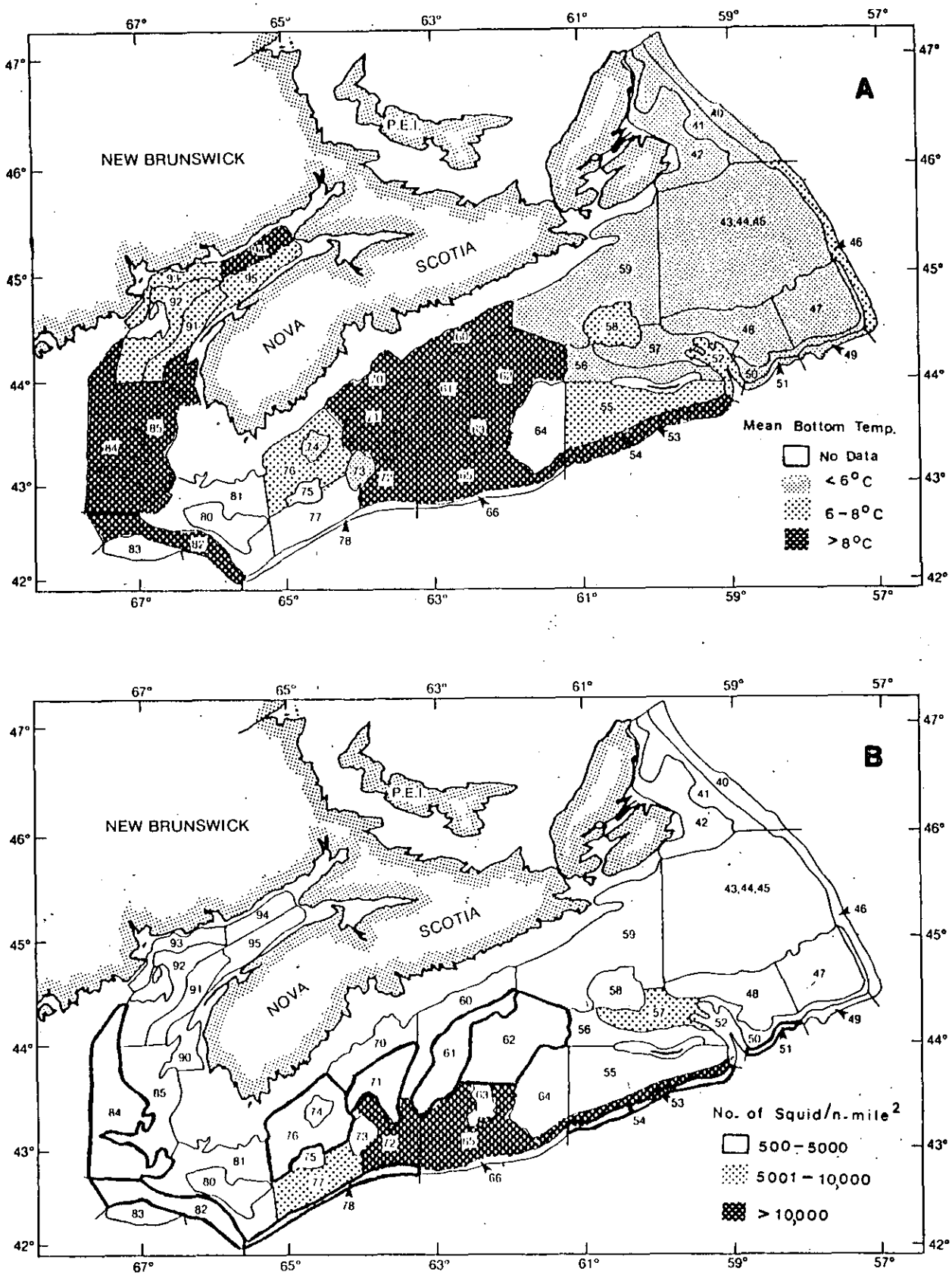


Fig. 3. (A) Distribution of mean bottom temperature by strata on the Scotian Shelf in July 1985.
(B) Distribution of squid density by strata on the Scotian Shelf in July 1985.

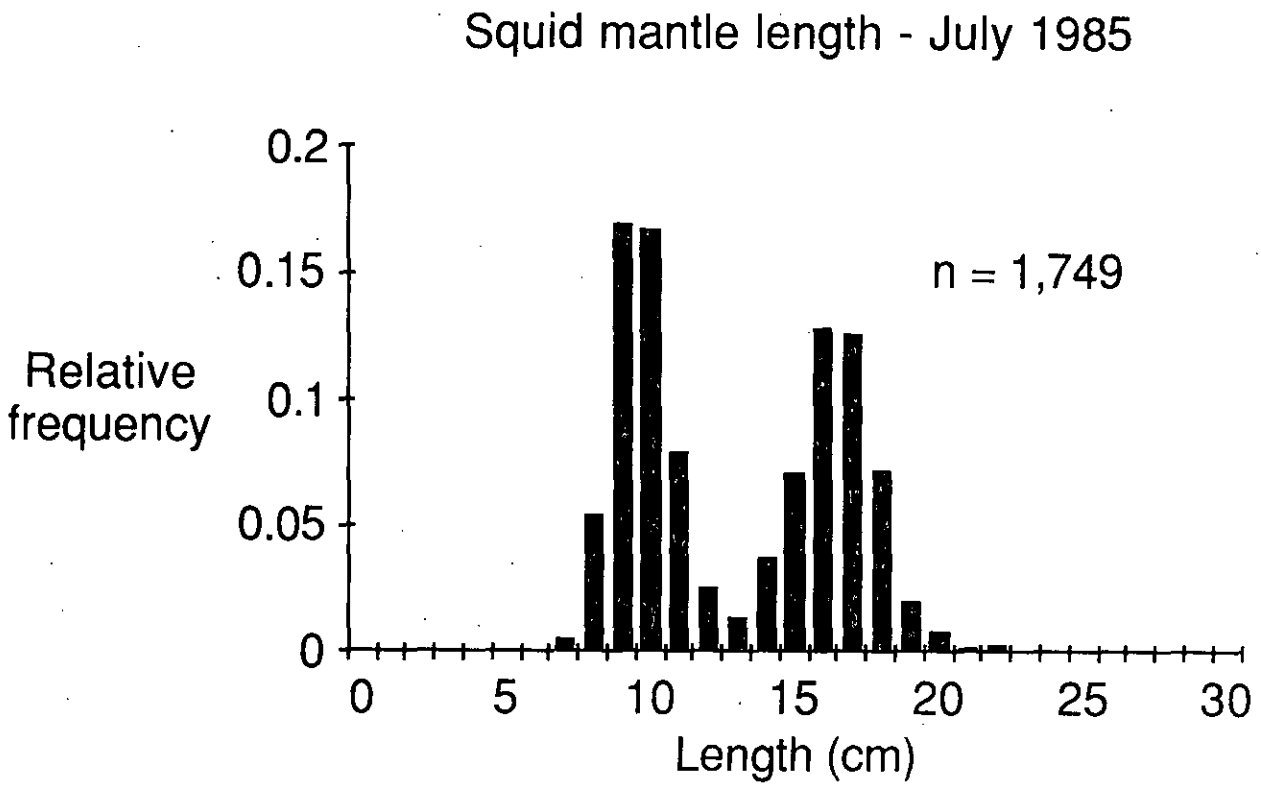


Fig. 4A. Squid length frequencies on the Scotian Shelf from the groundfish survey in July 1985.

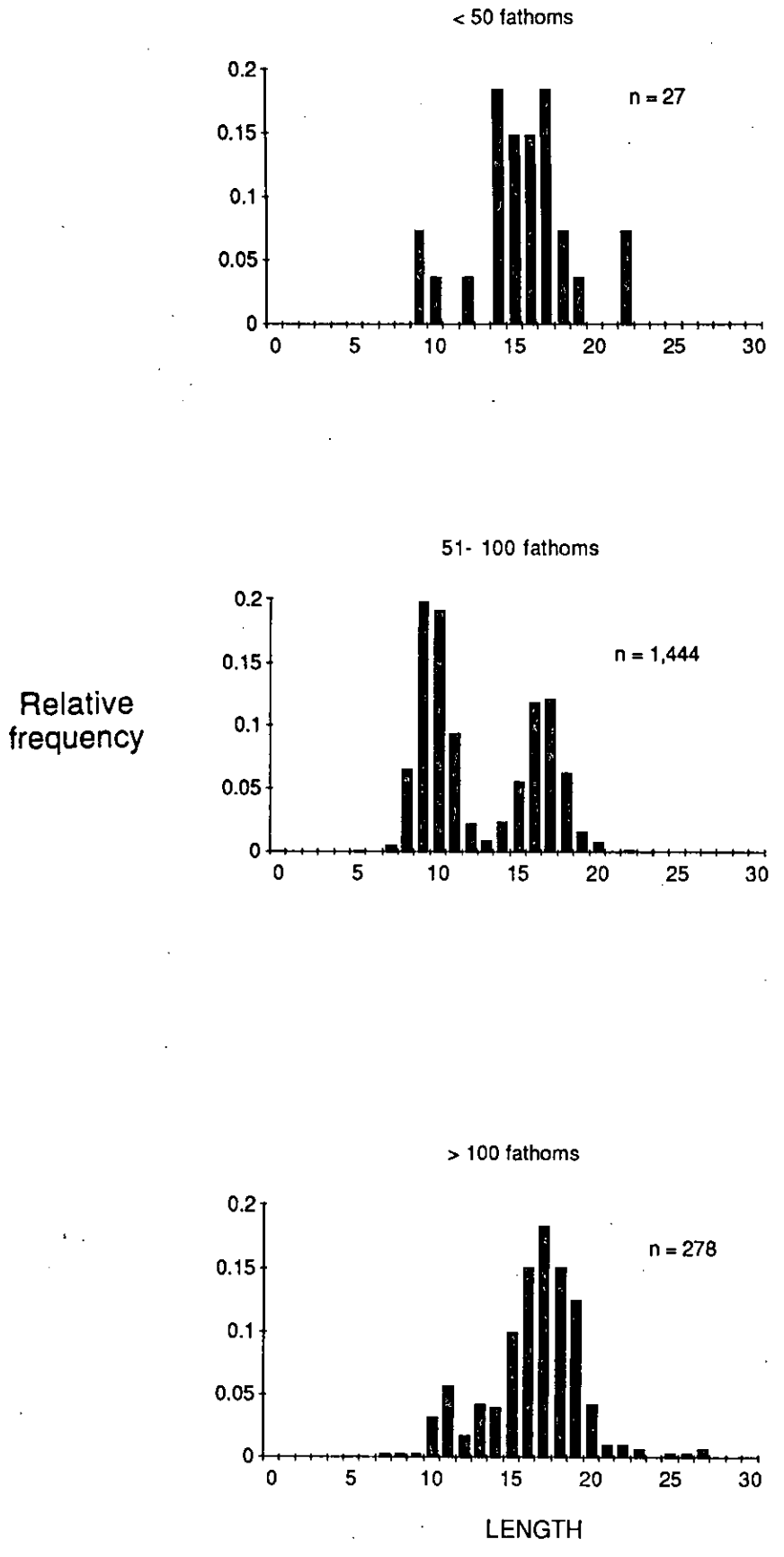


Fig. 4B. Depth-stratified squid length frequencies on the Scotian Shelf from the groundfish survey in July 1985.