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Squid fisheries (*Loligo pealei* and *Illex illecebrosus*) off the Northeast United States, ICNAF Subarea 5 and Statistical Area 6.

by

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Abstract

The biology of the two commercially important squid species (*Loligo pealei* and *Illex illecebrosus*) is reviewed. Commercial catch and effort statistics are presented and discussed as indicators of the increased interest of various countries in this fishery in Subarea 5 and Statistical Area 6. Monthly landings and surv cruise data are used to estimate species composition of the landings. Also commercial length frequency data and research cruise length frequency and catch per tow indices are analyzed to document trends in abundance.

Introduction

Squid species (essentially *Loligo pealei* and *Illex illecebrosus*) in the Northwest Atlantic, ICNAF Areas 5 and 6, until the late 1960's supported only a small US coastal bait fishery (1000-2000 metric tons per year). Since entry of distant water fleets to the fishery in 1964, reported landings have increased from 1000 MT to 56,640 MT in 1973 (Figure 1).

There has been concern that these stocks might reach an overfished condition if catches continued to increase unrestricted. In order to provide for an orderly development of this fishery there is a need to develop an assessment and provide estimates of the effects of various levels of exploitation. Previous assessment papers have dealt primarily with *Loligo*, and the Total Allowable Catch of between 50,000 MT and 80,000 MT, recommended by STACRES for 1974, was based primarily on a Japanese (Ikeda *et al.*, 1973) estimate of *Loligo*'s stock size and possible yield. The TAC set by ICNAF for 1974 and 1975 was 71,000 MT.

This paper reviews the biology, landings, research vessel survey results, length composition and estimates of stock size of both species of squid found in ICNAF Subarea 5 and Statistical Area 6.

Biology

The two species of squid of commercial importance in this area, are *Loligo pealei* (common, winter or longfinned) and *Illex illecebrosus* (summer or shortfinned squid). *Loligo* has been reported as far north as New Brunswick but is primarily distributed from Cape Hatteras to Corsair Canyon on Georges Bank. *Illex* is a more northern species ranging to southwest Greenland, with highest concentrations from Newfoundland to the Gulf of Maine, and offshore south to New York.

Seasonal differences in distributions are evident in both species (as illustrated in Fig. 6A-L from US groundfish survey cruises). *Loligo* probably forms one stock which migrates as much as 200 km generally remaining in waters above 8° C. In the winter they are found offshore primarily in 8°-12° C water along the upper continental slope, from western Georges Bank to Cape Hatteras. The spring onshore movement appears to begin in the south, proceeding northward. By April larger, mature *Loligo* move inshore as far north as the Delaware area to spawn. US commercial landings from 5Zw (1973, 1974) indicate that these large individuals arrive in the Massachusetts area by late April. Smaller individuals, in much greater numbers, arrive in May and June. Fall groundfish surveys show that the range in *Loligo* catches is much wider (from .1 to 4.4 lbs per tow) and generally lower, where bottom temperatures are less than 14° C (but greater than 8°) (Serchuk and Rathjen, 1974); while at temperatures greater than 14° (between Chesapeake Bay and Cape Hatteras) few catches are less than 1.5 pounds per tow. This consistently greater volume of *Loligo* per tow, in warmer waters indicates an increase in aggregation tendency in each area as the temperature increases or the season progresses.

The greatest number of eggs are spawned in the month of May and hatch in July (Summers, 1971). Size differences in young-of-the-year (YOY), and observations of ripe adults from commercial samples in 5Zw in July and on fall groundfish survey cruises in September, indicate an extended breeding season of about 6 months.

Loligo can be expected to live 14-24 months and grow to 18-28 cm (dorsal mantle length), though some males survive to about 36 months and greater than 40 cm (Summers, 1971). There may also be a significant number of two-year-old's that survive two spawning seasons, as seen in April 1973 where about 25% of the commercial samples were 30 cm or over and presumably about 1½ years old. However, it is generally assumed that heavy mortality occurs after first spawning so that such individuals may have not spawned in their first season.

Loligo grows an average 1-1.5 cm per month (Summers, 1971), with males growing faster and larger than females. A length-weight equation for sexes combined was derived from a least squares fit of the Ln of weight vs. the Ln of length for a US commercial sample of 175 *Loligo*, this is $Wgm = .010099 Lmm^{1.75113}$.

Illex belongs to an oceanic family, the *Ommastrephidae*, and little is known of its biology or life history. Seasonal migrations to coastal Newfoundland, Nova Scotia and New England, into 10-15 meters of water, in the spring and summer allow for an inshore fishery. At this time large surface schools may be formed. In late fall (October-December) movement is to the southeast and open ocean from Newfoundland, and offshore in SA 5 and 6. Unlike *Loligo*, *Illex* is not restricted to water above 8° C (Mercer, 1973), and catches vary relative to depth and temperature combinations. *Illex* is found in greater concentrations along the edge of the shelf, where temperatures are generally greater than 5° C. Spawning is believed to occur offshore at great depths from December to June (primarily December to March), with most *Illex* dying after spawning. They are faster growing and generally shorter lived than *Loligo*, surviving 12-16 months and 24-35 cm, with monthly increments of about 2 cm for both sexes.

The USSR reports (1973 Redbook, part II) that generally one generation of *Illex* is found, with mean length of 14 cm in May, growing to 22 cm in October. Spring catches consist of small individuals and summer catches are primarily immature. They find that in October male gonads are 60-80% developed while females are just beginning to ripen, and feel that the females will reach maturity during the spawning migration to open ocean.

Mercer (1973) gives the length-weight equations as:

$$\text{Males:} \quad W = .004034 L^{3.511}$$

$$\text{Females:} \quad W = .01301 L^{3.1090}$$

with constants derived from a least squares linear fit of the Ln of weight vs. the Ln of length.

Both *Illex* and *Loligo* feed on small fish, crustaceans and squid of their own or other species. *Illex* is an important predator on capelin in the Newfoundland area and may strand themselves on the beaches in pursuit of this species.

Squid themselves are preyed upon in varying degrees by about 40 fish species[1] (Table 1), and by marine mammals, as the pilot whale (Mercer, 1974), indicating great importance in the food web of the shelf.

Commercial fishery

United States squid catches off New England have been reported since the late 1800's (averaging 500-2000 MT), but until recently there has been no separation of species in reported landings. Interest in squid in Subarea 5 and Statistical Area 6 by other countries has increased since the USSR first reported catches in 1964, (during the time of the Soviet buildup of the red and silver hake fisheries in 5Z and 6). In 1973 there were 11 countries, besides the US, reporting squid landings totaling 55,000 MT (Table 2).

[1]Roland Wigley, personal communication.

Aside from a US inshore trap fishery for *Illex* (for use as bait in other fisheries), squid are fished with otter trawls, on the bottom.

The US bait fishery for *Illex* is located in shallow water east and north of Cape Cod, during the summer (April-September). *Loligo* is caught throughout the year, but about 95% of the US landings are reported in April-June.

Japan, Spain and Itlay participate primarily in the offshore directed squid fishery, initiated by Japan in 1967. Spain entered this fishery in 1970 and Italy in 1972. Japan and Italy fish for *Loligo* from October to March along the edge of the continental shelf (the Japanese have a butterfish fishery associated with their fishery for *Loligo*, so effort data is reported as a mixed fishery). Spain has, in addition to this winter fishery, steadily increased its effort into the summer months exploiting *Illex* in the same offshore waters. Lopez-Veiga (1974), describes a separate fishery for each species, along the shelf edge, distinguished by season. In the period April-September, primarily *Illex* is landed, and from October to April it is primarily *Loligo*, *Illex* having moved into deep water. The Spanish squid fishery also produces a substantial by-catch of species as butterfish and mackerel (up to 65% in March and April).

Separating catches of squid to species by month and area of landings, total estimated species landings (Figure 2) and landings by species and country (Table 3) were calculated by two different methods (unless reported otherwise): 1) landings from October through March were considered to be *Loligo*, while April through September catches were assumed to be *Illex*, and 2) October through March landings were again considered as *Loligo* but April through September catches were broken down further. Fifty percent of the inshore landings were considered *Loligo*, derived from 1969 summer survey catches where only 54% of squid in strata less than 60 fathoms were *Illex* (Table 4) (spring and autumn composition was less than 10% *Illex*); and 40% of the offshore landings were assumed to be *Loligo*. This decision was made from observations of occurrences of *Loligo* at depths greater than 60 fathoms during the summer survey cruise (about 35%) and as reported by Spain (Lopez-Veiga, 1974), where about 35% of their April-September squid catches are *Loligo*.

Fishing effort and catch per effort

Commercial catch per effort trends are difficult to describe as squid catches have only been reported as a directed fishery in the last three years. Table 5 shows metric tons per days fished, for landings with squid (both species) as the main species, (*i.e.*, comprising greater than 50% of the total landings of a gear type in an area); as reported in the 1972 and 1973 ICNAF Statistical Bulletins for all countries. Also shown are US commercial estimates from 1970 and 1971, and Japanese and Spanish estimates from the ICNAF Statistical Bulletins (1970, 1971) for the mixed and mollusc fisheries respectively, where shellfish (assumed to be squid) were greater than 50% of the total landings by month, area and gear type.

The changes in catch per effort (1972 to 1973) of the two major countries with a directed fishery, Japan and Spain, are consistent. Increases in effort by these two countries as reported in the 1973 ICNAF Statistical Bulletin are not reflected in similar increases in landings (except in 5Ze for Japan), resulting in decreases in catch per effort. Japanese medium (1000-2000 tons) stern trawler effort increased from 26 to 226 days fished while landings only increased from 480 to 3018 MT, producing a 35% drop in C/E from 1972 to 1973. Spanish small (500-1000 gt) stern trawlers participating in a directed squid fishery reported increases of effort from 1048 to 2024 days fished with landings of 11861 in 1972 increasing only to 14932 MT. This also indicates a 35% decrease in C/E. Japanese large stern trawlers (greater than 2000 tons) did, however, exhibit a 4% increase in C/E. (Landings by this vessel class decreased from 15779 to 9597 MT). Spanish reports (Lopez-Veiga, *et al.*, 1974) of sample catch per unit of effort (in MT/GRT) increased from 1969 to 1973 for *Loligo* and until 1972 for *Illex*, after which there was about a 30% drop in both species. These decreases may imply that the entire squid stocks (primarily *Loligo*) in 5Z and 6 are under substantial exploitation, (*i.e.*, F is a significant part of the total mortality on the stock). The catch per effort ratio for squid for other countries fluctuates by year in the different areas. Reported statistics indicate increased interest in a directed squid fishery by France in Areas 5 and 6A (from 71 days fished in 6A, B, C in 1972 to 85 days fished in 1973 in 5Zw and 6A only, while landings increased from 300 to 820 MT); and by Federal Republic of Germany, with the addition of large (over 2000 GT) stern trawlers in 6A and 6B, with a 120% overall increase in days fished, from 61 to 148.

Length and age composition

US commercial length samples were taken for each species of squid between July 1972 and December 1974. Aging has not been done on either species, as a technique has not yet been developed. However, a growth scheme and spawning schedule has been described by Summers (1971) and Squires (1967) for *Loligo* and *Illex*, respectively, both based on the assumption of heavy post spawning mortality after one year of age. Squid that survive a spawning season presumably were prevented from spawning, perhaps by a mating behavioral mechanism.

Growth for *Loligo*, shown from commercial length frequencies (Figure 3, A,B), is similar to what Summers describes (the position of his growth modes are indicated by the slanted lines).

There are generally three modes to be seen during the course of the year. In January, the first mode is "one year olds", probably 6-7 months (hatched last summer and will probably spawn this coming summer), and two modes of larger "two year olds", 13-14 months (fall spawned--most will spawn this spring) and 18-19 months (summer spawned--will spawn this spring). By March and April the "two year olds" (now 18 cm and greater) mature, and begin spawning in late April. The larger (28 cm and larger) "two year olds" spawn and most disappear from the fishery by May. Some of the younger "2 year olds", now 16-17 month 20-25 cm will survive until fall. At this time younger "one year olds" (5-6 months, 9-11 cm which were spawned in late summer or fall of the previous year) arrive and are recruited. Spawning of most "two year olds" is probably completed by June while one year olds continue to ripen and spawn through September. The earliest spawned young-of-year first appear in the fishery in September at about 6 cm; 1972 exhibited a high proportion of large individuals (over 30 cm) in August, which did not appear in later samples. These were probably two or three year olds which later moved offshore or died in September. In April 1973 (in SA 6 samples) there was an extremely high ratio (about 24%) of "two year old" *Loligo* (over 30 cm), arriving to spawn. These may be associated with the great number of *Loligo* (20-28 cm) which arrived in 5Zw in October 1974. The length frequencies at that time suggested that extended spawning from spring to fall had been taking place in previous years.

Japanese and USSR commercial *Loligo* length frequencies from the 1970, 1972, and 1974 fishery are consistent with US samples, demonstrating presence of larger individuals (30-40 cm) in the fishery in March and April, with the upper limit decreasing to about 19 cm in May. Japanese and Soviet samples (ICNAF sample data, 1974) indicate that sizes decreased in April in Statistical Division 6B and 6C in 1974, presumably due to earlier seasonal warming and subsequent earlier onshore migration of the main spawning stock to this area.

Illex length samples from the US commercial fishery in Subarea 5Y for 1972-1974 (Figure 4) indicate a single mode through most of the year. However, in May and June of 1973, the distribution of sizes ranged from a high proportion of smaller individuals (10-17 cm) to a low proportion of large individuals (23-35 cm). As *Illex* is believed to spawn from December to June the great range in length could be due to differences in time of hatching of a single year class, the older and larger squid arriving first. Large *Illex* disappear after June, leaving one size category until November when YOYs begin to appear in the fishery (see Figure 8b Fall Groundfish Survey length frequencies).

Polish and USSR length frequencies of *Illex* taken in 1973 and 1974 (ICNAF samples, 1973 and 1974) showed large individuals (26-35 cm) present in the fishery in March, but not in later months. It has not been explained why mature-sized individuals are in the inshore fishery as late as June, when spawning has been assumed to be all offshore. Beginning in May there is a single mode (average length - 15 cm), this mean length increases to 21 cm by August, but in September recruitment of the new year class (5-12 cm) lowers the mean length to 17 cm. Japanese samples from July, August and September 1974 in southern areas 6A-6C, show mean lengths to 20 cm in September. In October large *Illex* begin to move offshore presumably to spawn, and the average length drops to 11.5 cm in November.

In general, then, the commercial length frequencies of both species show the progression of the main group of individuals hatched the previous year. But in *Loligo* there may be second and third modes also appearing in the spring that are variable in importance from year to year. These probably correspond to groups two and three years in age.

Research vessel cruises

Abundance index

Estimates of relative abundance were made using sets of strata from US Groundfish Survey Cruises (Grosslein, 1969), which approximate the areas of the Middle Atlantic (strata 61-76), Southern New England (1-12), southern (13-15), eastern (16-18), and northern Georges Bank (19-25) (Figure 5), for fall (September-November) and spring (March-April) cruises (1967-1974). Stratified mean Ln catches per tow of *Illex* and *Loligo* were examined using these areas (Table 6). *Loligo* is abundant primarily in the Middle Atlantic and Southern New England in autumn, but is also consistently found on Southern Georges Bank. *Illex* is found primarily in Southern New England and Southern Georges Bank in fall and is relatively unavailable to surveys in spring.

Survey distributions (Figure 6-A-L) indicate that both species are distributed inshore and offshore during autumn surveys, although the extent of onshore movement of *Illex* is variable between years. (Note 1970 vs. 1973 Autumn.) *Loligo* is concentrated along the continental slope from Cape Hatteras to Corsair Canyon, and *Illex* is not often found in the survey area during the spring. Autumn surveys were consequently chosen as the best measure of relative abundance of these two species in this area, (Middle Atlantic to Georges Bank).

Autumn strata weighted mean Ln lbs per tow for all areas were plotted (Figure 7) to illustrate the overall trend of squid abundances (1964-1973). The *Loligo* index of abundance fluctuates from a low of .99 Ln mean pounds per tow in 1967 to 1.76 in 1969, drops again to 1.07 in 1971 and rises to a high of 2.26 Ln mean pounds per tow in 1973, showing a general increase during this period.

Illex indices are lower and less variable than *Loligo*, ranging from a low .08 mean Ln pounds per tow in 1969 (when *Loligo* indices were high) to a high of .34 in 1971 (when *Loligo* indices were low). The *Illex* abundance shows a decrease, from 1971 to 1973, when *Loligo* was increasing.

Length composition

Length compositions from stratified mean number at length, per tow, for Southern New England and Middle Atlantic, fall and spring cruises (1969-1973) for *Loligo* (Figure 8a) indicate presence of fewer (note change of scale in graph) but larger squid (to 30 cm) in spring, prior to spawning. In fall numbers increase and sizes decrease to 3-6 cm, from recruitment of the '0' age class. Beginning in 1971 in Southern New England and 1972 in Mid-Atlantic the increased proportion of *Loligo* in the 10-20 cm group during spring indicates more extensive spawning had been occurring in previous summer and fall months. There were also increased catches of the immature group (less than 10 cm) in the spring beginning in 1971, especially in the Mid-Atlantic area, though this may be due to availability changes during these years.

Availability of *Illex* in the survey area during spring is low, as seen in the distribution charts (Figure 6-g-i). In 1972 and 1973 there were too few *Illex* in the samples to obtain length frequency distributions in the Southern New England and Middle Atlantic strata. Where spring samples are available there is a single mode (Figure 8b), ranging from 5 cm in 1969 to 17 cm in 1971; representing a high portion of YOY in 1969 and older squid (probably about 8-10 months, hatched late in the previous season) in 1971. Fall samples have broader size ranges (4-23 cm) with one or two modes. In 1969 there was a single mode at 20 cm, in 1970-1973 there were two modes at 5-7 and 17-18 cm. These modes probably represent two groups of YOYs spawned early (December-January) and late (May-June). Absence of larger *Illex* in these cruises is due primarily to the time of year that the surveys are made. Spring cruises are conducted in late March and early April, after many of the larger *Illex* have spawned and died. In fall (late September and October) it is assumed that large individuals have begun to move offshore to spawn.

Prerecruit index

US and foreign commercial catches of *Loligo* indicate that recruitment of individuals 8 cm and less had not begun by fall survey time, I therefore used the mean number per tow in this size range as an index of relative strength of incoming year classes (Table 7). Foreign catches indicate that catches of *Illex* less than or equal to 10 cm are minimal before the fall survey cruises, so 10 cm was used as a prerecruit value for *Illex*.

It does not appear, looking at survey indices, that the *Loligo* fishery has reached the point where the total landings are noticeably influenced by the size of the prerecruited fall stock, *i.e.* even though fall prerecruit indices have dropped, as in 1970 and 1971, landings have continued to increase. However, the US commercial spring landings (1973 and 1974) do reflect high proportions of YOY *Loligo*, as indicated in the 1972 and 1973 fall indices. Foreign samples also reflect greater proportions of smaller *Loligo* (less than 15 cm) from January and February catches of 1970 and 1974 (when the 1969 and 1973 fall indices were high), than in 1972 when the fall 1971 index is lower.

Illex prerecruit abundance indices are lower and changes are less notable than with *Loligo*, there is also insufficient landings and length data to establish trends relating these indices to the landings.

Stock size estimates

Abundance indices from survey cruises can be used to provide a minimum estimate of squid biomass, with the equation

$$B' = \frac{WA}{a},$$

where B' = estimates of biomass
W = stratified mean weight per tow
A = strata area sampled (in square miles)
a = area swept by each tow (0.011 square miles).

Diel variations (caused by vertical migrations) in relative apparent abundance of *Loligo*, are significant, with daytime (0800 to 1600 hrs) catches (mean pounds per tow) 2 to 12 times greater than night catches. Using the total daytime mean catch per tow/total nighttime mean catch per tow ratio of *Loligo*, calculated from three gear comparison cruises using both the No. 36 and the No. 41 Yankee trawls, as a correction factor to increase night abundance indices to a level relative to times when *Loligo* were most available to the bottom gear, minimum estimates of *Loligo* biomass were made (this ratio was also applied to *Illex* night catches to provide a base estimate of the biomass of this species, as gear comparison, diel variations in *Illex* catches have not been examined) (Table 8). A second estimate of biomass was obtained using the average of: the gear comparison day/night ratio times the mean nighttime weights per tow; and the daytime mean weight per tow, as W in the above equation. This estimate was then raised by the ratio of the catchability of the 41/36 nets (1.41) to produce a third estimate which will account for the wider opening #41 Yankee Net (personal communication, Bowman, 1974).

It should be noted that *Illex* has a wider distribution and consequently the abundance indices observed in the survey areas may reflect yearly distributional differences.

The abundance of *Illex* by these indices is about 4% of that of *Loligo*; the abundance of *Loligo* is about 58,000 MT. These are minimum estimates.

Discussion

Squid landings of the two species, *Loligo* and *Illex*, have increased about 50 fold since entry of the first distant water fleet to the fishery in 1964. The steady increase from incidental catches to 56,800 MT in 1973 reflects the growing interest of the 12 countries now reporting squid catches. Comparisons of catches and effort exerted by the two countries reporting directed squid fisheries (Japan and Spain) show overall decreases in catch per effort in their 1973 squid fisheries.

Relative abundance can also be determined from research vessel surveys. These indices are limited by the availability of squid to the bottom trawl gear, which as presented earlier in this paper, is less for *Illex* than *Loligo*, and varies with the time of day. The results are in general agreement with previous estimates of stock size (Ikeda, *et al.*, 1973). The fall indices indicate a continual increase in *Loligo* abundance since 1971, accompanied by a continual decrease in the mean pounds per tow of *Illex* (probably due primarily to availability, not abundance). The possible 'warming trend' (see temperatures, Table 6), may be affecting the squids inversely, as can be expected because one species is more northern and prefers cooler waters. Squid populations, with their rapid maturity and growth, can be expected to respond rapidly to environmental changes.

Commercial length-frequencies indicate that the fishery for *Loligo* is concentrated on the spawning stock in the spring (15 cm and larger), with some immatures being landed. In the fall mature (18 cm and larger) and maturing (less than 15 cm) *Loligo* are taken. YOYs are first recruited in September (at about 6 cm) in relatively small numbers.

US and foreign lengths samples, and observations of maturity of *Illex*, indicate that this species is fished in the summer while it has moved inshore. As spawning will occur in the winter and spring the fishery is concentrated on immature individuals.

Squid may be expected to respond to exploitation with little delay effects because they are short-lived. Therefore a gradual development of the squid fisheries toward the optimal harvest rate would be most desirable.

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Table 1. Fish predators of squid*

Pelagic	**Benthic**	**Inshore**
Bonito	Haddock	Silverside
Bluefin tuna	Cod	Smelt
Skipjack tuna	Pollock	3-spine stickleback
Mackerel	Red hake	Weakfish
Swordfish	Silver hake	
	Spotted hake	
	Tom cod	
Semi-pelagic	Sea robin	**Other**
Alewife		Spiny dogfish
Butterfish		Smooth dogfish
Scup	Four-spot flounder	Mackerel shark
Bluefish	Fluke	Thresher shark
Striped bass	Sand flounder	Barrelfish
Redfish		
	Barndoor skate	
	Little skates	
	Big skates	
	Tilefish	
	Longhorn sculpin	
	White perch	
	Toadfish	
	Sea bass	
	Goosefish	

*From 1) Roland Wigley (personal communication)
2) Bigelow and Schroeder

Table 2. Annual squid landings in metric tons, 1963-1973, by country. ICNAF Areas 5 and 6.

Areas	Year	Canada	Bulgaria	France	Fed. Rep. Ger.	Japan	Italy	Spain	Poland	Romania	USSR	USA	GDR	Total
5 & 6	1963											2,105		2,105
	1964										4	929		933
	1965										176	1,154		1,330
	1966										389	1,173		1,562
	1967					6					833	1,829		2,662
	1968					1,731					3,176	1,762	10	6,679
	1969					7,122					1,340	1,461	1	9,924
	1970					13,639		4,510			655	1,061	20	19,885
	1971	1	90			10,602		4,187			6,138	1,182		22,210
	1972		499	296	463	18,691	3,200	11,859	5,428	67	6,976	1,214	14	48,707
	1973		410	820	1,641	15,526	3,165	14,932	9,199	150	8,977	1,635	313	56,768
5	1963											1,210		1,210
	1964										4	189		193
	1965										176	387		563
	1966										341	193		534
	1967										330	913		1,243
	1968					112					2,415	903	10	3,440
	1969					3,724					1,182	739	1	5,646
	1970					5,363					655	483	20	6,501
	1971	1	80			4,661		256			5,659	711		11,368
	1972		480	6	63	7,862		5,797	5,042	28	6,381	459	14	26,138
	1973		396	403	136	5,811		10,147	9,157	18	8,631	873	313	36,161
6	1963											895		895
	1964											740		740
	1965											767		767
	1966										48	980		1,028
	1967					6					503	916		1,425
	1968					1,619					761	859		3,239
	1969					3,398					158	722		4,278
	1970					8,276					---	578		8,854
	1971		10			5,941		3,941			479	471		10,842
	1972		19	290	400	10,829	3,200	6,063	836	39	595	748		22,569
	1973		14	417	1,505	9,715	3,165*	4,785	42	132	346	762		20,492

*Using 1972 Spanish ratio.

Table 3. Estimated species breakdown for squid landings[1/] in ICNAF Areas 5 and 6.

Year	Can.	Bulg.	Fra.	FRG	Japan[b]	Italy[a]	Spain	Poland	Rom.	USSR	USA[c]	GDR	Cuba	Total
							LOLIGO							
1963											484(1294)			484(1294)
1964										4(0)	214(572)			218(576)
1965										21(99)	265(709)			286(808)
1966										108(226)	270(722)			378(948)
1967					6					262(548)	421(1125)			689(1679)
1968					1714(1721)					1132(2184)	405(1083)	(5)		3351(4993)
1969					7051(7079)					820(1080)	336(898)			8207(9057)
1970					13503(13557)		4465(4483)			308(482)	244(652)	(10)		18520(36184)
1971		10(50)			10496(10528)		337(1881)			983(3561)	272(727)			12098(16747)
1972		9(254)	296	463	16043(17102)	2747(2928)	5702(8165)	79(2754)	0(33)	1118(4045)	269(742)		(7)	26726(36789)
1973[d]		31(410)	820	1639	14039(14396)	2880(2994)	7448(11145)	1064(5134)	93(139)	1024(5000)	570(1100)	7(163)		29615(42940)
							ILLEX							
1963											1621(810)			1621(810)
1964											715(358)			715(358)
1965										155(78)	889(444)			1044(522)
1966										236(118)	903(452)			1139(570)
1967										571(286)	1408(704)			1979(990)
1968					17(10)					2104(1052)	1357(678)	10(5)		3488(1745)
1969					71(43)					520(260)	1125(562)	1(1)		1717(866)
1970					136(82)		45(27)			347(174)	817(408)	20(10)		1365(701)
1971	1(1)	80(40)			80(48)		3861(2317)			5156(2578)	910(455)			10088(5439)
1972		490(245)			2648(1589)	453(272)	6157(3694)	5349(2674)	66(33)	5854(2927)	945(472)		14(7)	21976(11913)
1973[d]		379(0)			1366(1009)	285(171)	7483(3784)	8139(4070)	46(0)	7953(3976)	1060(530)	313(156)		27024(13696)

[1/] Squid landings from STATLANT 21-B forms and Summ. Doc. 74/38. Left figure shows breakdown by seasonal distribution of catch assuming Oct.-March = Loligo, April-Sept. = Illex. Right figure in parentheses is further breakdown (see text) assuming only 60% of April-Sept. squid = Illex in Offshore Fishery (Japan, Spain, Italy) and 50% of April-Sept. squid = Illex in Shelf Fishery (remaining countries).

a - Catches separated by using Japanese seasonal ratio.
b - 1967-1970 catches separated by using 1971 Japanese ratio.
c - 1963-1971 catches separated by using 1972 US ratio.
d - 1973 figures in parentheses for Japan, Spain, Romania, and Bulgaria are actually reported Loligo and Illex breakdown for 1973.

Table 4. Percent composition of *Illex* in catches of squid from groundfish surveys, by depth range and area (strata).

Year	Cruise	Season	Depth	Mid-Atlantic (61-76)	So. New Eng. (1-12)	Georges Bank (13-20)
1969	*Albatross IV*	Summer	<60fm	3.7	75.8	26.8
			>60fm	38.7	100.0	100.0
1972	*Albatross IV*	Spring	<60fm	0.0	0.0	
			>60fm	0.1	0.2	
1973	*Albatross IV*	Spring	<60fm	0.0	0.0	
			>60fm	0.0	1.0	
1970	*Albatross IV*	Fall	<60fm	6.1	1.7	8.4
			>60fm	22.7	25.7	91.2
1971	*Albatross IV*	Fall	<60fm	4.3	3.7	19.4
			>60fm	90.0	10.7	72.2
1972	*Bleak*	Fall	<60fm	2.2	4.5	
			>60fm	74.0	15.8	
1972	*Albatross IV*	Fall	<60fm	2.3	8.9	3.0
			>60fm	71.3	12.0	79.4
1973	*Belogorsk*	Fall	<60fm	1.2	0.2	
			>60fm	67.4	6.1	
1973	*Albatross IV*	Fall	<60fm	0.0	0.3	6.8
			>60fm	13.9	3.2	14.6

Table 5. Squid mean landings per day in metric tons by division, country, gear.

Div.	Country	Gear	YEAR 1970	1971	1972	1973
5Y	USA	otsi 2	3.67	.28		
		Pound net		3.21		
5Ze	France	otsi 6			2.00	8.14
	Spain	otsn 5			14.38	9.23
	*Japan	otsn 6	22.55	6.29		16.32
		otsn 7	37.27	26.32	24.38	33.64
	Poland	otsn 6				11.09
5Zw	USA	otsi 2		1.57	3.48	3.97
		otsi 3		3.55	11.0	3.60
		otsn 2				2.86
	France	otsi 6				11.16
	FRG	otsn 6			9.0	6.17
	Spain	otsn 5		4.04	8.53	7.56
	Japan	otsn 6	19.74	14.89		14.11
		otsn 7	28.38	11.28	19.91	18.61
6A	USA	otsi 2			2.6	1.60
		otsi 3			4.4	3.5
		otsn 2				1.0
	France	otsi 6			1.0	8.87
	FRG	otsn 6			8.3	10.58
		mtsn 6			3.3	6.33
		otsn 7				7.43
	Spain	otsn 5		7.76	7.95	7.08
	Japan	otsn 6	24.27	13.78	18.67	14.39
		otsn 7	32.46	13.44	17.26	13.24
6B	France	otsi 6			4.11	
	FRG	otsn 6			7.36	3.33
		otsn 7				9.63
		mtsn 6			5.00	
	Spain	otsn 5		11.92	12.28	
	Japan	otsn 6	24.88	12.60		9.99
		otsn 7	25.25	16.22	17.20	14.39
6C	France	otsi 6			1.63	
	Spain	otsn 5		8.61	12.91	
	Japan	otsn 6				16.42
		otsn 7			15.40	14.61
Total	USA	otsi 2	3.67		3.35	3.79
		otsi 3		3.55	5.50	3.58
		otsn 2				2.49
		Pound net		3.21		
	France	otsi 6			4.26	9.64
	Spain	otsn 5		8.99	11.32	7.38
	Japan	otsn 6	22.82	12.22	18.67	13.38
		otsn 7	29.89	16.92	18.81	19.65
	Poland	otsn 6				11.09
	FRG	otsn 6			8.21	10.07
		otsn 7				9.00
		mtsn			3.50	6.33

*All Japanese C/E based on 24 hours/day.

Table 6. Stratified mean Ln catches per tow (in pounds); and temperature for *Loligo pealei* and *Illex illecebrosus*, from U.S. Survey Vessel, Spring and Fall, 1967-1973.

			SPRING			FALL		
AREA	Strata	Year	*Loligo* Ln wt/tow	*Illex* Ln wt/tow	Temp. ** °C	*Loligo* Ln wt/tow	*Illex* Ln wt/tow	Temp. ** °C
Mid-Atl.	61-76	1967	--	--	--	2.18	.16	13.3
		1968	.28	.00	5.7	2.32	.12	13.6
		1969	.14	.10	5.5	2.29	.06	15.5
		1970	.35	.04	7.5	1.46	.23	10.0
		1971	.44	.03	6.9	1.18	.21	13.1
		1972	1.47	.00	8.7	2.68	.25	16.0
		*1973	.82	.01	8.0	2.62	.04	14.4
		1974	1.92	.07	10.3			
So. New Eng.	1-12	1967	--	--	--	.74	.39	9.6
		1968	.45	.04	5.0	1.92	.47	11.1
		1969	.49	.01	5.7	2.47	.13	12.1
		1970	.41	.01	6.1	1.41	.22	10.6
		1971	.76	.01	6.3	1.45	.34	10.8
		1972	.85	.00	7.0	1.48	.41	12.7
		*1973	.75	.01	6.8	2.71	.12	13.0
		1974	.93	.08	8.3	2.5	.08	13.1
So. Georges Bank	13-15	1967	--	--	--	.66	.29	8.4
		1968	.63	.00	6.3	.57	.42	12.6
		1969	1.02	.00	6.8	1.26	.13	12.7
		1970	.36	.00	5.9	.80	.38	10.8
		1971	.63	.02	5.8	.89	.95	11.9
		1972	.89	.02	7.3	.69	.28	11.8
		*1973	1.23	.09	8.9	1.81	.16	13.2
		1974	.12	.07	7.8	.99	.30	12.6
East Georges Bank	16-18	1967	--	--	--	.41	.05	8.2
		1968	.00	.01	3.9	.54	.50	10.3
		1969	.18	.00	5.4	.60	.08	10.1
		1970	.13	.02	4.8	.85	.18	9.2
		1971	.05	.00	4.6	.37	.20	10.8
		1972	.06	.00	5.8	.19	.14	10.2
		*1973	.00	.00	6.2	1.87	.34	11.9
		1974	.00	.00	6.9	.40	.02	12.0
No. Georges Bank	19-25	1967	--	--	--	.02	.05	7.1
		1968	.00	.00	4.7	.18	.24	9.7
		1969	.00	.00	4.7	.36	.01	8.9
		1970	.00	.00	5.0	.39	.16	9.9
		1971	.00	.00	4.8	.60	.38	11.2
		1972	.00	.00	5.0	.73	.23	10.5
		*1973	.00	.00	5.4	1.25	.40	11.0
		1974	.00	.00	6.6	.94	.08	10.9

*Spring 1973 cruises were made with a 41 trawl, instead of Yankee 36; relative abundances are not comparable.

**Mean bottom temperatures per strata set.

Table 7. Prerecruit index (strata mean number (less than recruited size) per tow)) from fall survey cruises, for *Loligo* and *Illex* (Middle Atlantic-Georges Bank).

Year	*Loligo* (≤8 cm)		*Illex* (≤10 cm)	
	mean #/tow	mean wt/tow	mean #/tow	mean wt/tow
1967	126.9	6.8	0.7	0.1
1968	159.9	12.2	0.6	0.1
1969	217.4	16.5	0.3	0.03
1970	79.3	5.2	0.2	0.1
1971	161.5	6.1	0.6	0.05
1972	258.8	11.6	1.8	0.1
1973	353.9	19.6	0.3	0.04
1974				

Table 8. Minimum biomass estimates for squid in 5Z and 6 (in metric tons) from survey cruise abundance indices.

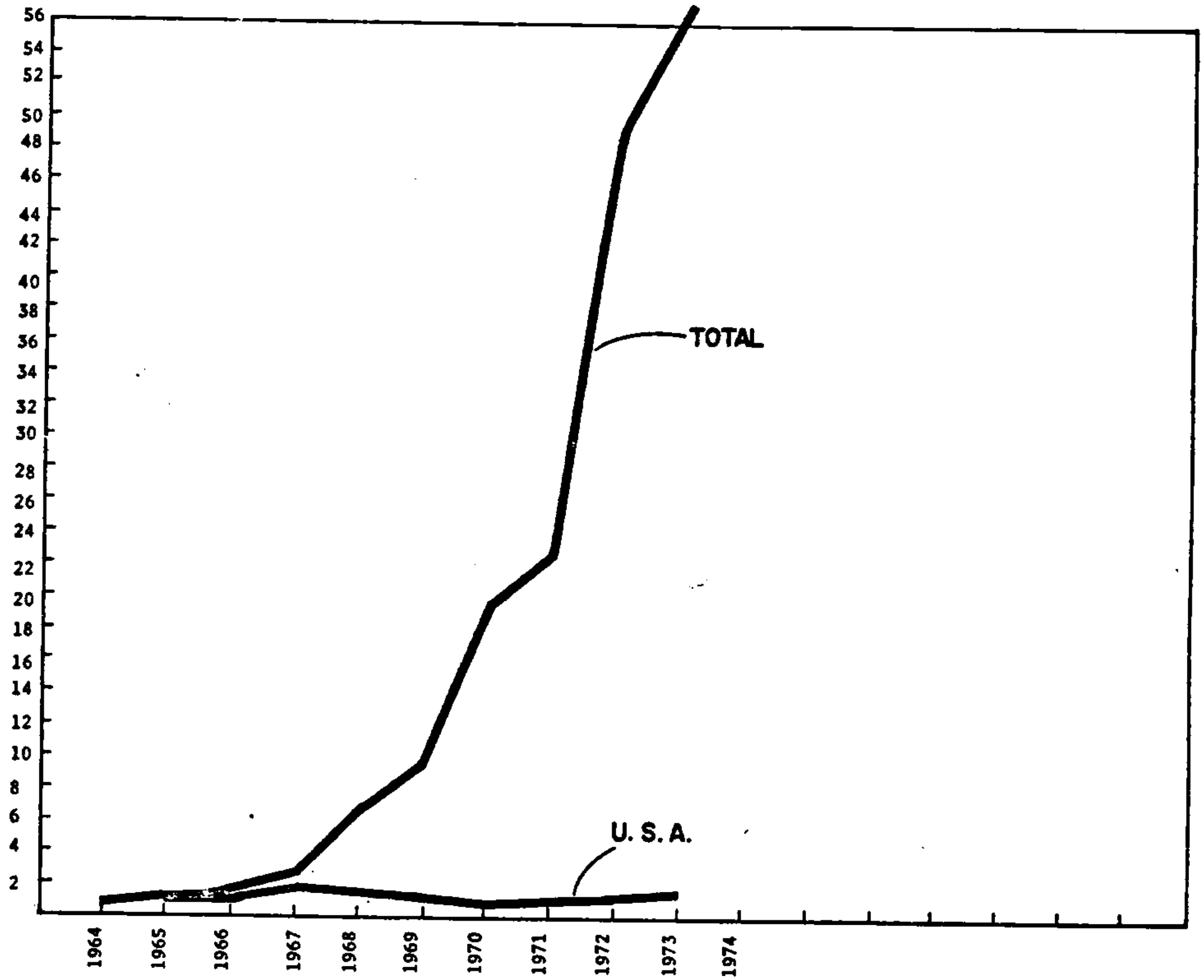
Year	*Loligo*			*Illex*		
	B'_a	B'_b	B'_c	B'_a	B'_b	B'_c
1967	15,268	25,922	36,550	1,128	4,583	6,461
1968	28,063	47,011	66,286	1,480	4,231	5,966
1969	37,586	59,437	84,098	311	1,793	2,529
1970	12,025	28,875	40,714	1,079	13,338	18,806
1971	11,694	17,784	25,075	1,351	7,667	10,812
1972	25,396	25,115	35,412	1,423	8,522	12,016
1973	42,250	62,965	88,781	883	6,480	9,138
1974		60,119	84,768		13,390	18,880

B'_a = minimum estimate using total survey abundance indices

B'_b = estimate using average of: (day-night ratio from gear comparisons X mean nighttime weights per tow) and daytime mean weight per tow.

B'_c = B'_b X 1.41 (41/36 trawl ratio for *Loligo* in gear comparison)

Figure 1. Total and U.S.A. Squid landings (1964-1973) in Thousand Metric Tons, ICNAF Areas 5 and 6



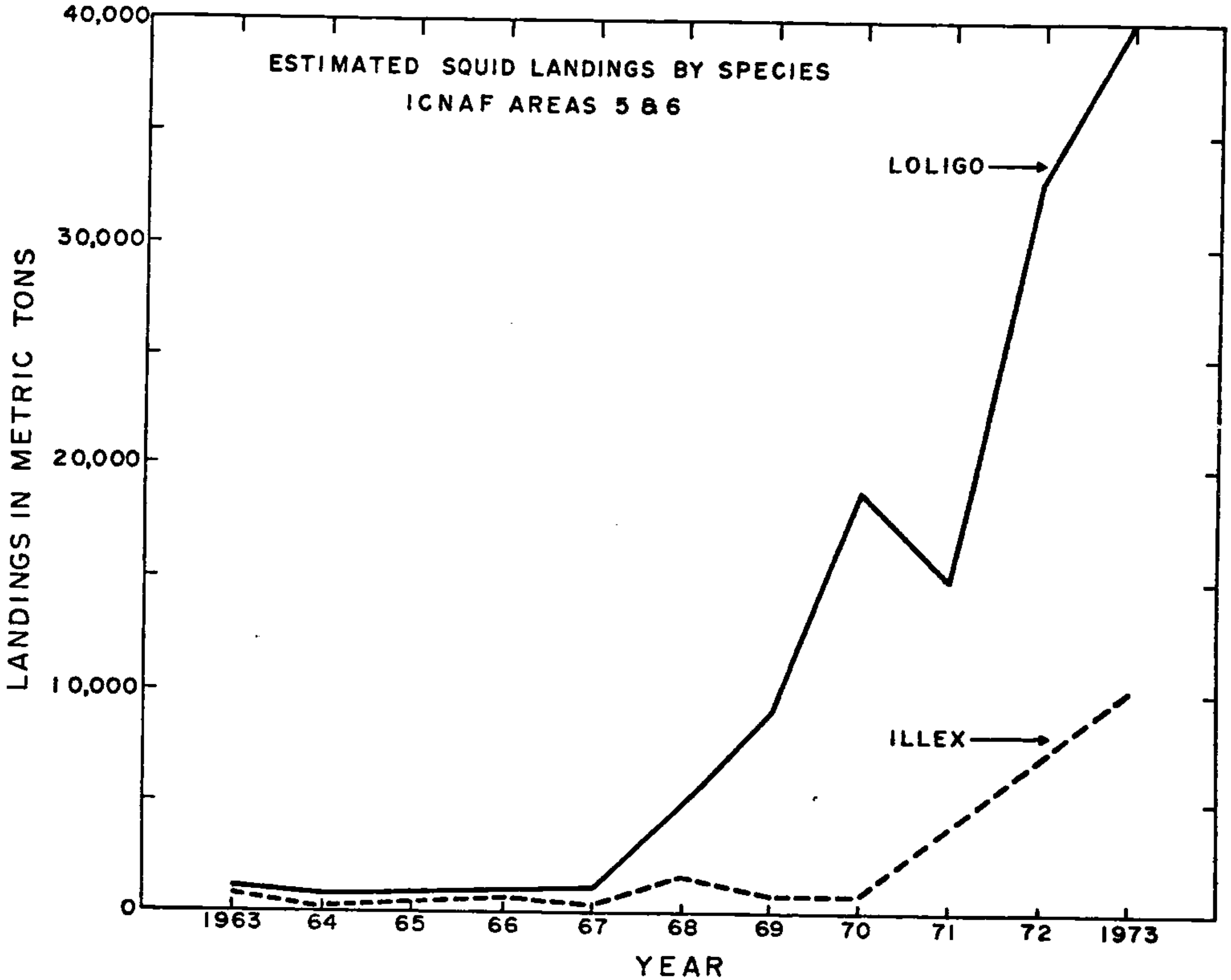


Figure 2. Estimates of total squid landings (all countries) by species, in ICNAF Subarea 5 and Statistical Area 6, 1963 to 1973.

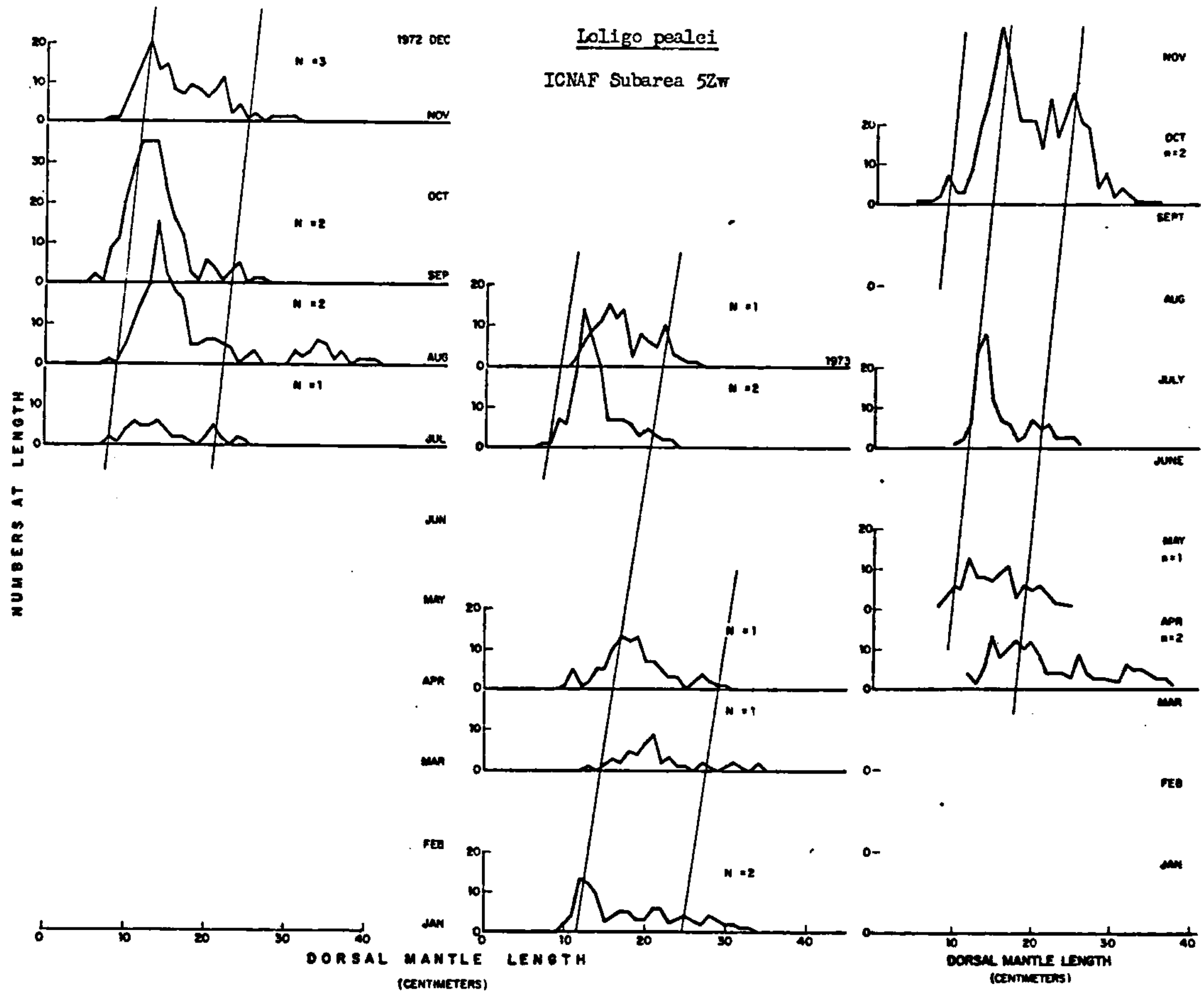


Figure 3a. US commercial length frequencies of *Loligo pealei*, in ICNAF Subdivision 5Zw, 1972-1974.

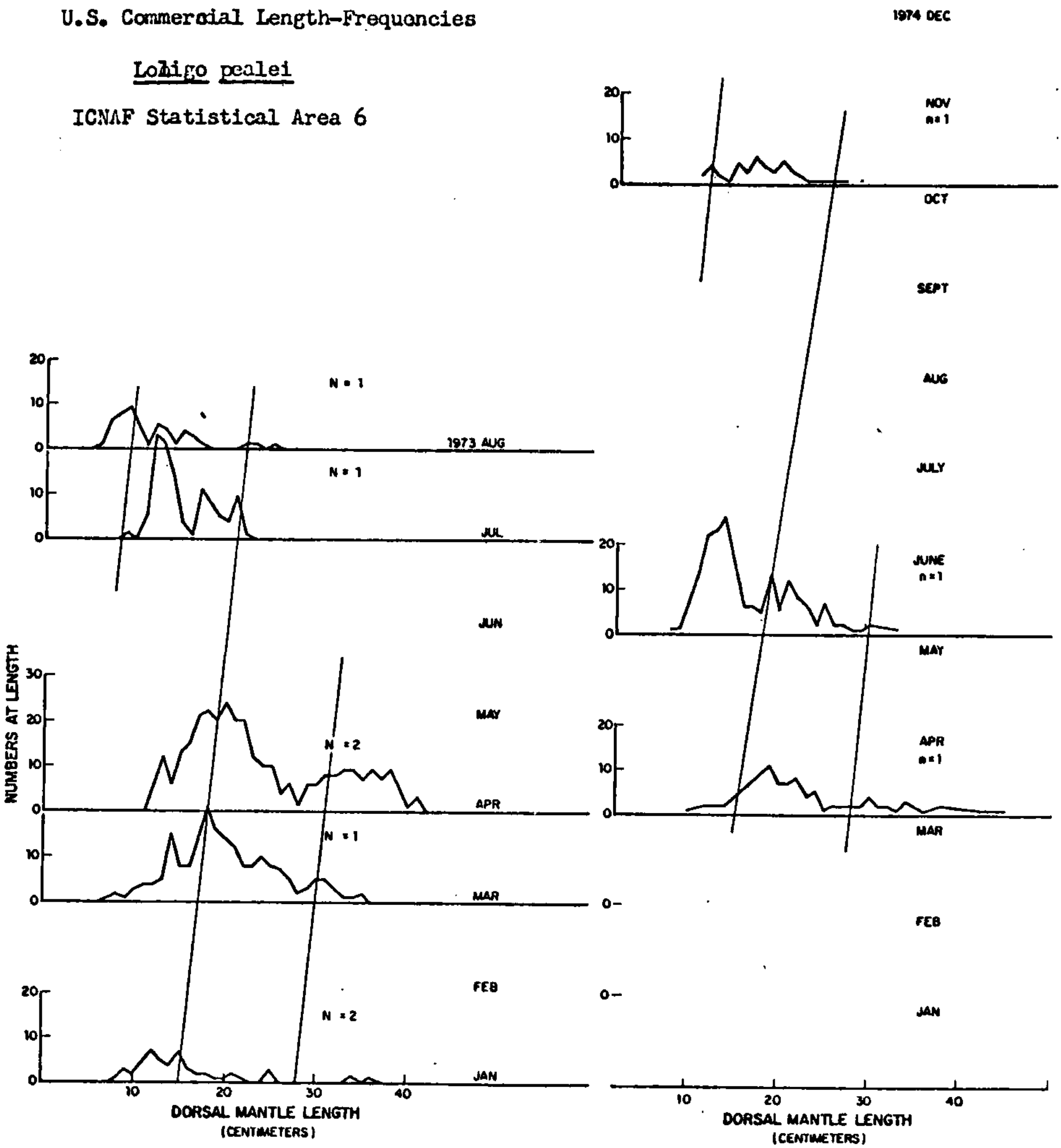


Figure 3b. US commercial length frequencies of *Loligo pealei*, in ICNAF Statistical Area 6, 1973-1974.

U.S. Commercial Length-Frequencies

Illex illecebrosus

ICNAF Subarea 5Y

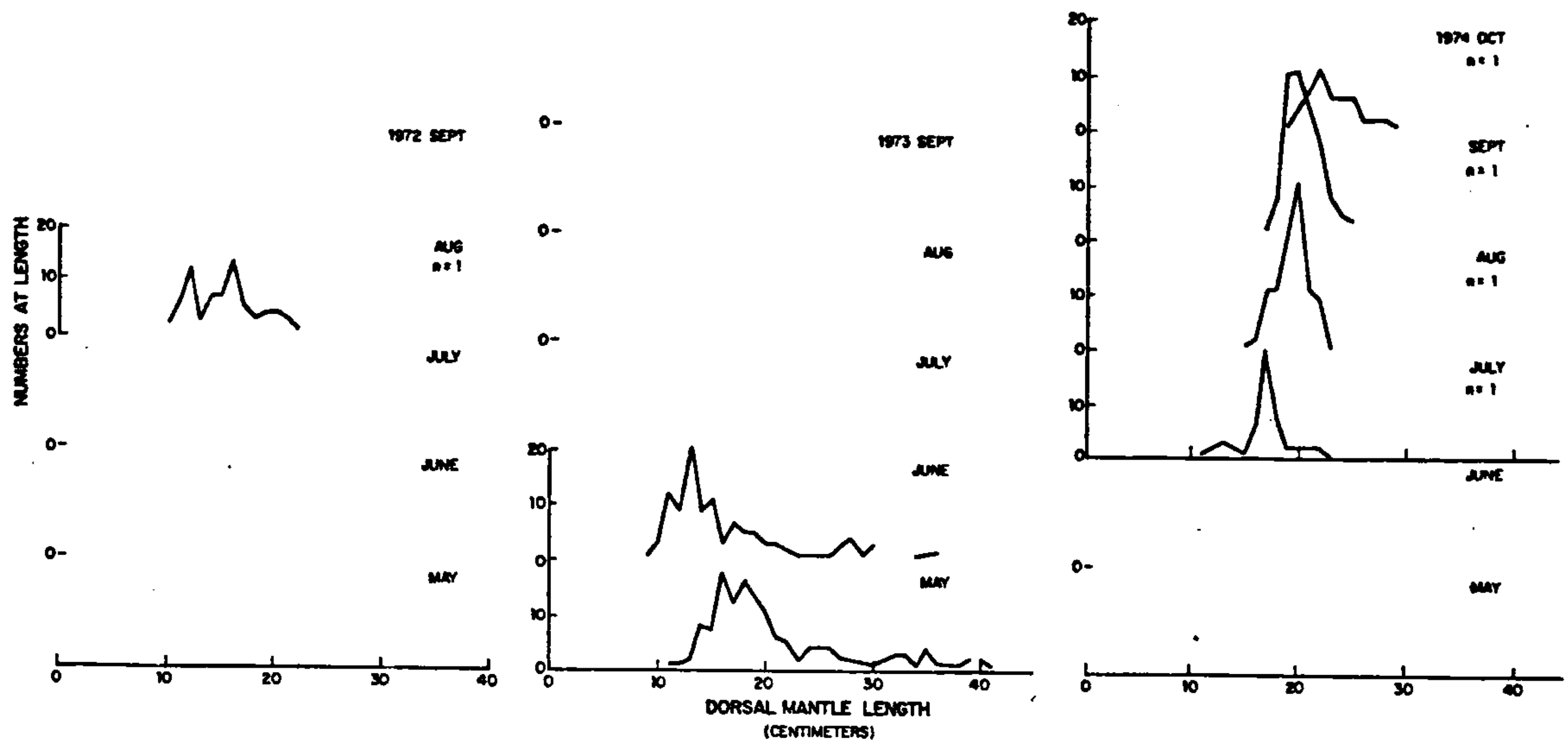


Figure 4. US commercial length frequencies of *Illex illecebrosus* in ICNAF Subdivision 5Y, 1972-1974.

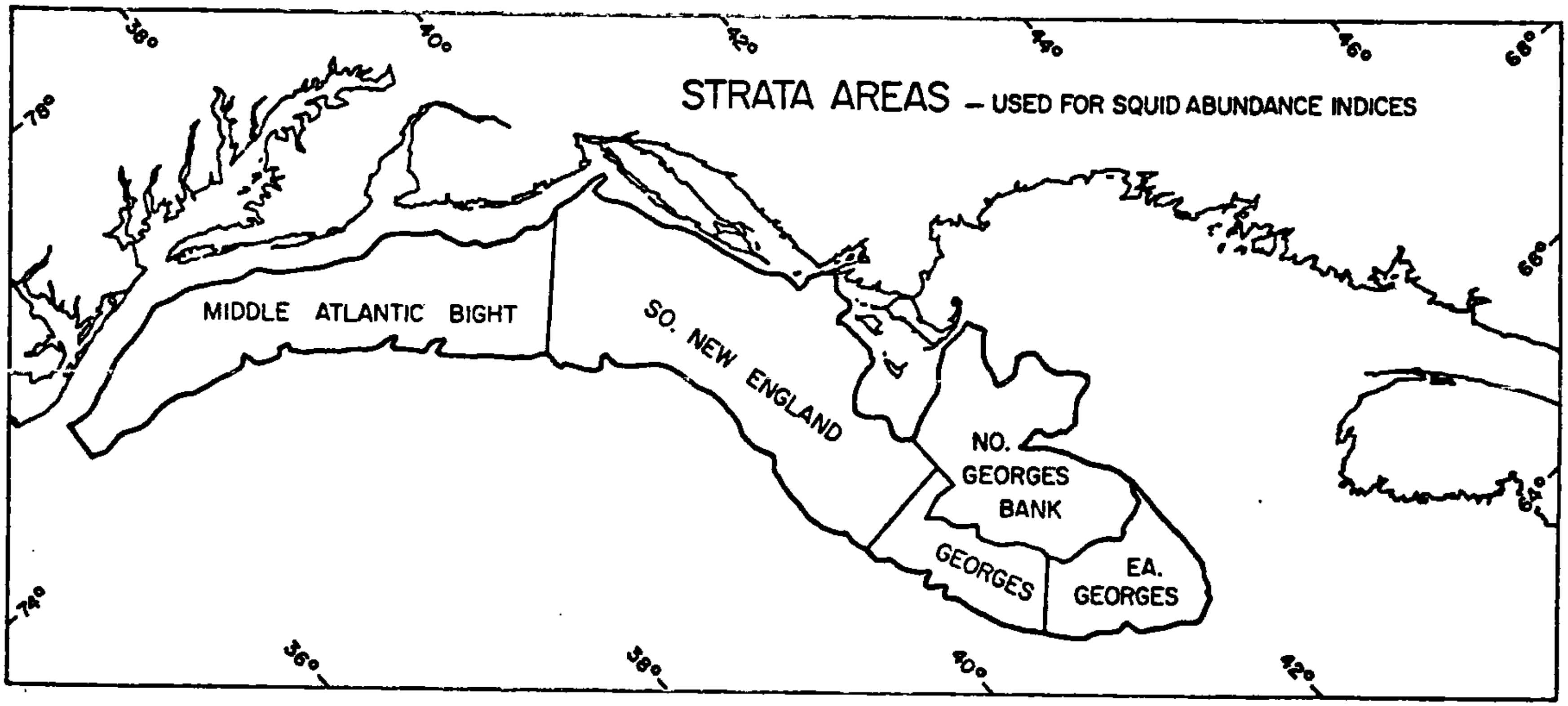


Figure 5. Strata areas, Middle Atlantic to Georges Bank, used in analysis of US groundfish survey abundance indices.

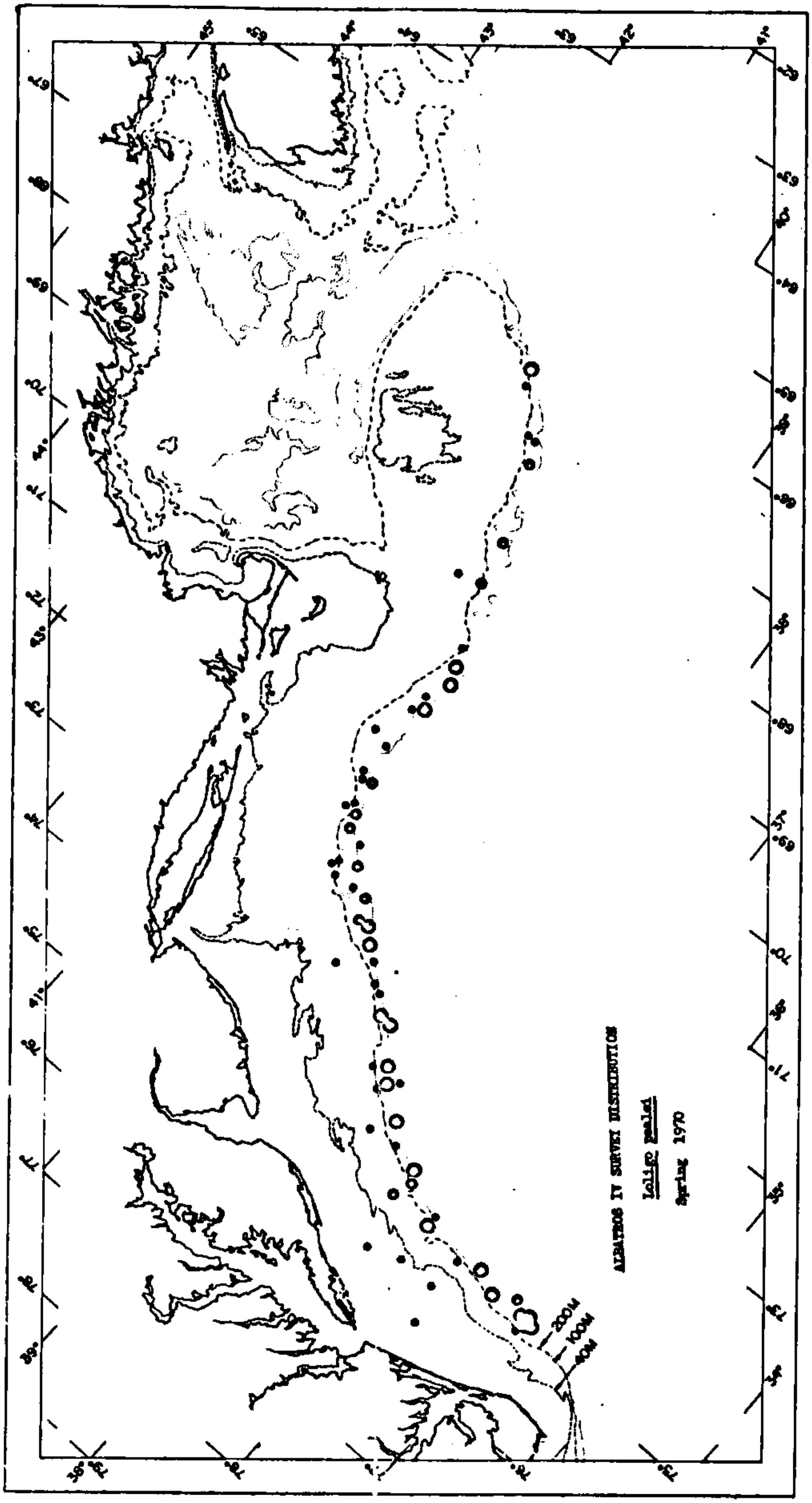


Figure 6a. Spring 1970 distribution of *Loligo pealei* from US groundfish surveys.

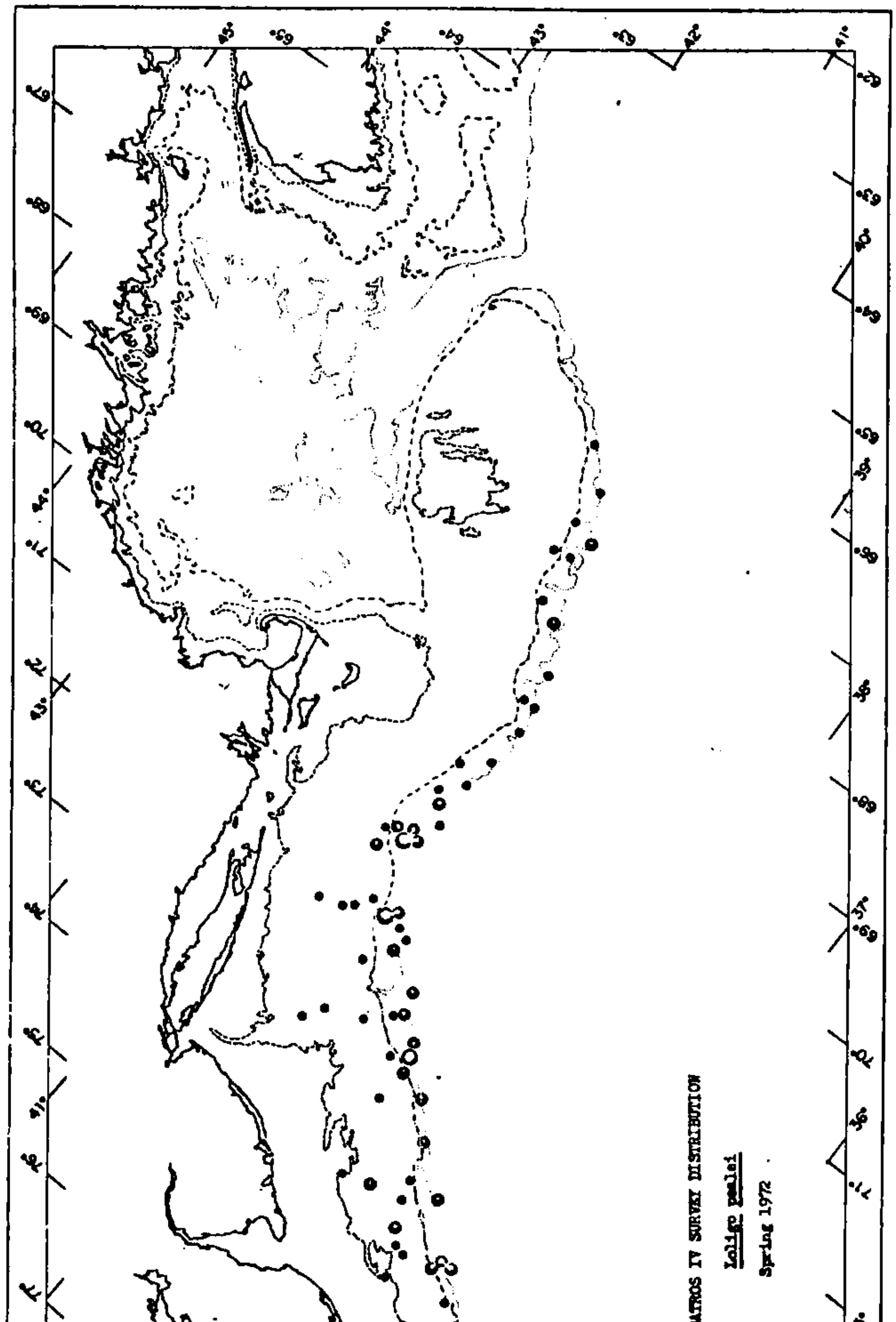


Figure 6b. Spring 1972 distribution of *Loligo pealei* from US groundfish surveys.

F 8

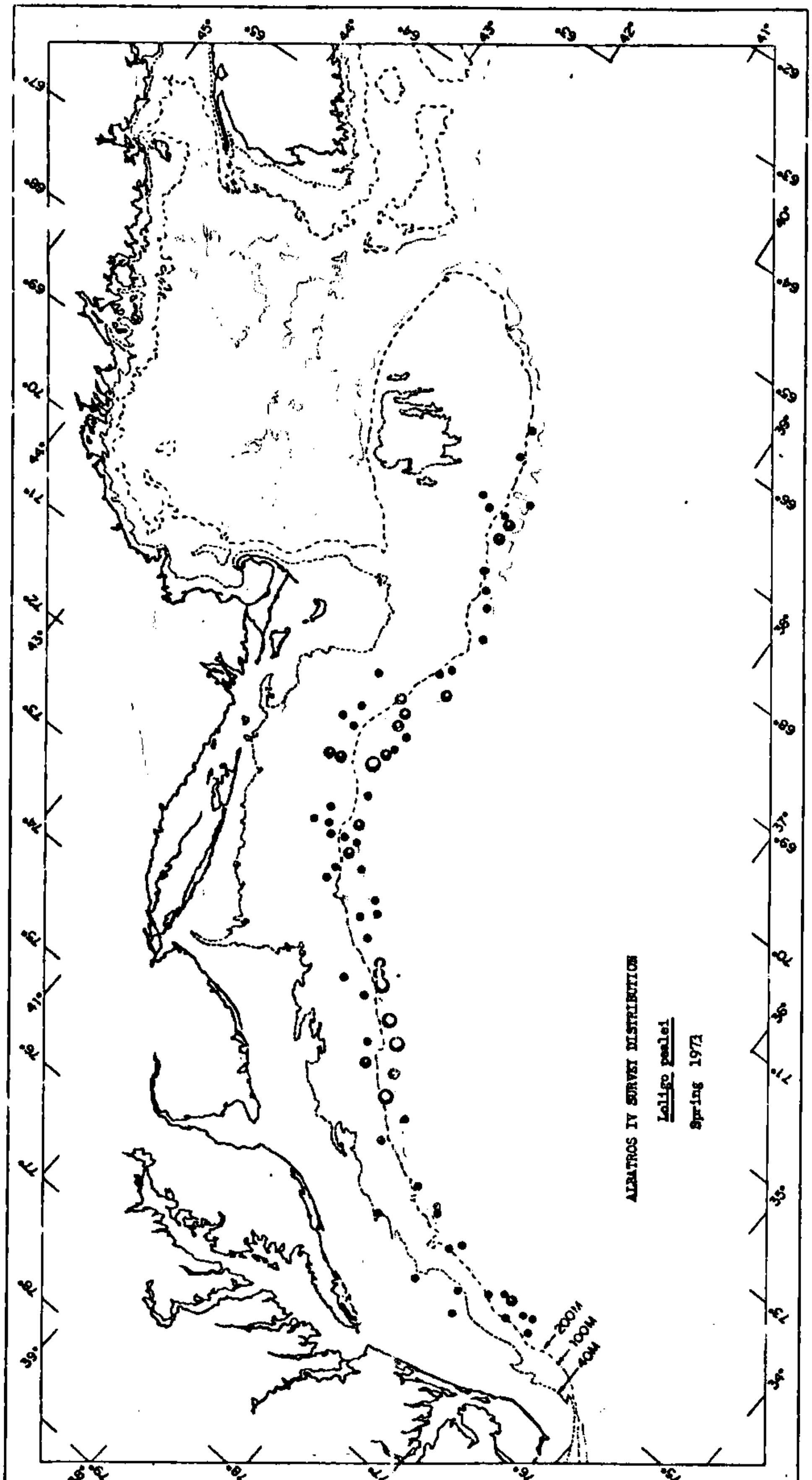


Figure 6c. Spring 1973 distribution of *Loligo pealei* from US groundfish surveys.

F 9

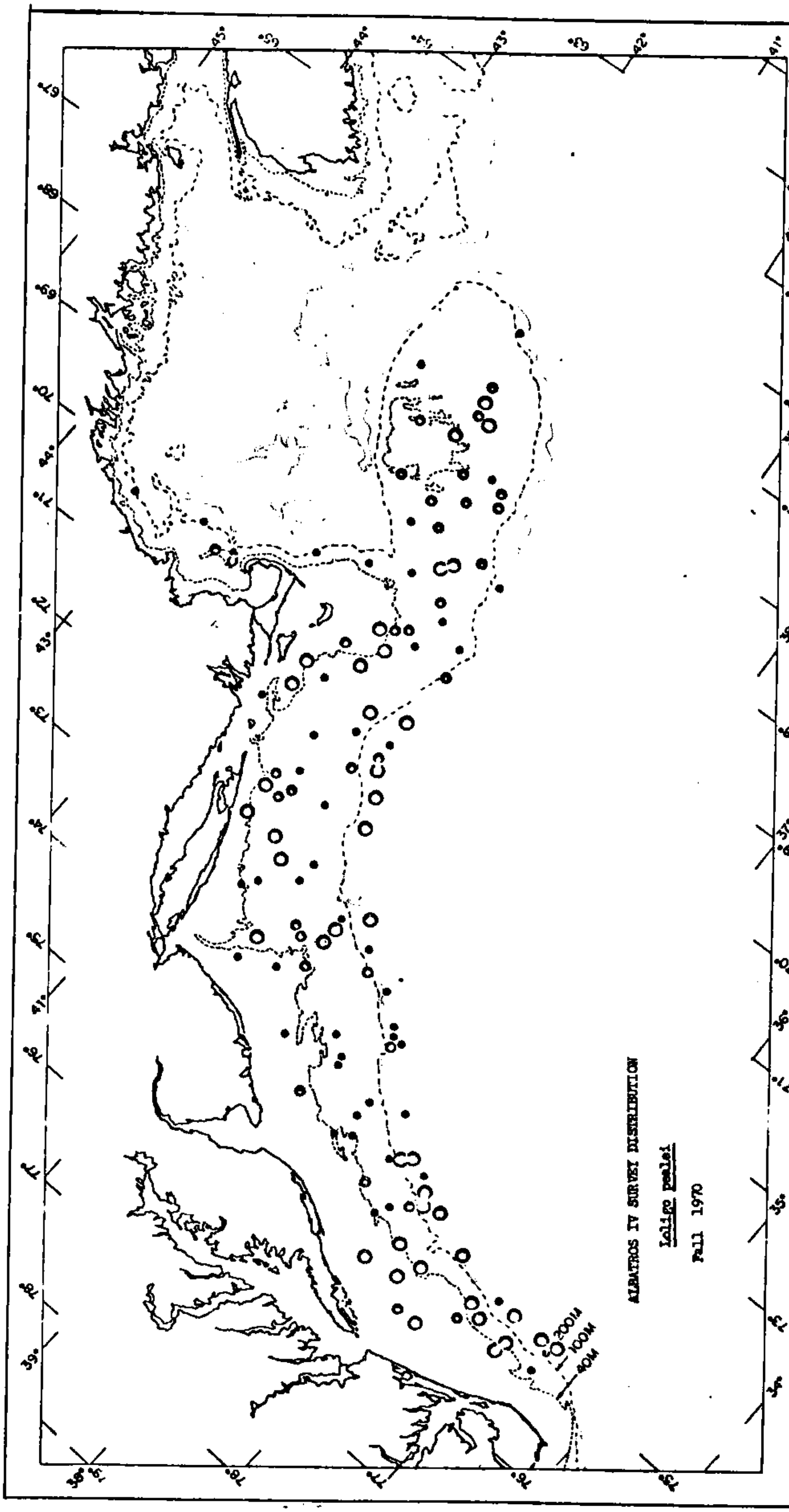


Figure 6d. Autumn 1970 distribution of *Loligo pealei* from US groundfish surveys.

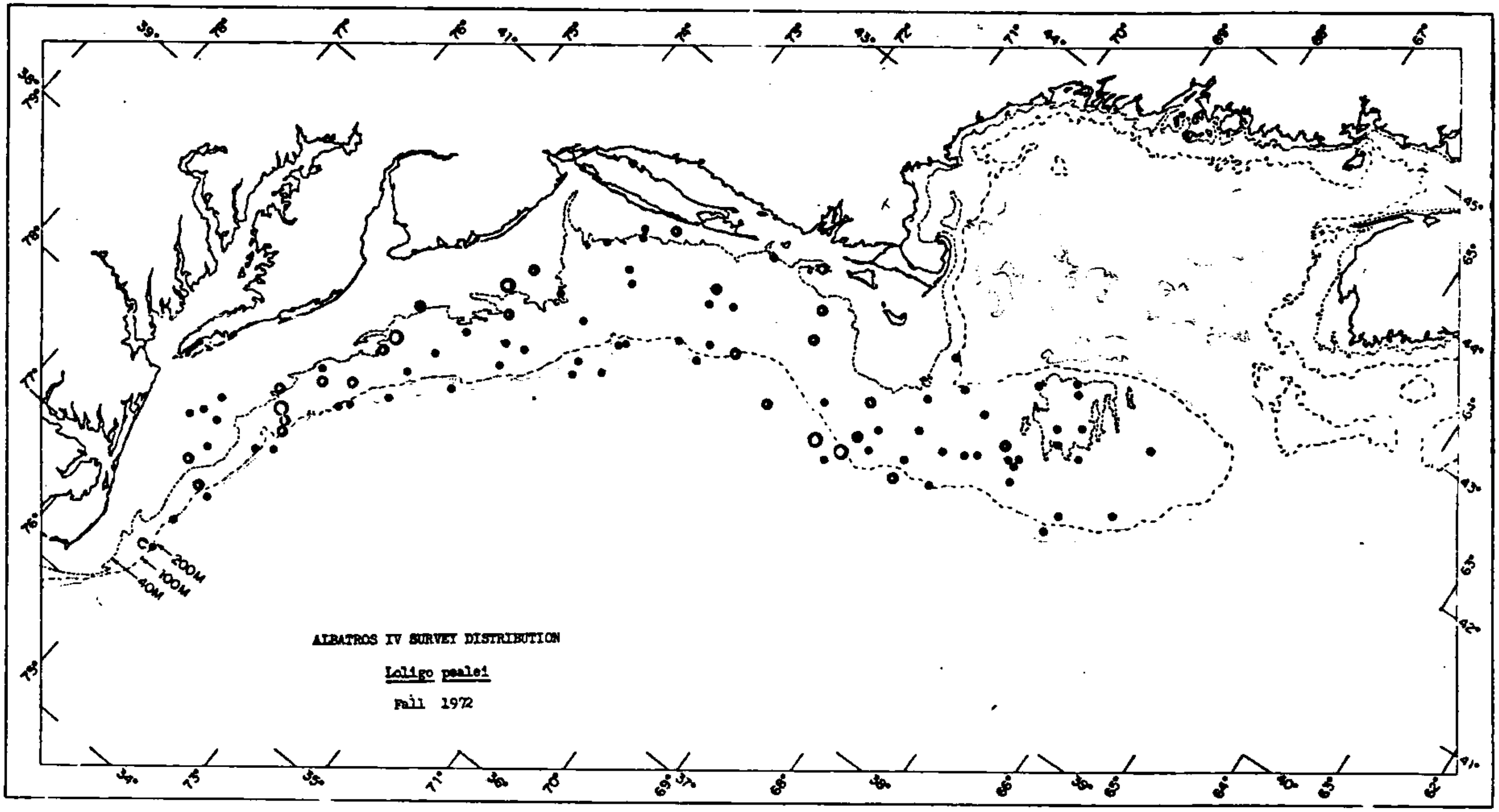


Figure 6e. Autumn 1972 distribution of *Loligo pealei* from US groundfish surveys.

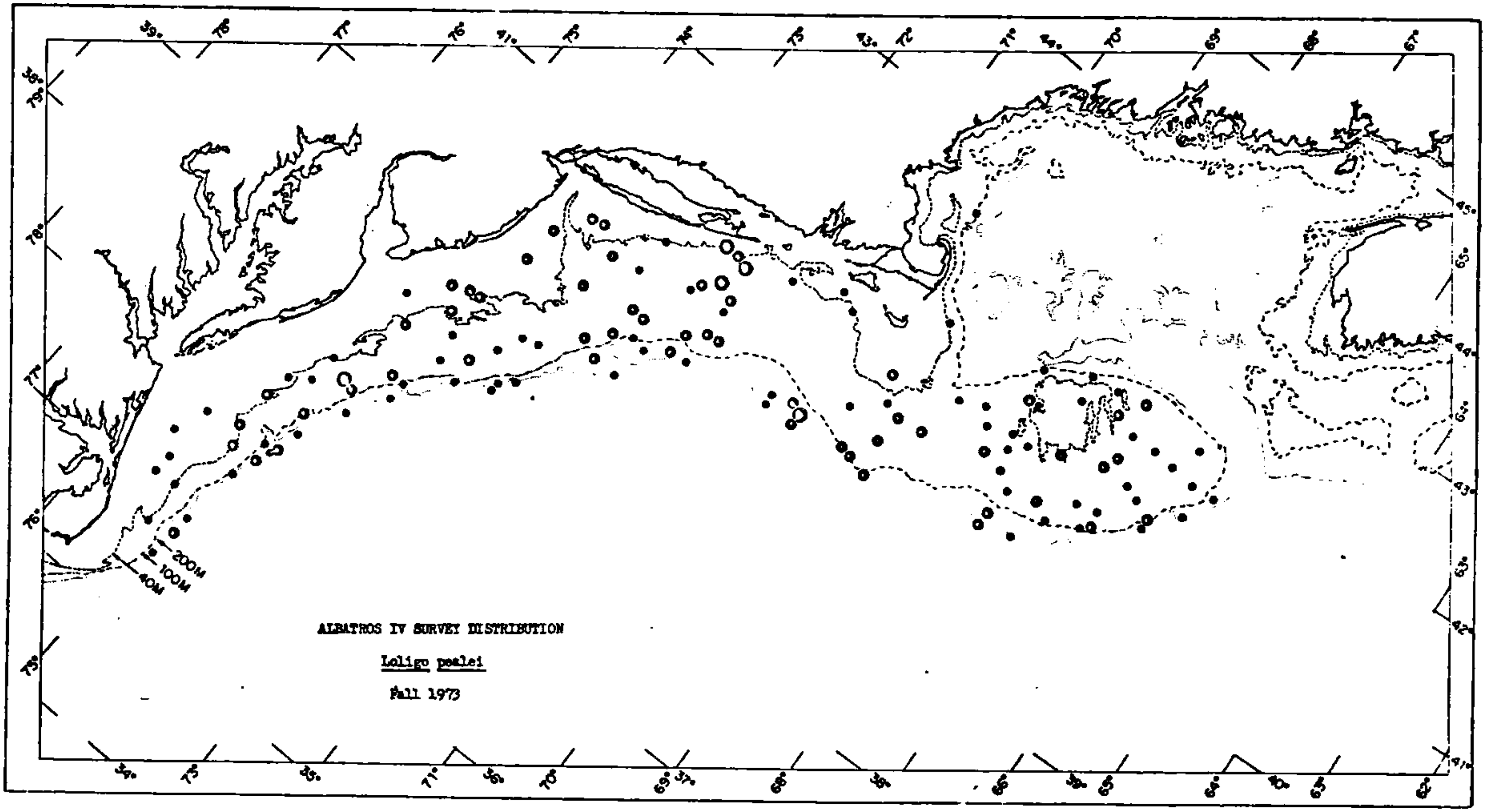


Figure 6f. Autumn 1973 distribution of *L ligo pealei* from US groundfish surveys.

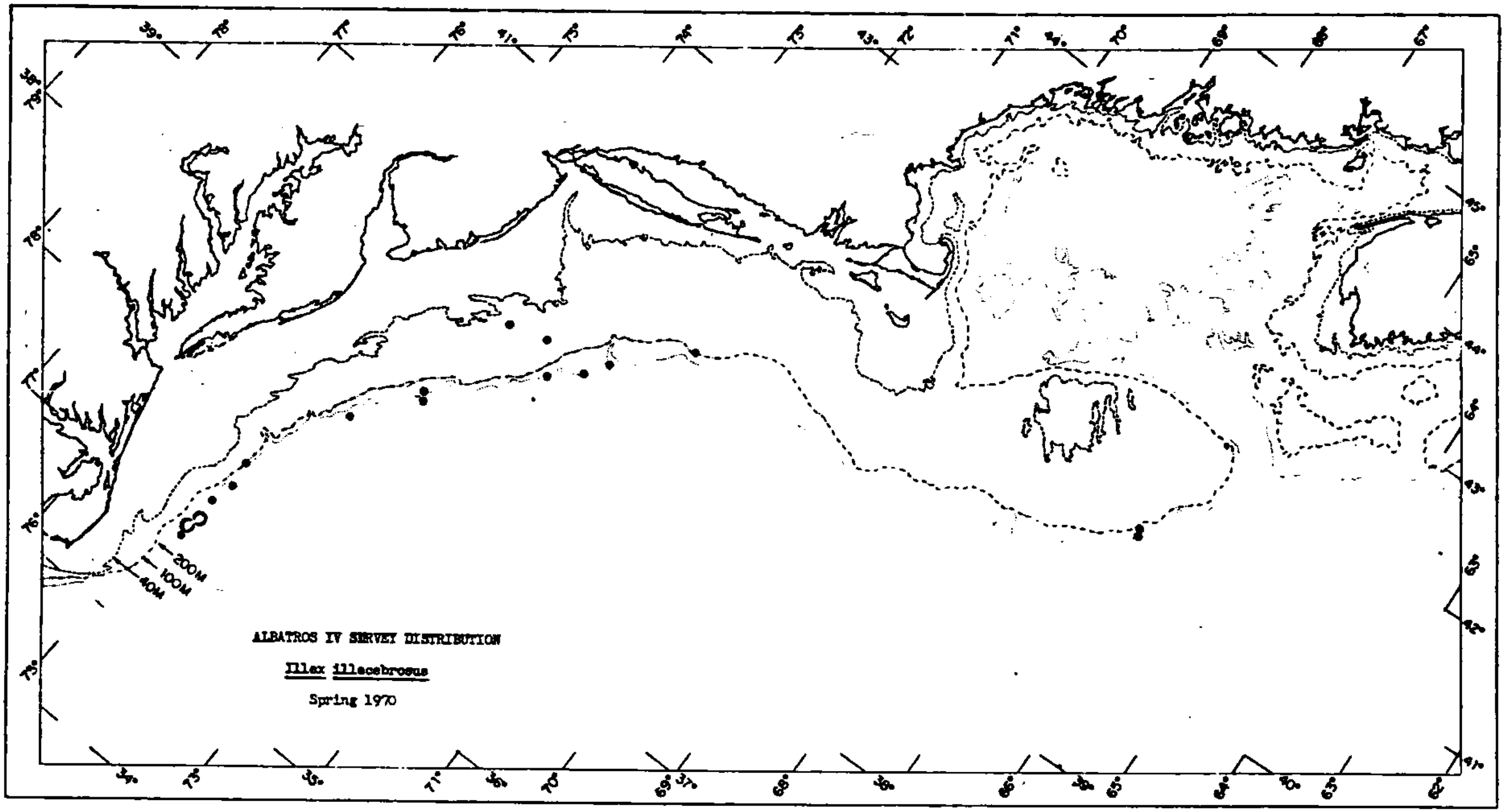


Figure 6g. Spring 1970 distribution of *Illex illecebrosus* from US groundfish surveys.

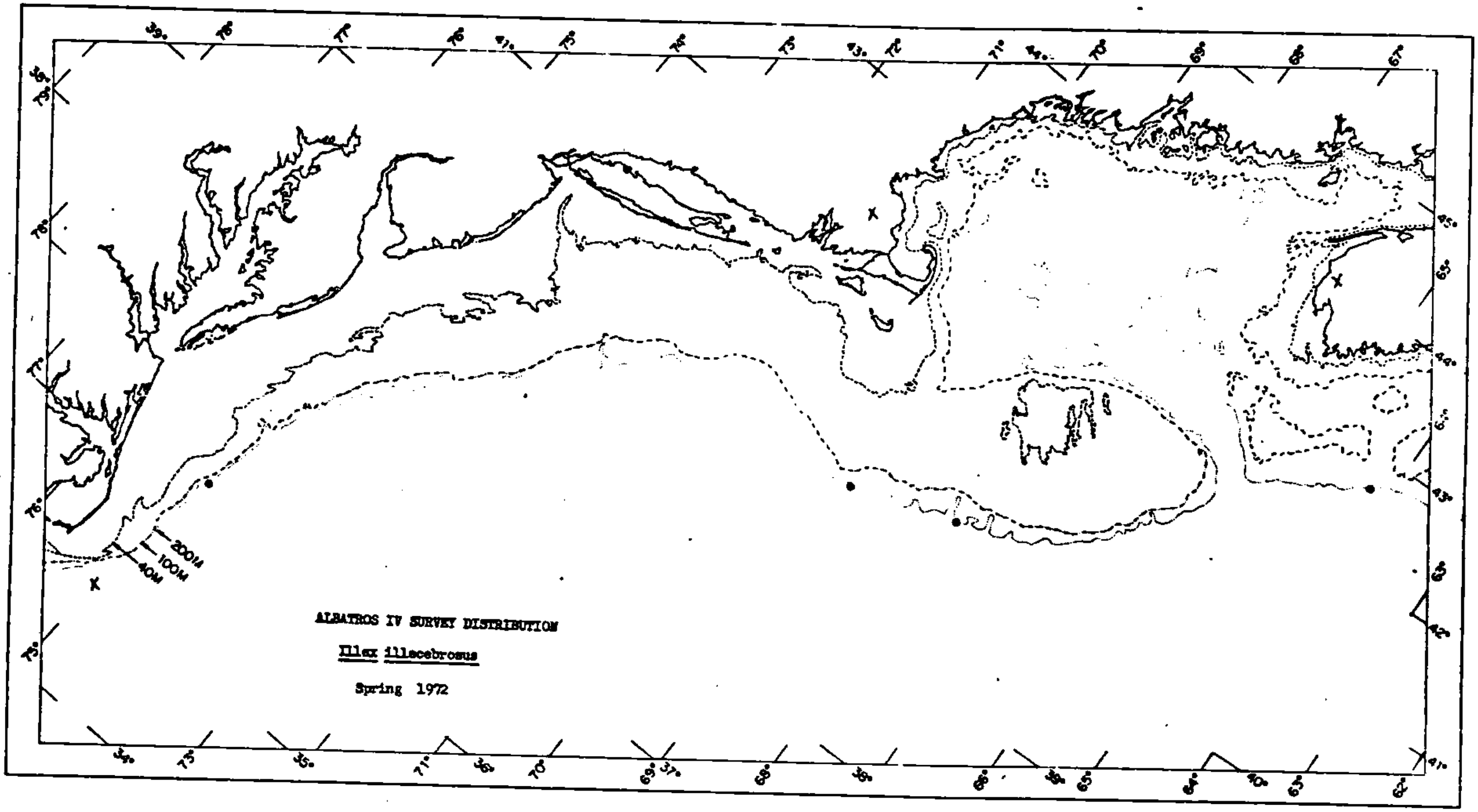


Figure 6h. Spring 1972 distribution of *Illex illecebrosus* from US groundfish surveys.

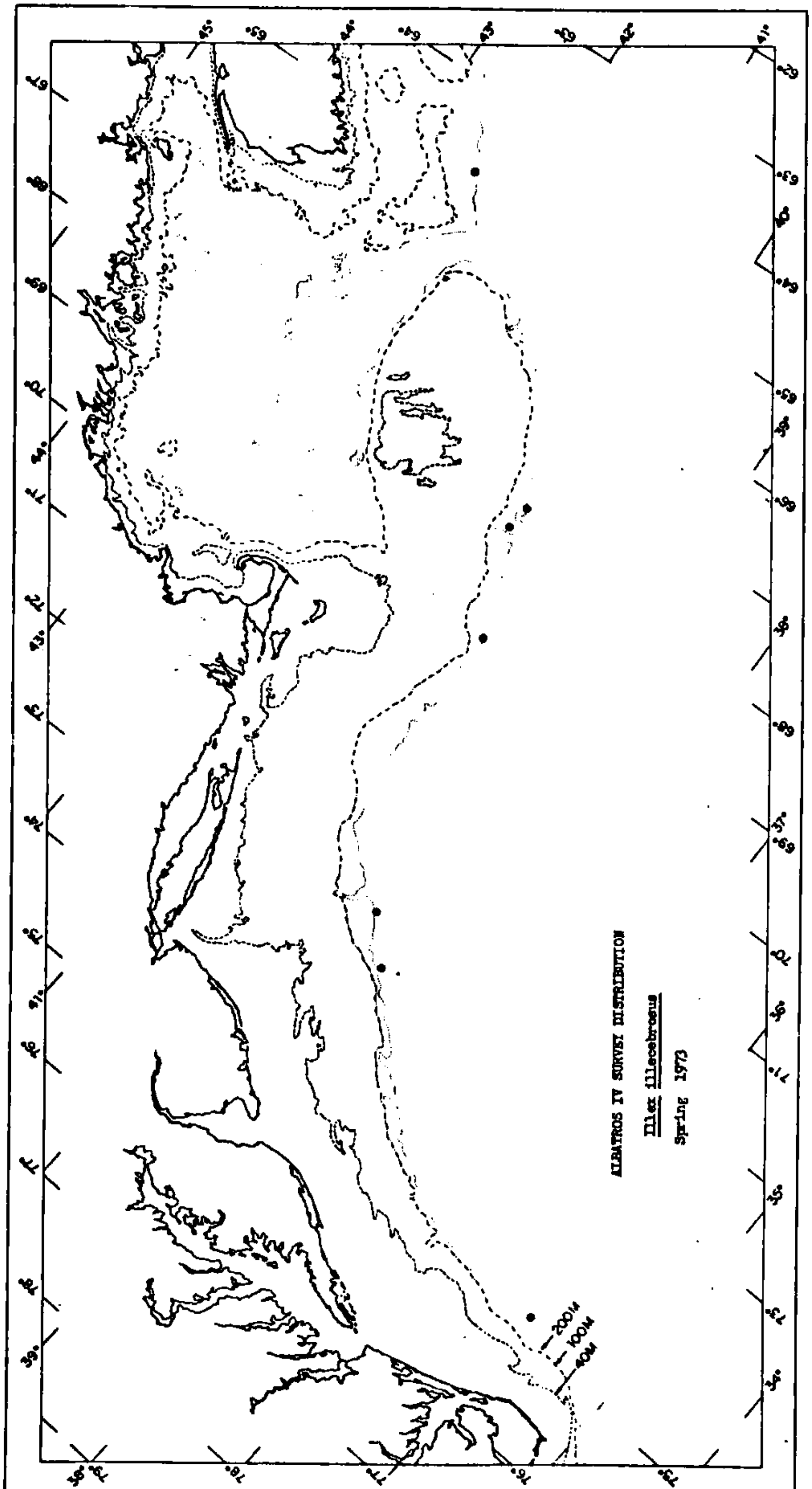


Figure 61. Spring 1973 distribution of *Illex illecebrosus* from US groundfish surveys.

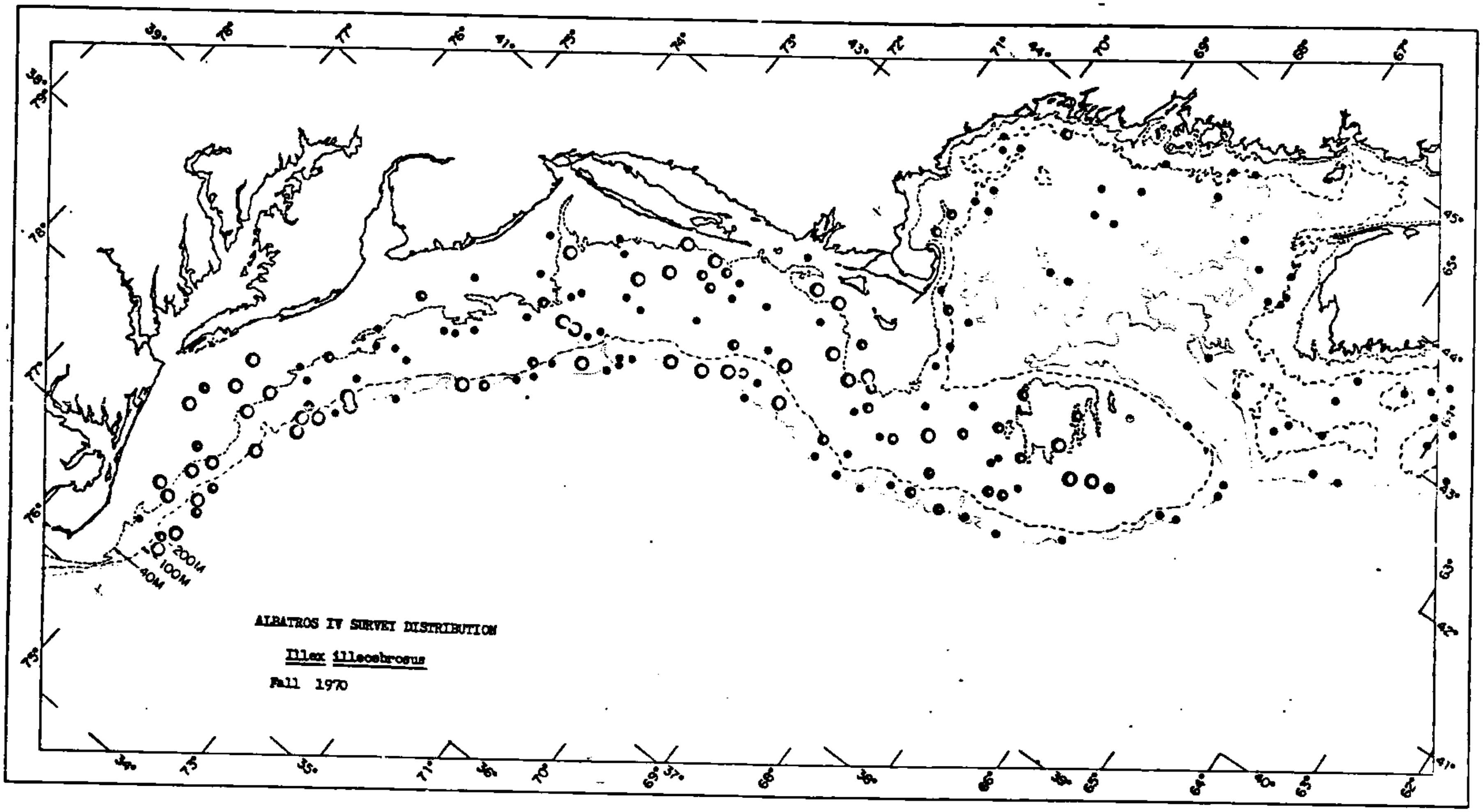


Figure 6j. Autumn 1970 distribution of *Illex illecebrosus* from US groundfish surveys.

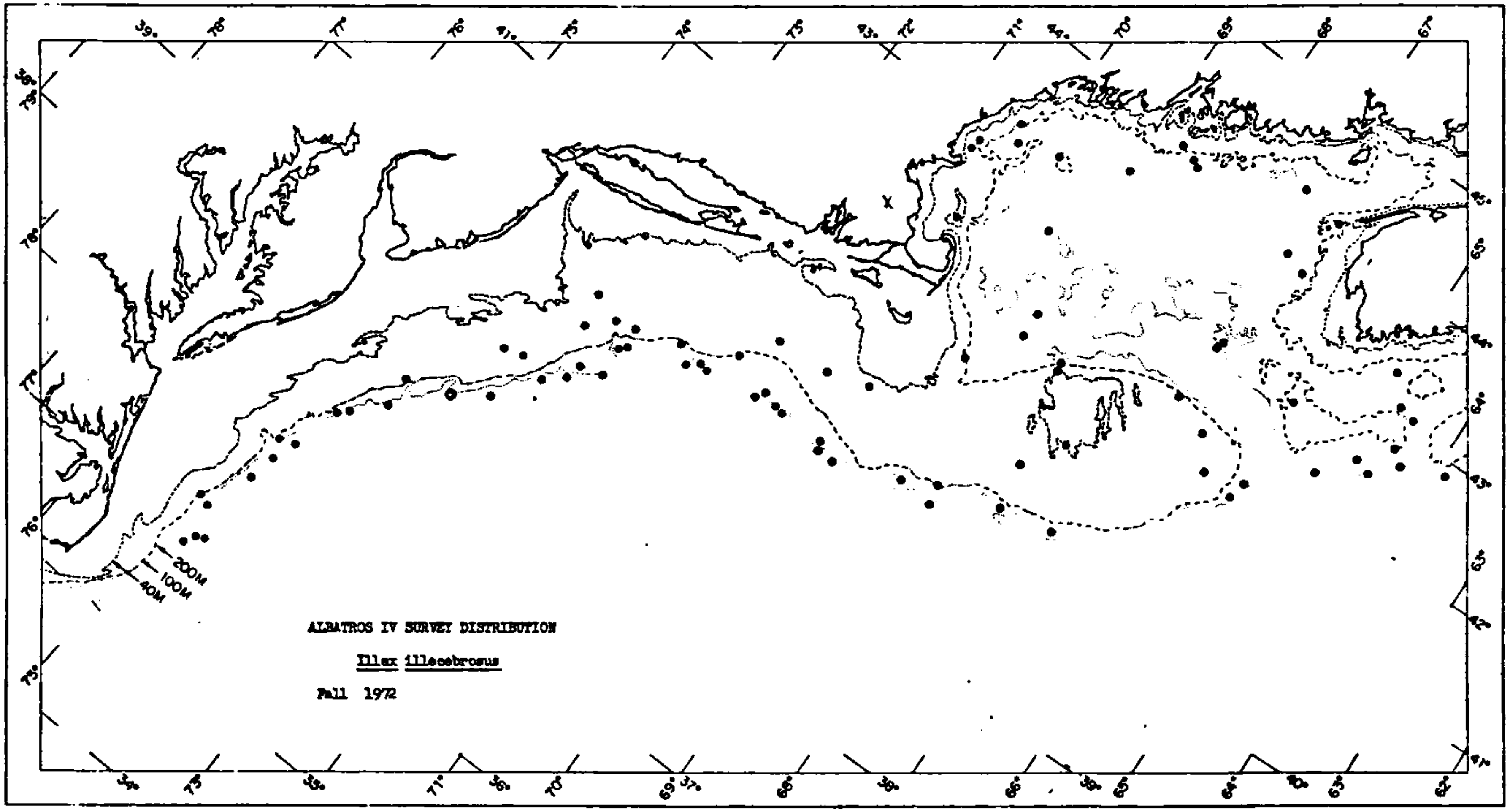


Figure 6k. Autumn 1972 distribution of *Illex illecebrosus* from US groundfish surveys.

G 3

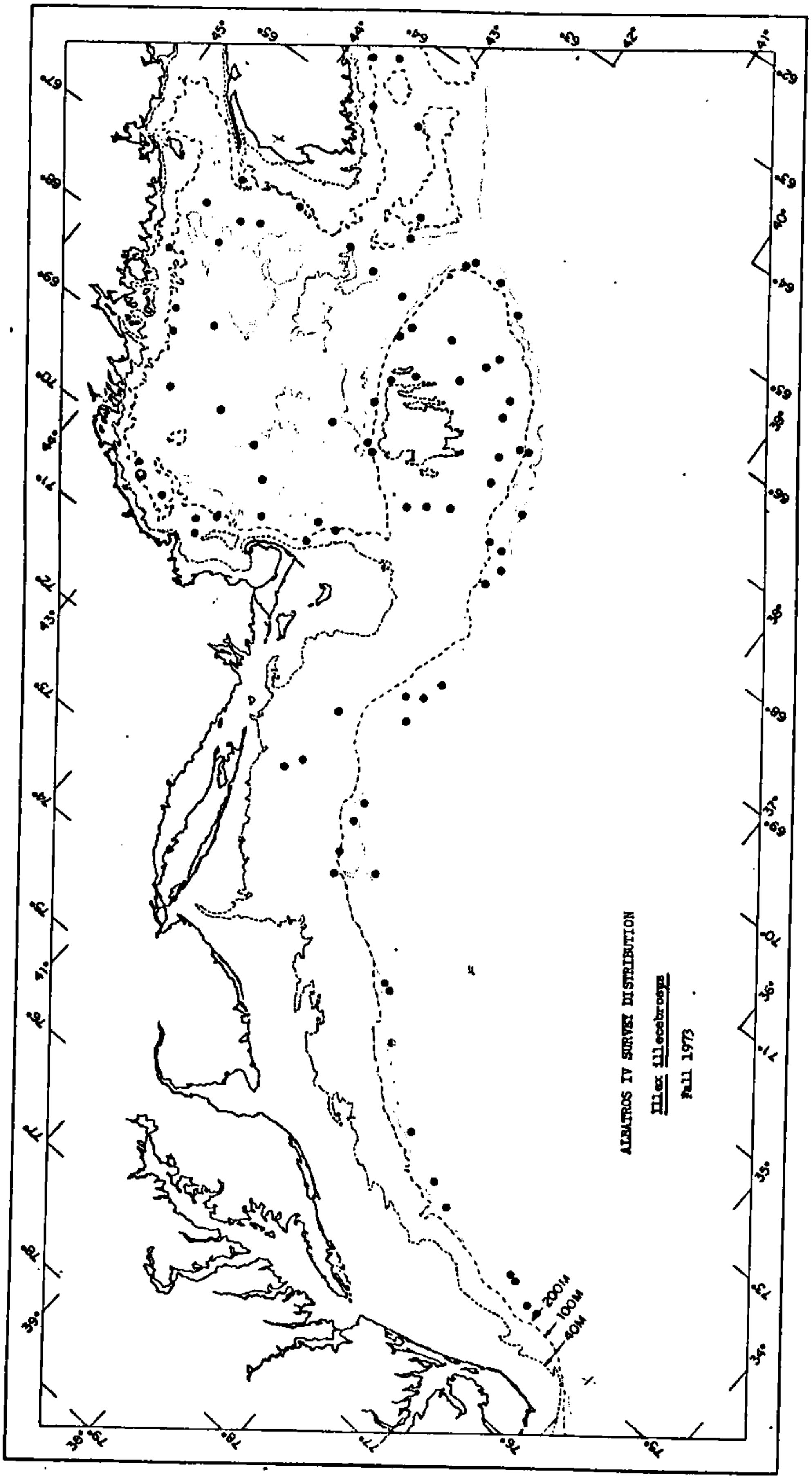


Figure 61. Autumn 1973 distribution of *Illex illecebrosus* from US groundfish surveys.

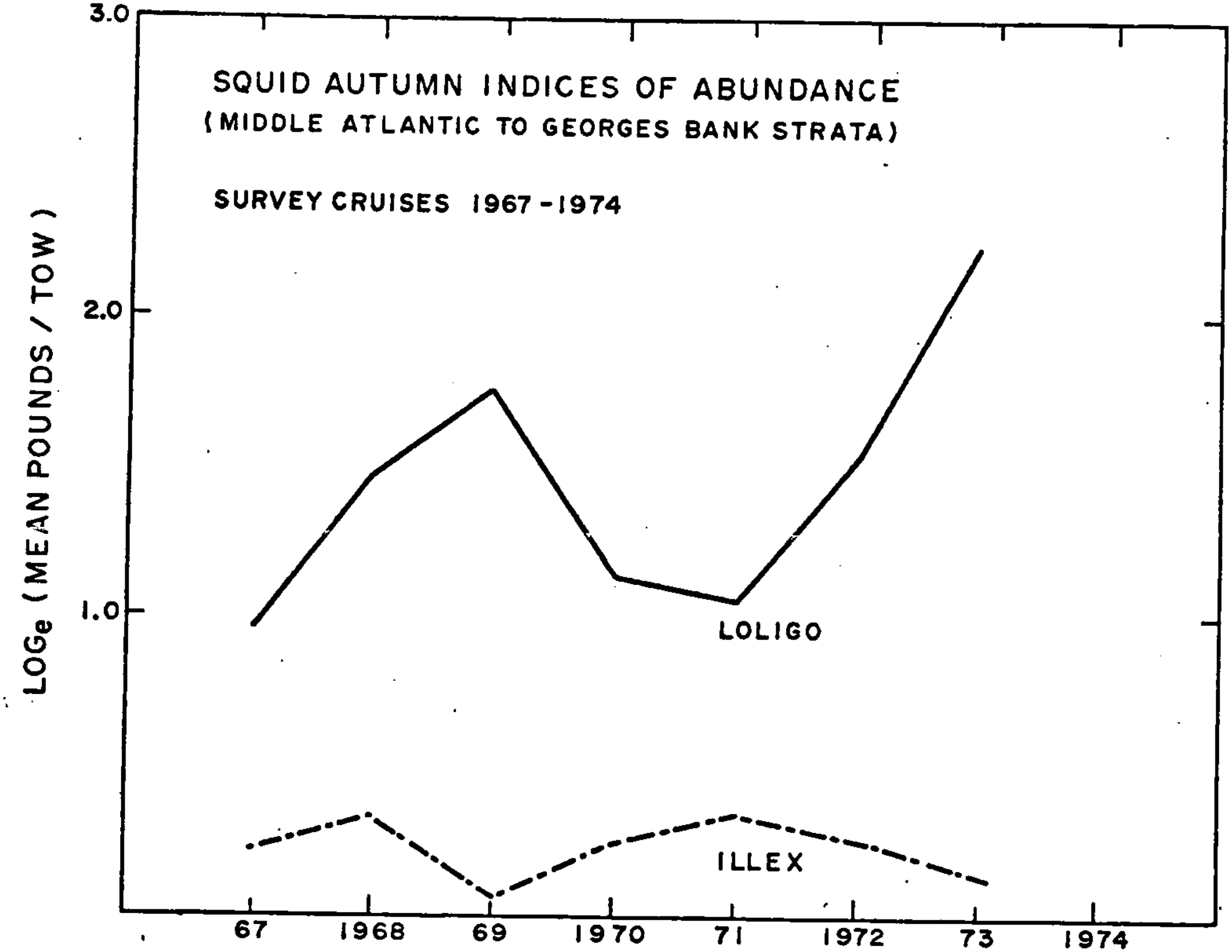


Figure 7. Autumn survey abundances (Log_e mean pounds per tow) for squid, *Loligo pealei* and *Illex illecebrosus*, 1967 to 1974, from Middle Atlantic to Georges Bank.

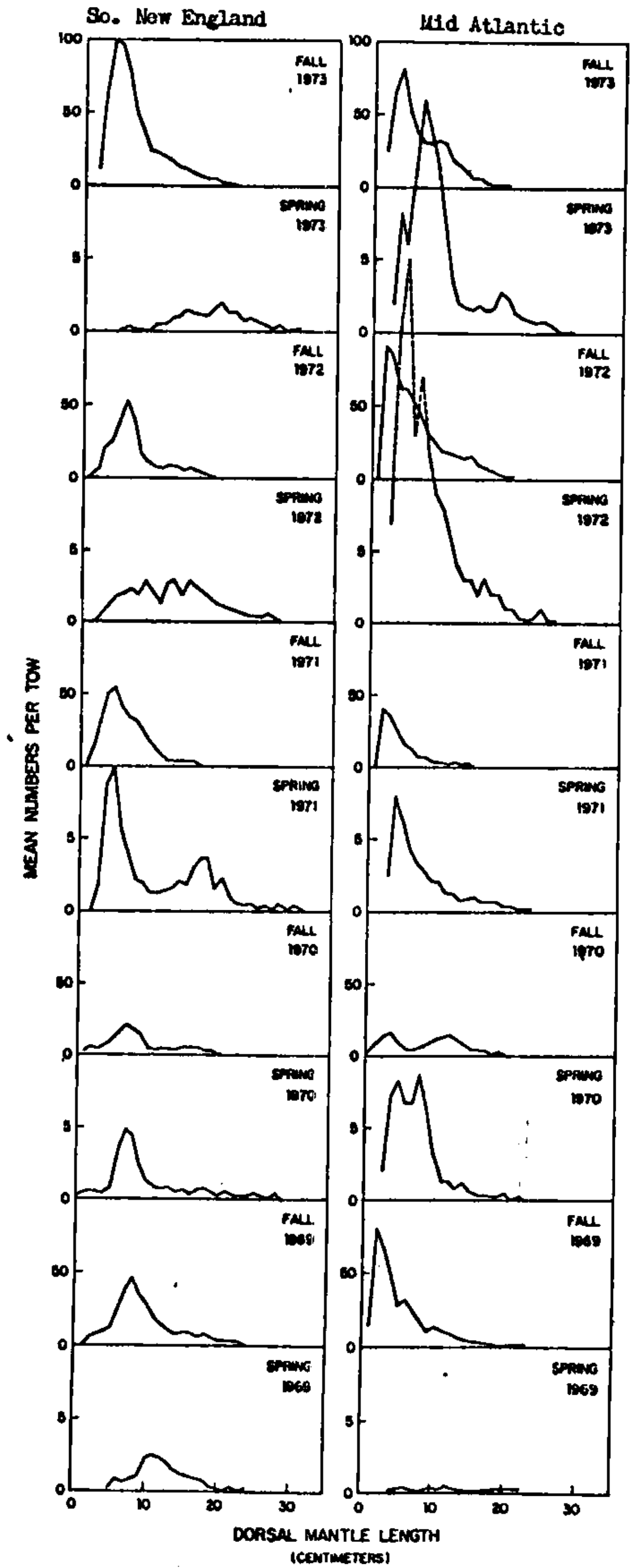


Figure 8a. Mean numbers at length per tow of *Loligo pealei* from US groundfish surveys, spring 1969 to autumn 1973 in the Middle Atlantic and Southern New England strata.

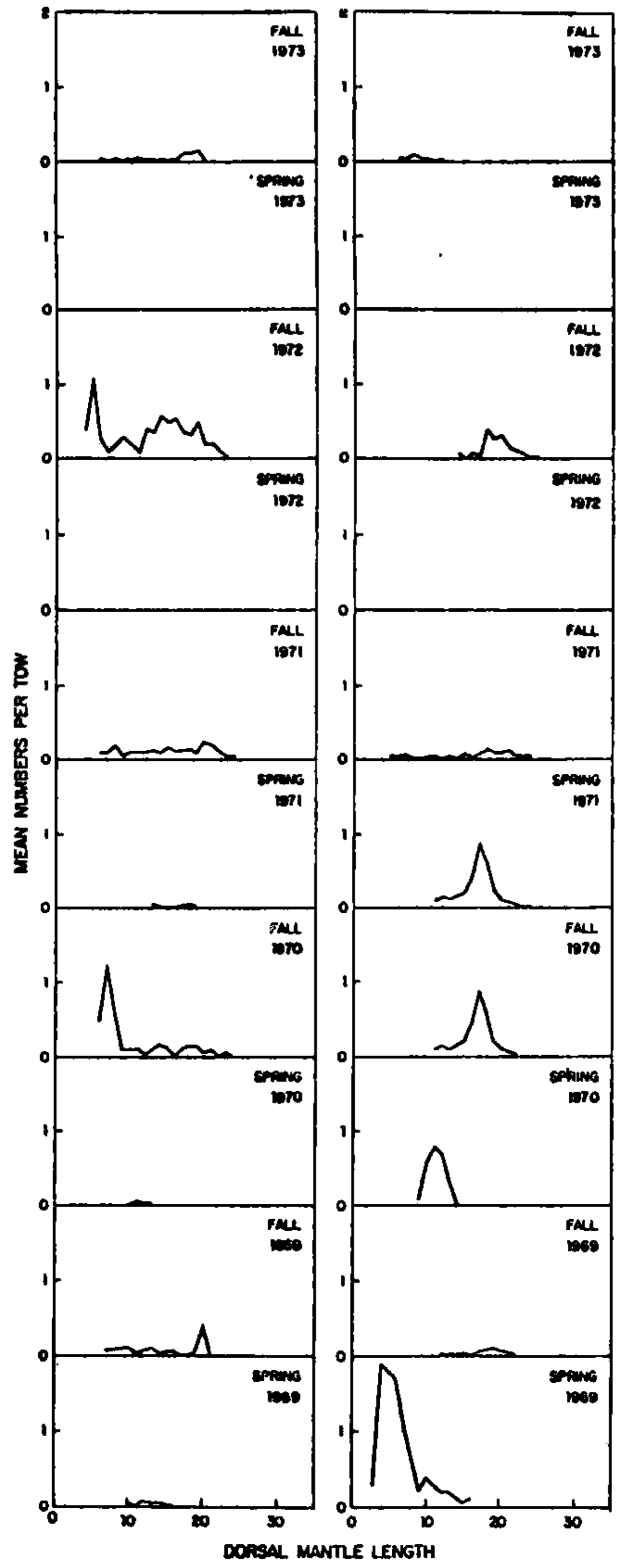


Figure 8b. Mean numbers at length per tow of *Illex illecebrosus* from US groundfish surveys, spring 1969 to autumn 1973 in the Middle Atlantic and Southern New England strata.

G 7