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STATUS OF THE LONG-FINNED SQUID, LOLIGO PEALEI, STOCKS OFF THE NORTHEASTERN USA

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by

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SUMMARY

Research survey biomass and abundance estimates for the long-finned squid, Loligo pealei, off the northeastern USA are updated for 1982 and 1983. Commercial catch data are also updated for 1982 and January-October 1983. Distant-water-fleet (DWF) catches decreased 22% in 1982 from the level observed in 1981, while USA catches were the highest on record. Through October 1983, USA catches were already 2.3 times higher than the 1982 total, while DWF catches were about 44% of the 1982 level.

Stock abundance estimates for L. pealei based on the 1982 autumn trawl survey (primarily the 1982 year class) were 10% above both the 1968-81 mean and the 1981 level. Preliminary results from the 1983 autumn survey indicate that abundance is presently above the 1982 level. Abundance of the spring and autumn 1983 cohorts should provide a level of recruitment of 2.1-4.6 billion individuals (assuming 100%-45% catchability in the survey trawl) which, if fished at the 1978-81 level of fishing mortality, would support an estimated yield of 54,300-54,800 mt in an offshore/inshore fishery and 60,300-66,900 mt in an inshore fishery in 1984-85.

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INTRODUCTION

This document updates information regarding the status of the long-finned squid (Loligo pealei) stock (Lange 1982) in the area from the Mid-Atlantic to the Gulf of Maine. Information presented includes catch and length frequency data from the 1982 and early 1983 USA and distant-water-fleet (DWF) fisheries, and minimum biomass and abundance estimates and pre-recruit abundance indices for 1982 and 1983 (preliminary) from NEFC autumn bottom trawl survey data.

BIOLOGY

Loligo pealei, the long-finned or common American squid, is generally distributed between Georges Bank and Florida, with fishable concentrations between southern Georges Bank and Cape Hatteras. Long-finned squid undergo seasonal migrations to shallow inshore waters from southern Cape Cod to the Chesapeake Bay in spring and summer to spawn. Spawning occurs over about a 6-month period (May-October) with peaks in May and, to a lesser extent, in October resulting in two distinct cohorts in most years. In late autumn, they move offshore to overwinter along the edge of the continental shelf. Loligo pealei is a short-lived species which is assumed to die after spawning at about 18-36 months of age.

COMMERCIAL CATCH

The provisional international catch in 1982 was 20,705 metric tons (mt) (Table 1), an 8% decrease from 1981, and 4% below the 1968-81 mean. The projected total for 1983 is about 20,000 mt.

The provisional 1982 USA catch, taken primarily between May and September, totaled 4,900 mt (Table 1), representing a 112% increase from 1981 and almost a two-fold increase from the 1968-81 average. This amount included about 1,100 mt taken in joint ventures with foreign companies. The USA catch during January-October 1983 (11,300 mt) was over twice that for all of 1982, and includes about 2,430 mt taken in joint ventures. The projected total USA catch for 1983 is about 12,000 mt.

Catches by Japan, Italy, and Spain (Table 1) totaled 15,805 mt in 1982, representing a 22% decrease from 1981 and a 20% decrease from the 1968-81 mean. DWF catches through October 1983 totaled 7,835 mt, with about 1,240 mt caught during April-October. This fishery takes place primarily between December and February.

MANAGEMENT

The squid stocks in USA waters are currently managed on an April 1 - March 31 fishing year. Domestic and DWF allocations and catches of *L. pealei* for the 1982-83 fishing year and

preliminary values for the 1983-84 fishing year are presented in Table 2. Sixty-three percent of the allocated portion of the final total allowable level of foreign fishing (TALFF) and 72% of the domestic annual harvest (DAH) were taken during the 1982-83 fishing year (Table 2). Final catches by the DWF amounted to 71% of their initial allocation.

DAH was increased from 7,000 mt during the 1982-83 fishing year to 22,000 mt for 1983-84. Forty-nine percent of the DAH was taken during April-October 1983. DWF allocations were reduced from 20,350 mt during 1982-83 to 5,550 mt during 1983-84.

CATCH PER UNIT EFFORT

Catch per unit effort (CPUE) data from the USA directed otter trawl fishery (excluding joint ventures) during 1976-82 are presented in Table 3. Fishing trips were analysed based on the percentage (in 5% intervals) of long-finned squid in the total catch to determine which trips constituted directed effort. A large number of vessel trips caught 25% or less squid and were assumed to represent non-directed effort. The number of trips with 26-75% squid in the catch was low. However, there was an increase in the number of trips reporting 76-100% squid. Directed effort was, therefore,

defined as that from trips in which 76% or more of the catch was long-finned squid.

CPUE fluctuated widely during 1976-82, ranging from 7.63 mt per day in 1976 (all vessels, all areas) to 2.50 in 1978. Similar patterns were observed for each vessel class (except vessel class 4, in 1981) indicating that fluctuations were due to availability or abundance rather than changes in vessel fishing power. The 1982 value (5.27) was the second highest of the series. Preliminary indications suggest that CPUE in 1983 may exceed all previous levels observed, especially in the southern New England area (statistical areas 538 and 539, Figure 1).

LENGTH FREQUENCY OF COMMERCIAL CATCH

Length frequencies were pooled by month over all otter trawl catches sampled from the 1982 USA long-finned squid fishery on Georges Bank and in the southern New England and Mid-Atlantic areas. Modes in the length distributions are assumed to represent age groups spawned at about the same time of year. Catches in each area were, as expected, dominated by larger individuals of the 1981 year class. Significant catches were also made of the 1980 year class as it moved inshore to spawn during the first half of the year. The spring cohort of the 1982 year class was also an important component of the catch during November.

Catches on Georges Bank in March consisted of several modes ranging from about 14 cm (probably the 1981 spring cohort) to 31 cm (the 1980 spring cohort). Catches in July consisted of a single mode at 17 cm probably representing the spring 1981 cohort (Figure 2).

Catches in the southern New England area generally consisted of two-three modes (Figure 3). The autumn 1980 cohort was represented during January-August, ranging from about 26 to 30 cm. The spring 1981 cohort was the dominant age group in most months and ranged from about 17 cm in January to 23 cm in November. The autumn 1981 cohort first appeared in April (11 cm) and was important in the catch during July-November, ranging from about 10 to 15 cm. The spring 1982 cohort first appeared in November (10 cm) and made up about half of the catch during that month.

Catches in the Mid-Atlantic area were sampled during most months and, as with the southern New England catches, generally consisted of two or three age groups (Figure 4). The spring 1980 cohort was taken during January-July, ranging from about 23 to 31 cm. The autumn 1980 cohort ranged from about 18 cm in January to 31 cm in November. The spring 1981 cohort was again the dominant age group and ranged in size from about 15 cm in January to 26 cm in December. The autumn 1981 cohort was first caught in May at about 10 cm, and, as this age group continued to move inshore through the summer, became the dominant group

and attained lengths of about 20 cm by December. The spring 1982 cohort was first taken in small numbers in August at about 6 cm and reached about 10 cm by December.

Length frequencies collected by USA observers in 1982 from the DWF fishery (primarily from the Mid-Atlantic area) were skewed toward the lower length intervals with a predominant mode in each month between 8 and 13 cm (Figure 5). This mode represented recruitment and growth of the 1981 autumn cohort during January-March (8-9 cm) and in July, August and October (13 cm). Recruitment of the spring 1982 cohort was reflected by the dominant mode at 8 cm during September-December (catches were relatively small during those months). Although additional modes were not obvious in most months, that portion of the monthly distributions in excess of 15 cm represented a mixture of the 1981 and 1980 year classes.

Length frequencies were also obtained from the April-November shoreside landings in 1983. Joint venture samples from 1983 have not yet been processed. Catches on Georges Bank during August and October were primarily from the autumn 1982 cohort (15-16 cm), with a second mode at about 19-20 cm probably representing the spring 1982 cohort (Figure 6). As in 1982, the southern New England catches generally consisted of two or three age groups (Figure 7). The spring 1982 cohort was represented in the catches during April- September ranging from 16 to 21 cm. The autumn 1982 cohort entered the catch in

June at about 13 cm and dominated the catch during July (13 cm) - October (19 cm). The autumn and spring 1981 cohorts were represented in the catches during April (23 and 28 cm) and May (24 and 32 cm).

Catches from the USA fishery in the Mid-Atlantic area were sampled during September-November 1983 (Figure 8). The autumn 1982 cohort dominated catches in each month and ranged from about 9 to 12 cm, while the spring 1982 cohort was also evident during October (22 cm). The spring 1983 cohort entered the fishery during November (8 cm).

BIOMASS AND ABUNDANCE

Minimum biomass and abundance estimates for L. pealei were derived by areal expansion of stratified mean weight and numbers per tow calculated from NEFC autumn bottom trawl survey data (Table 4). These estimates were made using the equation:

$$B = WA / a$$

where B = estimate of biomass or abundance, W = stratified mean weight or number per tow, A = strata (Figure 9) area sampled (in square miles), and a = area swept by each tow (0.011 square

miles). Estimates were adjusted to account for day-night differences in abundance (Sissenwine and Bowman 1978), as this species is more available to the trawl during daylight than darkness. The minimum estimates in autumn include a high proportion of pre-recruits which will grow considerably in weight by the time they enter the fishery in January-March.

The 1982 autumn survey estimates (24,600 mt and 3.7 billion individuals) were 1% and 10% above the 1981 estimates and 23% below and 10% above the 1968-81 means. The proportion of the abundance comprised of pre-recruits ($\leq$8 cm) increased from 72% in 1981 to 83% in 1982, compared to the average during 1967-81 of 86% (Table 5). The 1982 pre-recruit index (256.6 individuals per tow) was 7% above the 1968-81 mean and 10% above the median.

Preliminary estimates of minimum biomass and abundance from the 1983 autumn NEFC survey (51,561 mt and 4.7 billion individuals) were 110% and 26% above the 1982 levels, making the biomass estimate the highest on record (1968-83). The abundance estimate was the fourth highest of the time series. The 1983 pre-recruit abundance index was 6% below the 1968-82 mean (4% below the median) and 12% below the 1982 level. Pre-recruits represented about 69% of the total abundance index or about 3.3 billion individuals. This minimum estimate of pre-recruits was 6% above the 1982 value. However, even in years when abundance is apparently well above average,

availability to the fishery, especially the local inshore fishery, can be below average. Environmental factors in the immediate area of the fishery, as well as in the areas through which the squid must migrate, will affect the relationship of the abundance estimate from the autumn survey and availability at the onset of the DWF and USA fisheries 3-6 months later.

YIELD ANALYSIS

A yield analysis (Lange et al. 1983) was recently completed based on a simulation model (Lange 1981) which used monthly estimates of growth rate and fishing, natural, and spawning mortality rates and assumed two cohorts per year. Estimates of mortality rates were based on average survey catch per tow (by cohort) indices (1968-81) and estimates of the average catch in number from the international fishery. Recruitment was based on numbers of individuals per cohort at 6 months of age, with recruitment of the spring cohort estimated from the autumn survey and recruitment of the autumn cohort estimated from the following spring survey. During 1968-81, about 55% of the pre-recruits in the autumn surveys were from the spring cohort. Assuming the same proportion in 1983 and assuming 100% catchability of squid in the survey trawl, 1.8 billion of the 3.3 billion pre-recruits estimated during the 1983 autumn survey would be from the spring 1983 cohort.

Assuming 45% catchability (Lange et al. 1983), recruitment from the spring cohort would be about 3.9 billion individuals. Recruitment of the autumn cohort during the 1968-81 spring surveys was about 18% of that seen from the spring cohorts. Assuming the same proportion in spring 1984, an additional 0.3-0.7 billion individuals should be recruited assuming 100%-45% catchability. Total recruitment from the 1983 year class should, therefore, be 2.1-4.6 billion individuals, assuming 100%-45% catchability.

The yield analysis by Lange et al. (1983) provided estimates of yield per recruit at various levels of fishing mortality and average abundance based on different assumptions of squid catchability in the survey trawl. Yield per recruit was estimated for two types of fisheries with different exploitation patterns: a dominant offshore winter fishery coupled with a relatively small inshore summer fishery as has existed since the early 1970's (offshore/inshore), and a dominant inshore summer fishery similar to that traditionally conducted by USA fishermen with no offshore winter fishery (inshore fishery). Yield per 1000 recruits at the average level of fishing mortality estimated for 1978-81 was 25.8 kg assuming 100% catchability in the survey trawl and 11.8 kg assuming 45% catchability given an offshore/inshore fishery and 31.5 kg assuming 100% catchability and 13.1 kg assuming 45% catchability given an inshore fishery.

Simulated yield from the spring and autumn 1983 cohorts at the 1978-81 average level of fishing mortality and based on the above yield per recruit values would be 54,300-54,800 mt from an offshore/inshore fishery and 60,300-66,900 mt from an inshore fishery.

CONCLUSION

The total catch during 1982 was the third highest since 1977 and comparable to the 1968-81 mean, and while DWF catches were also the third highest since 1977, they were 20% below the 1968-81 mean. USA catches in 1982 were about twice the 1968-81 mean, while catches during January-October 1983 were over twice that for 1982. Joint venture catches accounted for about 22% of both the 1982 and January-October 1983 USA catches.

Catch per unit effort in the USA directed fishery (1976-82) has fluctuated widely, but was the second highest in the time series in 1982. The 1983 CPUE level is expected to exceed the previous high.

The autumn 1983 minimum abundance estimate was the fourth highest since 1968 and was 38% above the 1968-82 mean. Pre-recruit abundance in 1983 was also the fourth highest of the time series and was 14% above the 1968-82 mean, which may forecast increased recruitment to the 1984-85 fishery. However, availability to the fishery may also be affected by

environmental factors in the area of the fishery and in the area through which the squid most migrate.

Based on the 1982 and 1983 autumn research survey estimates, abundance of long-finned squid appears to be well above the 1968-81 average. Increased CPUE values observed in the 1982 USA fishery and all-time high CPUE values expected in 1983 also indicate that the stock is at a high level of abundance. Yield estimates from the spring and autumn 1983 cohorts varied from 54,300-54,800 mt for an offshore/inshore fishery to 60,300-66,900 mt for an inshore fishery.

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Table 1. Annual Loligo pealei catches (in metric tons) from the Northwest Atlantic (Cape Hatteras to Gulf of Maine) by the USA and the distant-water-fleet (DWF), 1963-1983.

Year	USA	DWF	Total
1963	1,294	0	1,294
1964	576	2	578
1965	709	99	808
1966	722	226	948
1967	547	1,130	1,677
1968	1,084	2,327	3,411
1969	899	8,643	9,542
1970	653	16,732	17,385
1971	727	17,442	18,169
1972	725	29,009	29,734
1973	1,105	36,508	37,613
1974	2,274	32,576	34,850
1975	1,621	32,180	33,801
1976	3,602	21,682	25,284
1977	1,088	15,586	16,674
1978	1,291	9,355	10,646
1979	4,252	13,068	17,320
1980	3,996	19,750	23,746
1981	2,316	20,212	22,528
1982[1]	4,900	15,805	20,705
1983[2]	11,716	8,190	19,906

[1] Provisional
[2] Preliminary, through October 31, 1983.

Table 2. Total domestic and distant-water-fleet (DWF) allocations and catches of Loligo pealei in the 1982-83 and 1983-84 fisheries (metric tons).

Item	1982 - 83	1983 - 84[1]
Optimum yield	44,000	44,000
Domestic annual harvest	7,000	22,000
Initial reserve	19,000	4,500
Initial TALFF	18,000	4,500
Final TALFF	37,000	21,166
Final DWF allocation	20,350	5,550
Domestic landings	5,024	11,156
shoreside	3,930	8,728
joint venture	1,094	2,428
DWF catch	12,734	1,592

[1] Values as of 31 October 1983.

Table 3. USA catch-per-unit-effort from otter trawls (metric tons per day) from trips where Loligo was 76% or more of the catch, 1976-82.

Area	Ton class[1]	Year						
		1976	1977	1978	1979	1980	1981	1982
				Annual				
All	All	7.63	4.91	2.50	5.18	5.18	3.76	5.27
538 + 539[2]	All	7.20	5.01	2.54	5.21	5.24	3.67	4.96
	2	7.94	5.28	2.55	4.37	4.91	3.11	3.65
	3	6.61	4.82	2.38	5.99	5.69	4.55	6.22
	4	-	-	-	-	4.07	6.23	5.51
538	All	7.32	5.10	2.54	5.22	5.28	3.57	4.94
539	All	4.84	0.90	2.64	-	1.92	9.76	8.00
				May - June				
All	All	7.69	5.06	2.63	5.19	5.22	3.67	5.23
538 + 539	All	7.28	5.13	2.54	5.22	5.27	3.64	4.95
	2	8.14	5.50	2.55	4.34	4.93	3.10	3.62
	3	6.61	4.85	2.47	6.04	5.73	4.48	6.22
	4	-	-	-	-	4.18	6.05	5.51
538	All	7.32	5.13	2.54	5.22	5.27	3.57	-
539	All	6.14	-	-	-	4.54	9.98	-

[1] Ton class 2- 5-50 tons
3- 51-150 tons
4- 151-500 tons

[2] See Figure 1.

Table 4. Loligo pealei minimum biomass (metric tons) and abundance (in millions) estimates[1] for the Mid-Atlantic to Gulf of Maine, 1968-1982.

Year	Biomass	Abundance
1968	29,114	1,212
1969	48,055	2,393
1970	19,640	1,946
1971	14,050	1,106
1972	21,039	1,533
1973	44,252	3,092
1974	46,442	4,757
1975	48,636	7,789
1976	51,436	4,372
1977	27,421	3,157
1978	18,800	1,251
1979	19,333	2,114
1980	34,275	9,314
1981	24,345	3,411
1982[2]	24,600	3,736
1983[2]	51,561	4,707

1) From areal expansion of stratified mean weights (kg) and numbers per tow, by strata set, assuming 100% catchability during day-time. Night-time catch data were expanded to account for diel differences in catch (Sissenwine and Bowman 1978).
2) Preliminary.

Table 5. Total and pre-recruit (≤ 8cm) numbers per tow[1] of Loligo pealei, 1967-83.

Year	All sizes	Pre-recruits
1967	134.5	126.9
1968	176.5	159.9
1969	237.3	217.4
1970	85.6	79.3
1971	163.3	161.5
1972	271.4	258.5
1973	372.0	353.9
1974	251.7	233.3
1975	614.4	593.3
1976	410.9	302.5
1977	388.5	297.7
1978	144.2	93.4
1979	193.7	156.5
1980	364.1	279.8
1981	226.2	161.8
1982[2]	310.4	256.6
1983[2]	328.7	224.3

[1] Stratified mean number per tow of all sizes and of individuals ≤ 8 cm mantle length from autumn bottom trawl surveys, Mid-Atlantic to Georges Bank (no day/night adjustment).
[2] Preliminary.

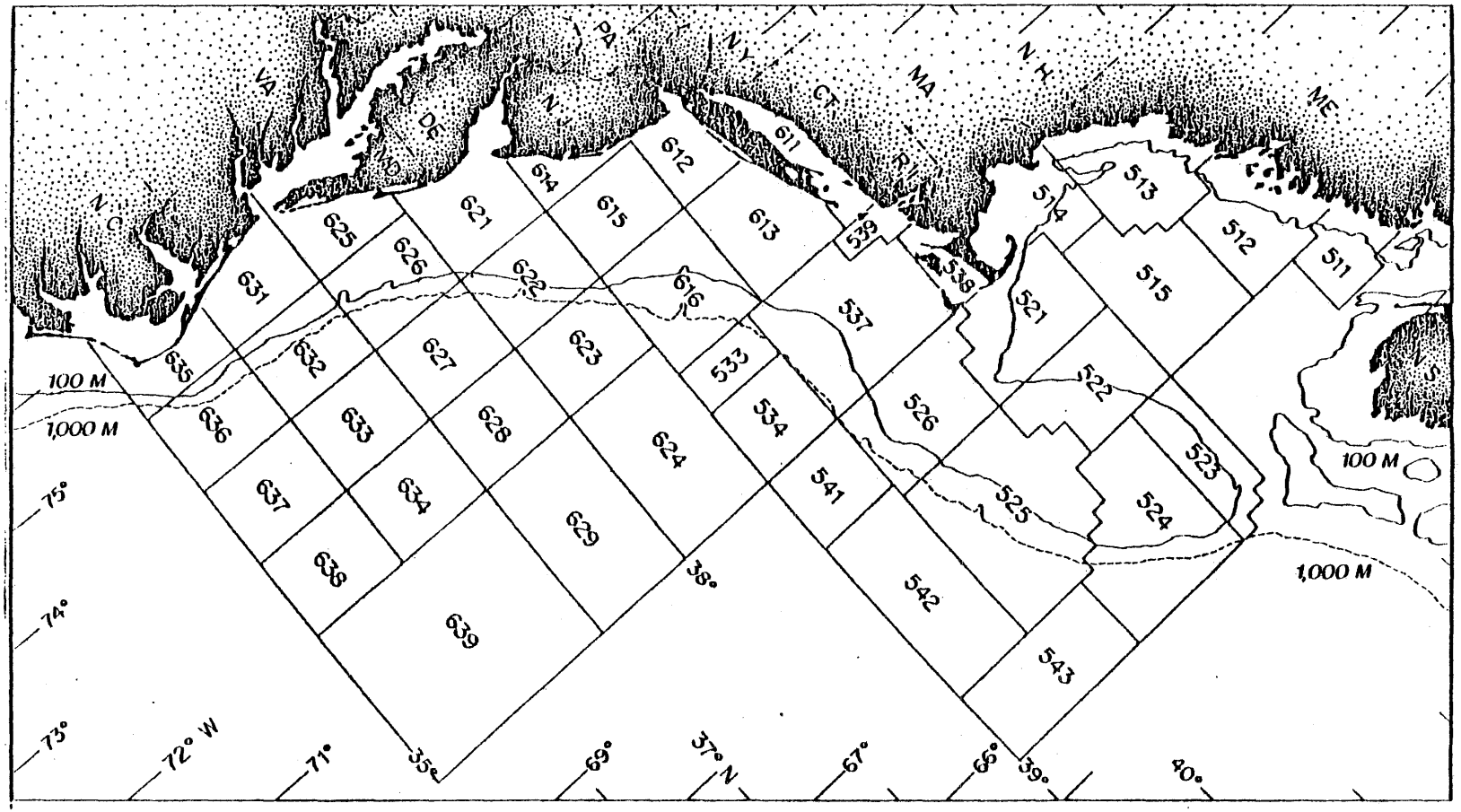

Figure 1. US Statistical Areas used in reporting location of catch and effort data.

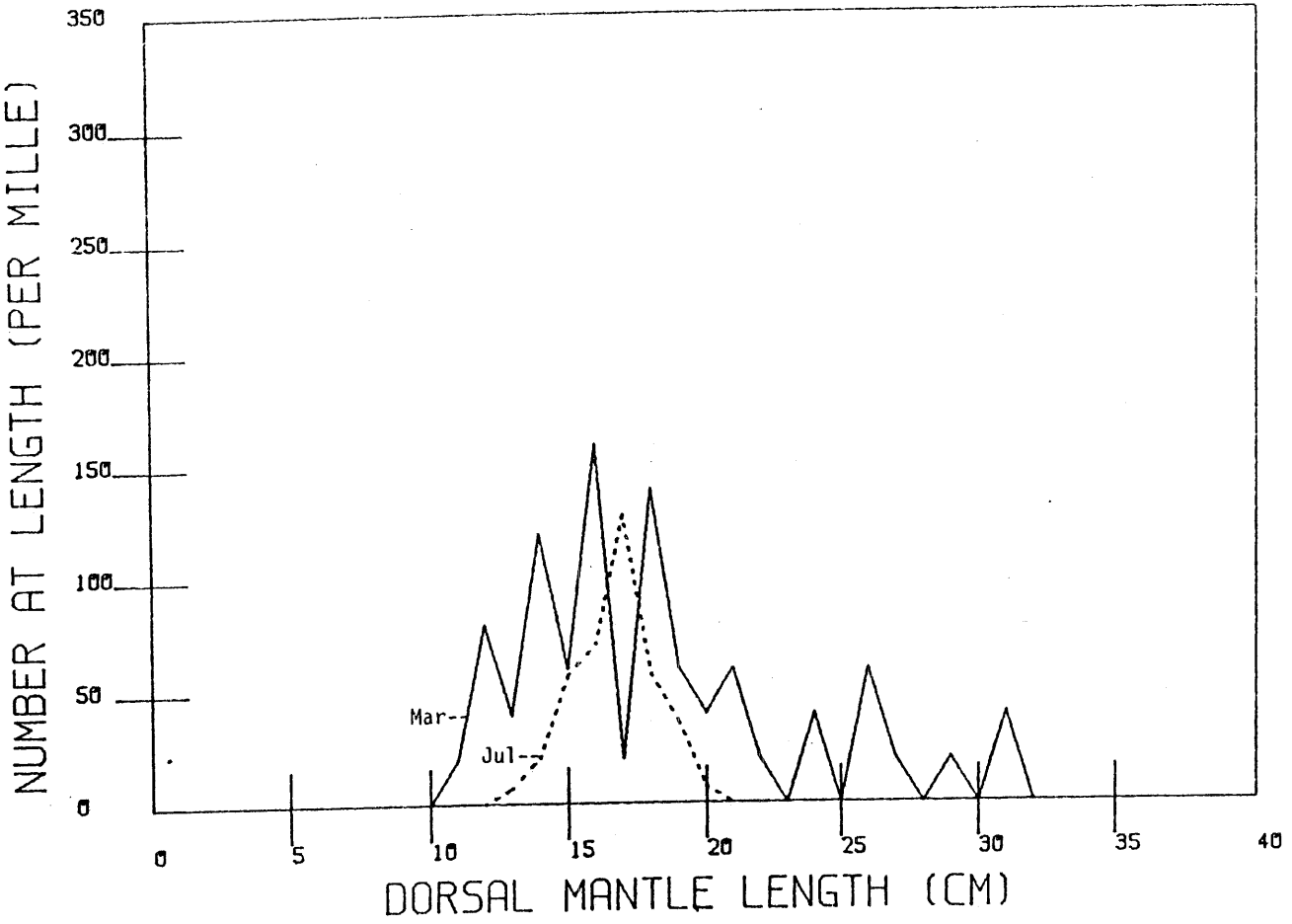

Figure 2. Length frequency distributions of the long-finned squid (Loligo pealei) from the 1982 USA fishery in the Gulf of Maine.

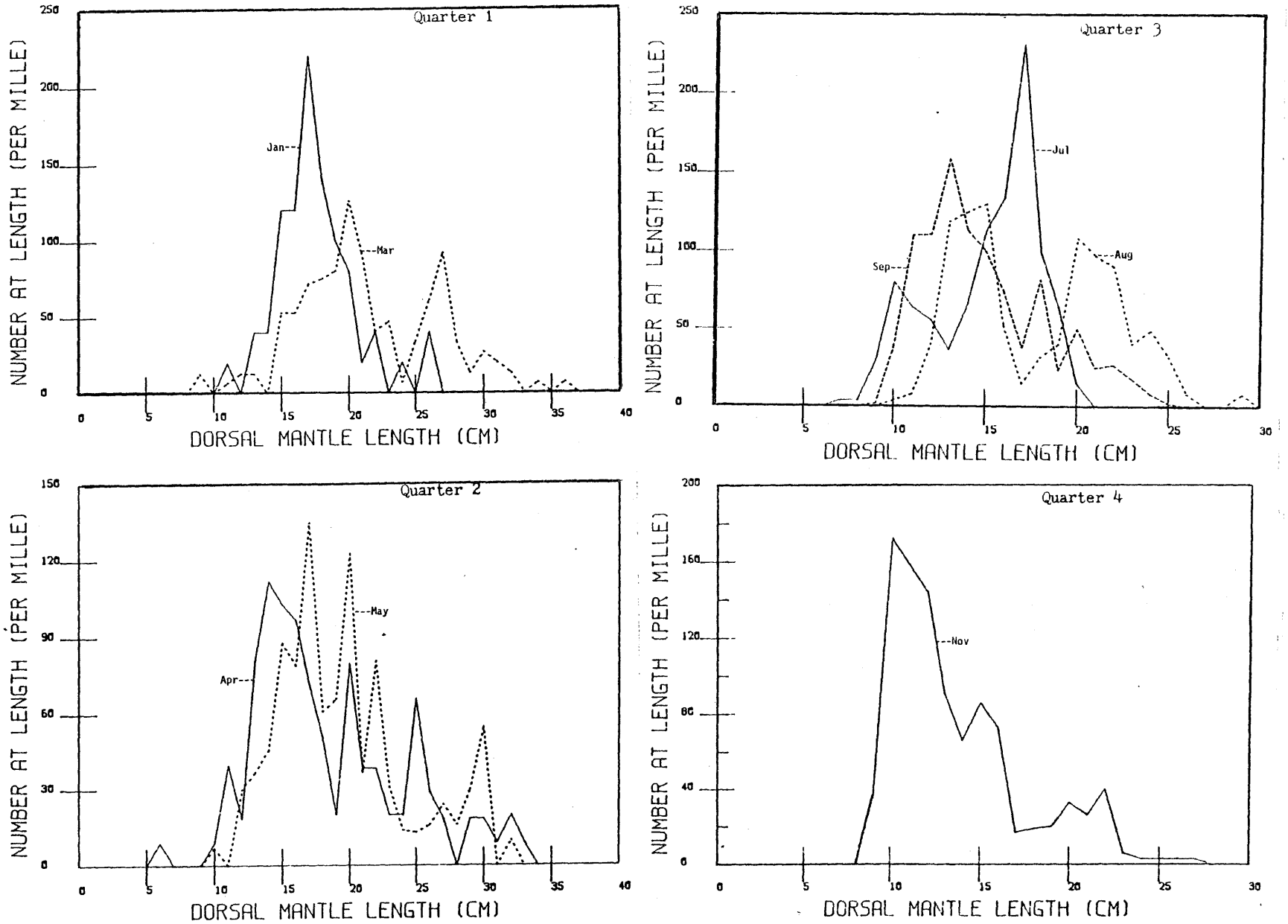

Figure 3. Length frequency distributions of the long-finned squid (Loligo pealei) from the 1982 USA fishery in the southern New England area.

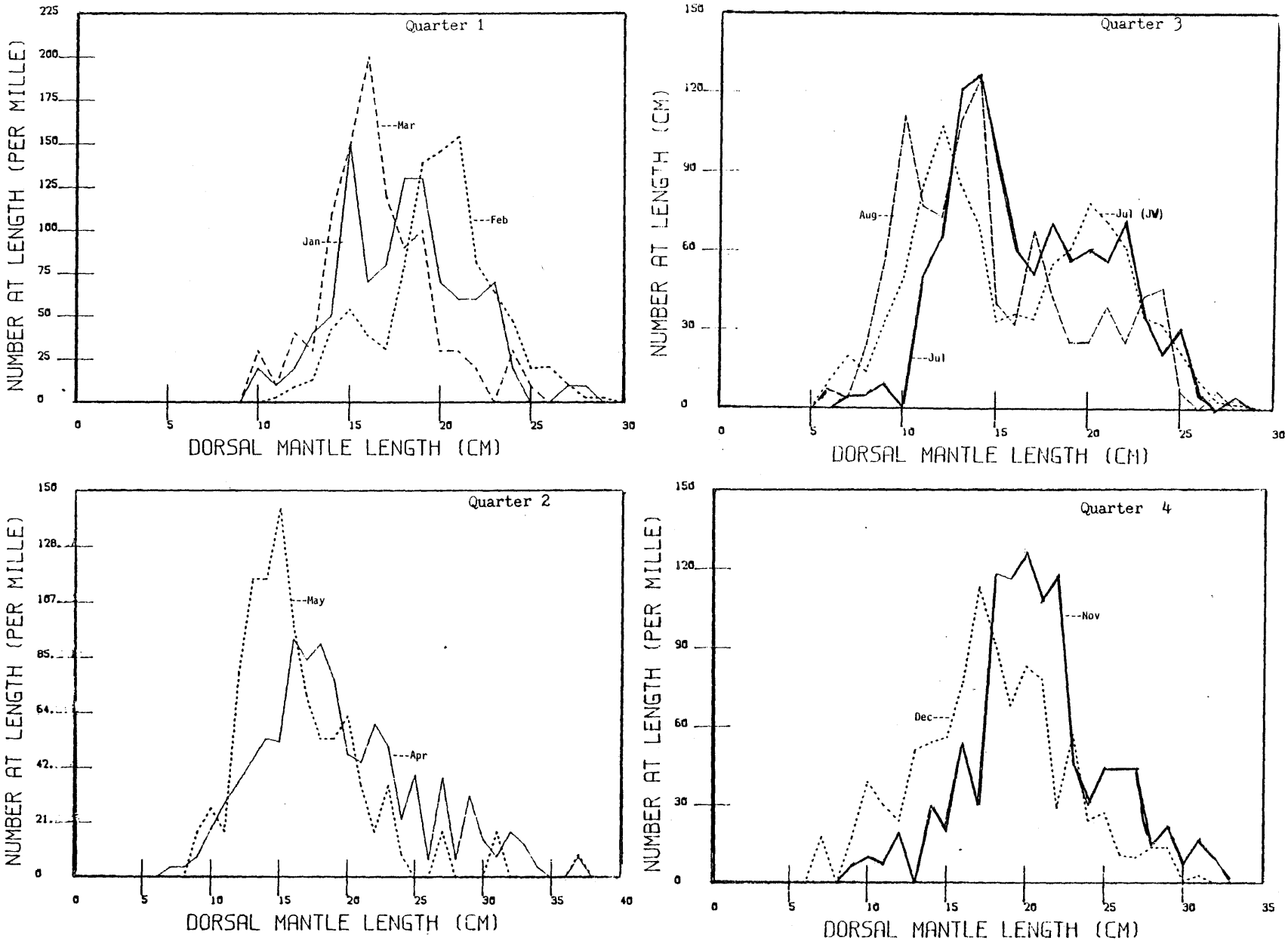

Figure 4. Length frequency distributions of the long-finned squid (Loligo pealei) from the 1982 USA fishery in the Mid-Atlantic area.

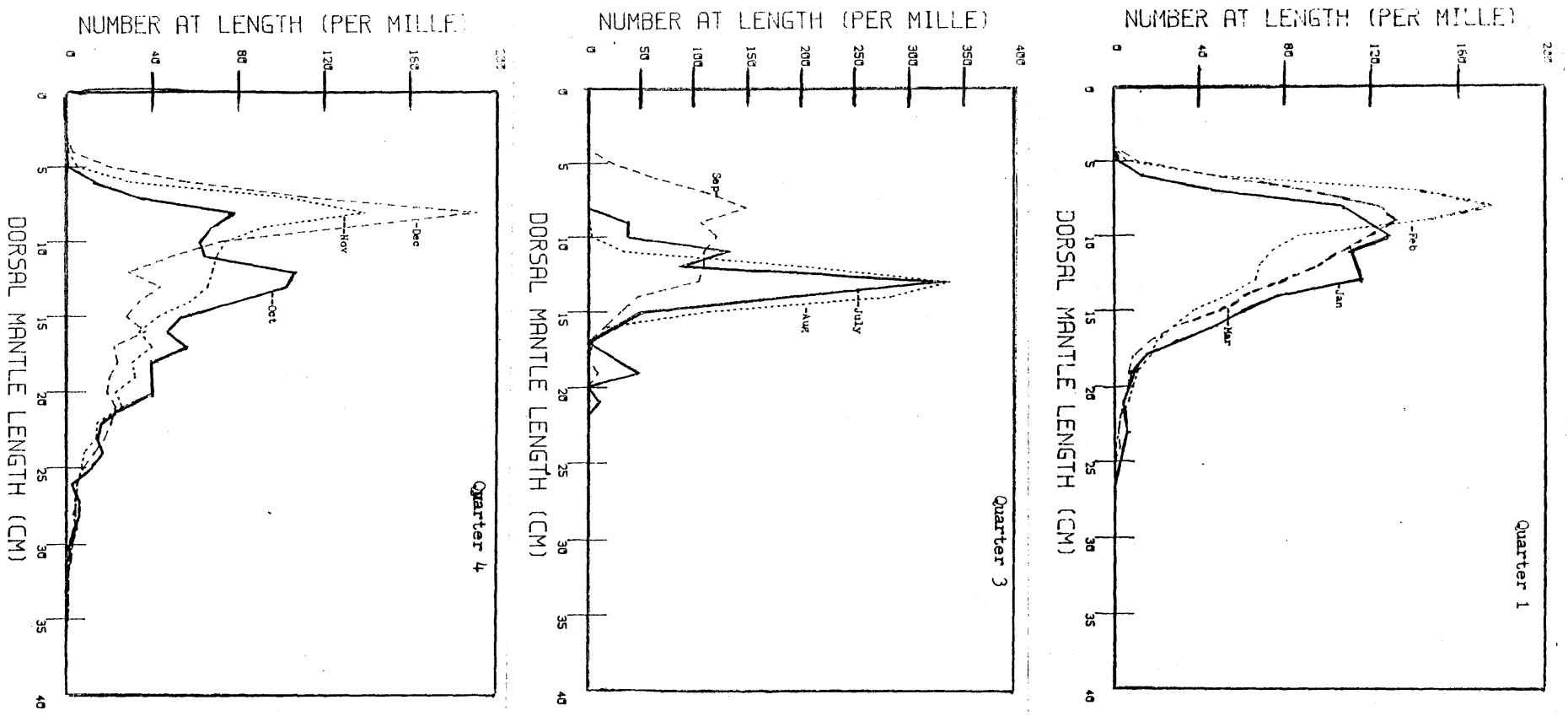

Figure 5. Length frequency distributions of the long-finned squid (Loligo pealei) from the 1982 distant-water-fleet (DWF) fishery based on NMFS Foreign Fishery Observer data.

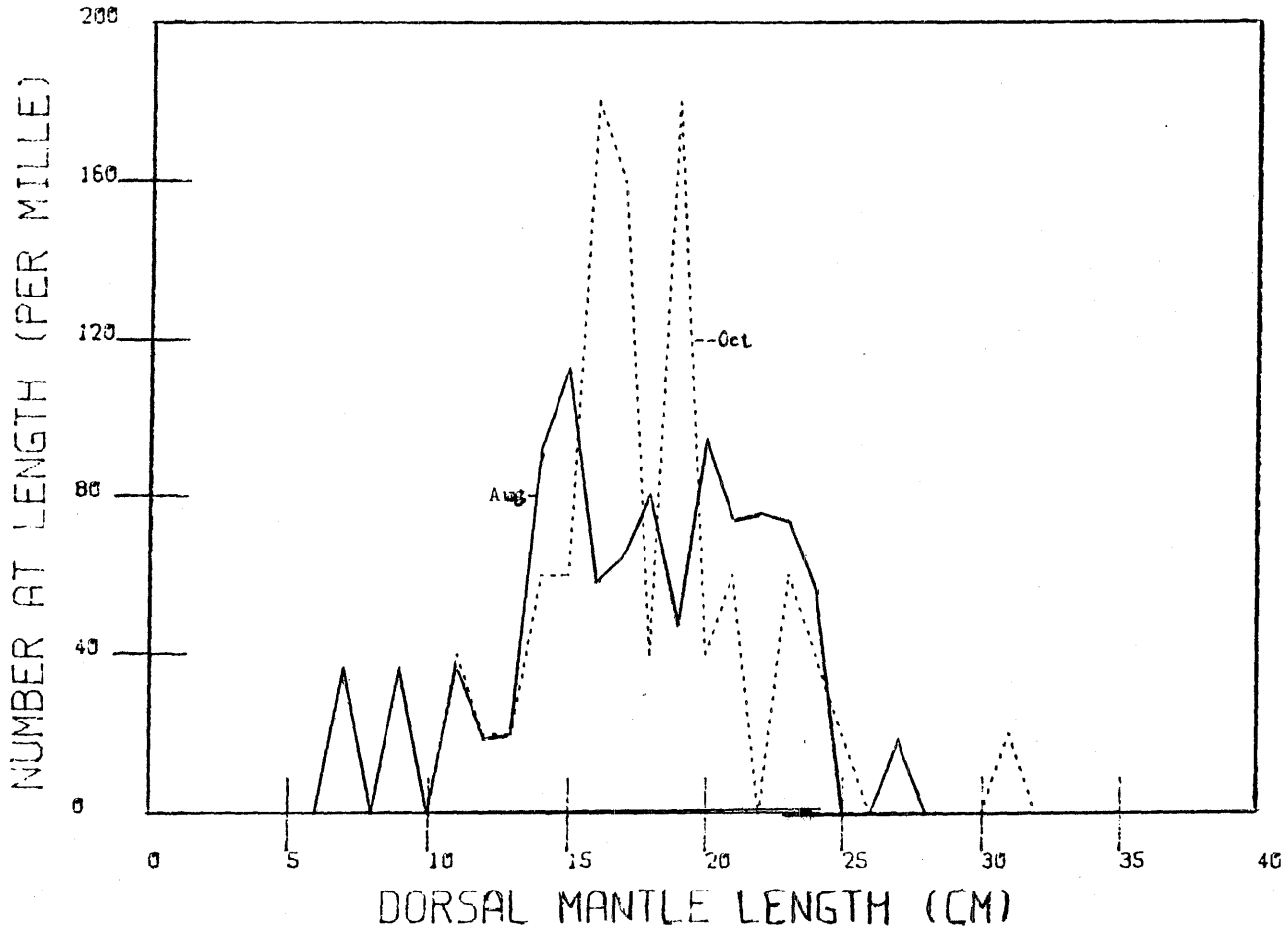

Figure 6. Length frequency distribution of the long-finned squid (Loligo pealei) from the 1983 USA fishery on Georges Bank.

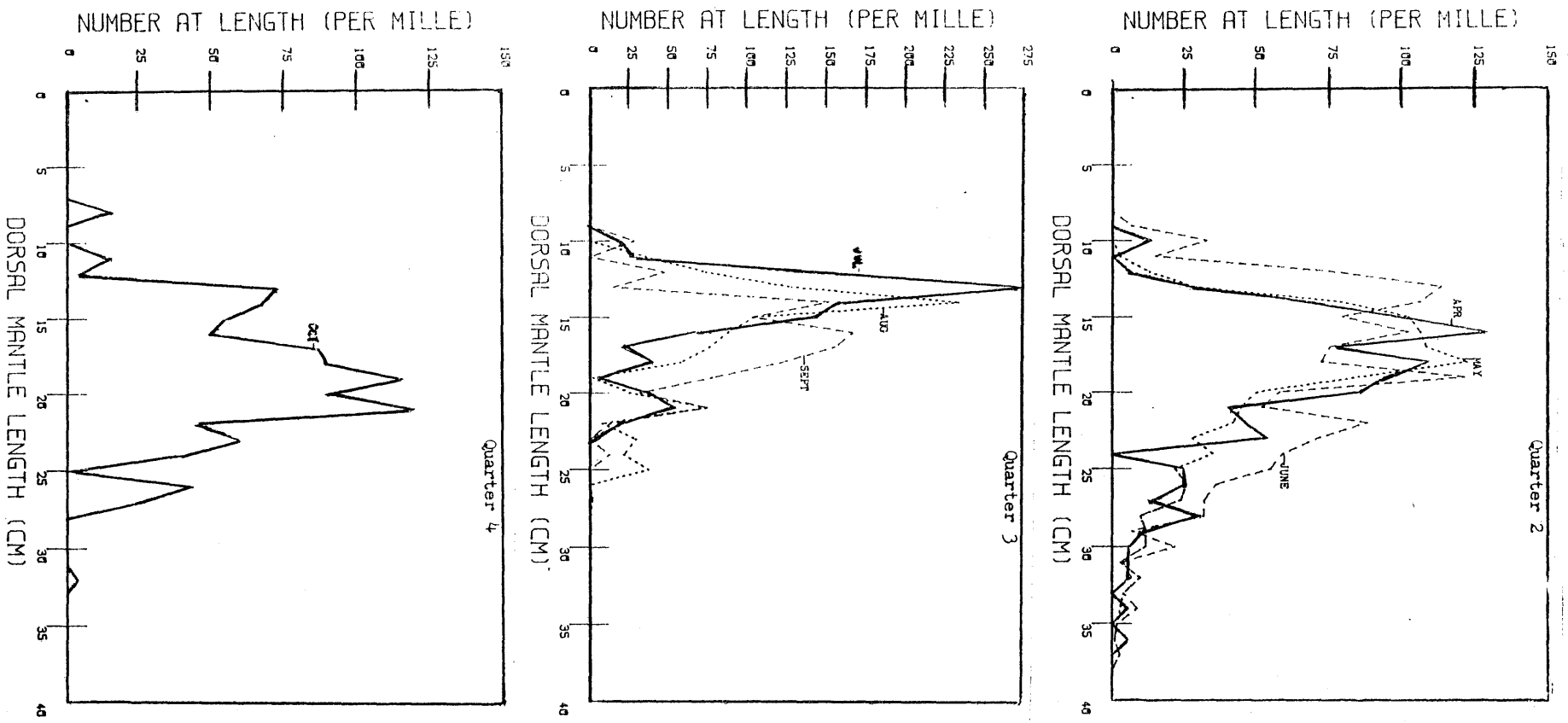

Figure 7. Length frequency distributions of the long-finned squid (Loligo pealei) from the 1983 USA fishery in the southern New England area.

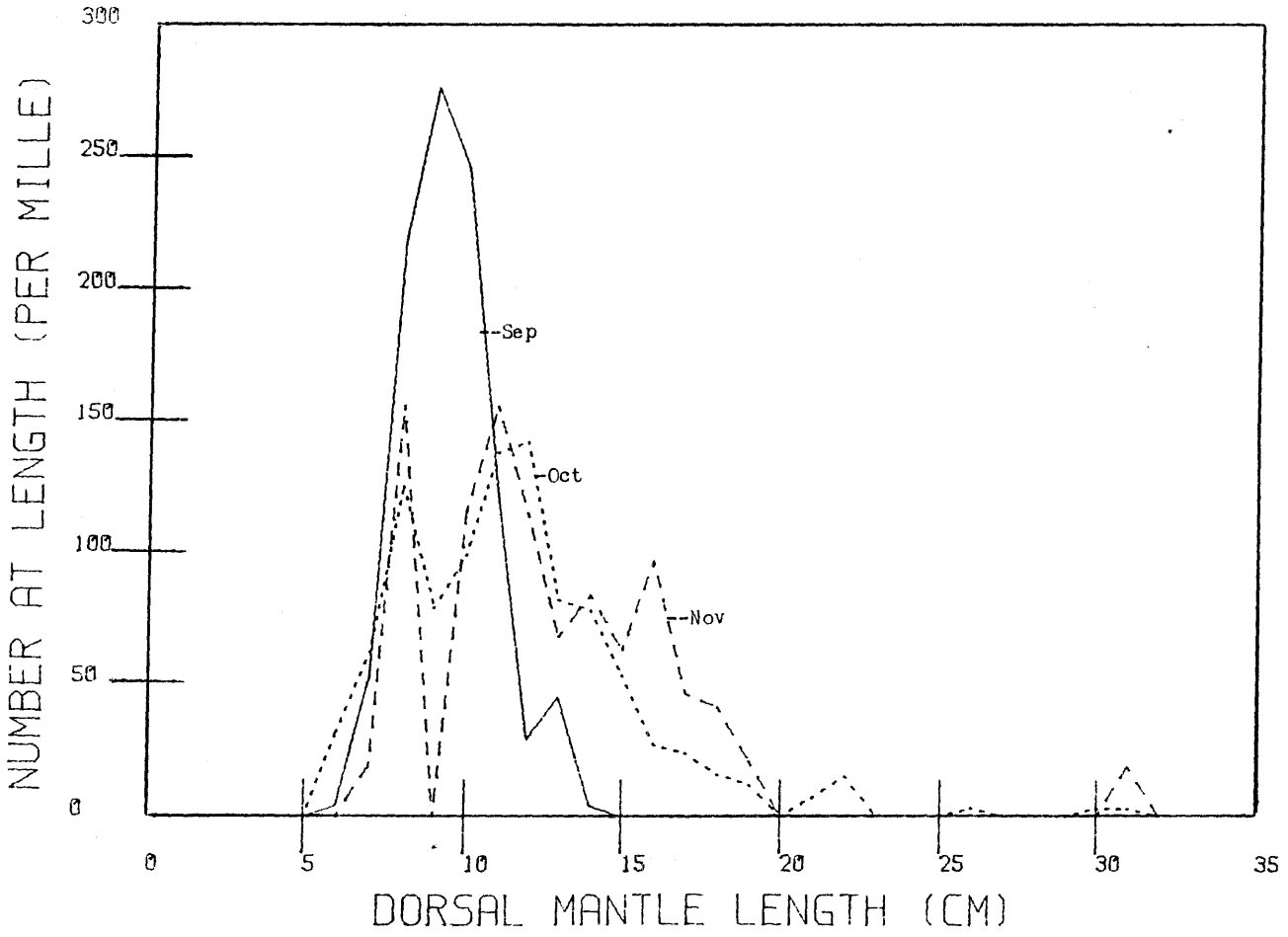

Figure 8. Length frequency distributions of the long-finned squid (Loligo pealei) from the 1983 USA fishery in the Mid-Atlantic area.

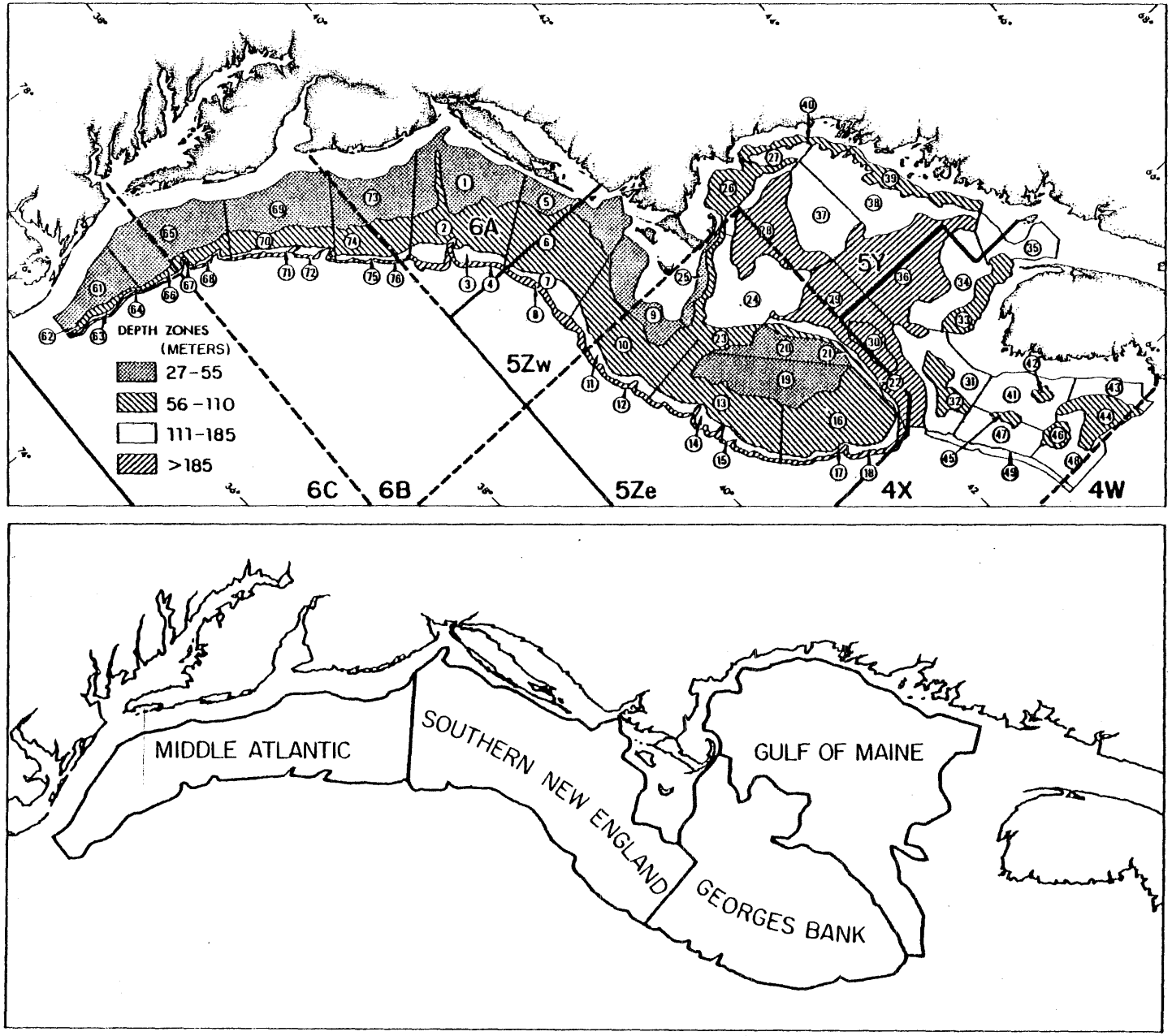

Figure 9. A. USA bottom trawl survey strata and NAFO Subareas 4-6.
B. Geographical areas off the Northeast coast of the United States.