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Status of the Short-finned Squid (*Illex illecebrosus*) off the Northeastern USA
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SUMMARY

Research survey biomass and abundance indices for the short-finned squid (*Illex illecebrosus*), off the northeastern USA are updated for 1983 and 1984. Commercial catch data are also updated for 1983 and January - November 1984. Distant-water-fleet (DWF) catches decreased in 1983 to a level comparable to that seen in the early 1970's, when this fishery was first begun, while domestic catches (9,944 mt) were nearly double those from 1982, and about eight times the previous high. Through November 1984, domestic and foreign catches totalled 910,410 mt and 600 mt, respectively. Much of the recent USA catch was taken in joint ventures (8,344 mt in 1983, and 6,010 mt through November in 1984).

Population abundance estimates for the short-finned squid derived from the NEFC autumn 1983 survey data were the lowest since 1973, while pre-recruit abundance was equivalent to the lowest level of the time series (1970). The 1984 autumn survey estimate, though lower than the average for 1975-81, is over twice the level of that for preceding years. Pre-recruit abundance is about twice the 1983 index but still well below the means for both the long-term (1968-83) and the previous period of low abundance (1968-74). This cohort, which will make up the bulk of the catch in 1985, may not support the present optimum yield of 30,000 mt. There is no evidence to indicate, however, that the catch in 1985 cannot be maintained at the level of recent years, which is considerably below 30,000 mt.

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INTRODUCTION

The short-finned squid (*Illex illecebrosus*) off the Northeastern USA is becoming increasingly important to the USA fishery, with catches during 1983 and 1984 of about 10,000 metric tons (mt) compared to the 1968-82 average of 911 mt. Distant-water-fleet catches have decreased from an average of 13,760 mt (1968-82) to under 2,000 mt in 1983 and 1984. This document updates information regarding the status of the short-finned squid stock (Lange 1983) in the area from the Mid-Atlantic to the Gulf of Maine. Information presented includes catch and length frequency data from the 1983 and 1984 USA and distant-water-fleet (DWF) fisheries, minimum biomass and abundance estimates and pre-recruit abundance indices for 1983 and 1984 (preliminary) from NEFC autumn bottom trawl survey data.

BIOLOGY

The short-finned (or summer) squid is primarily distributed between Newfoundland and Florida; fishable concentrations occur between Newfoundland and Cape Hatteras. This species undergoes seasonal migrations, moving into shallow waters from New England to Newfoundland and onto the continental shelf in the Mid-Atlantic area in the summer to feed. In late autumn, short-finned squid begin an offshore migration to the edge of and beyond the continental shelf where they spawn during the winter and to some extent into spring (Figure 1). *Illex illecebrosus* is

a short lived species which is assumed to die after spawning at ages of 12-24 months. Stock structure has not been fully determined, although there is strong evidence that short-finned squid located off the USA and Canadian coasts of Nova Scotia and Newfoundland may represent two components of a single stock (Hatanaka et al. 1984).

COMMERCIAL FISHERY

Description

The USA fishery for short-finned squid takes place primarily during the summer while the stock has moved inshore to feed. The USA catch had, until recently, been taken as bycatch in other fisheries. There is now a significant directed fishery (with both shoreside and joint venture participants) in the Mid-Atlantic area during summer (June - September). Principal bycatch in this fishery include silver hake, spotted hake and spiny dogfish. The DWF fishery generally occurs offshore during the summer (July - October). Important bycatch species in the DWF fishery include silver hake, spotted hake, and long-finned squid.

Management

The short-finned squid stocks in USA waters is currently managed on an April 1 - March 31 fishing year. Management is based on annual determinations of optimum yield (OY), domestic annual harvest (DAH), domestic annual processing (DAP), reserve, and total allowable level of foreign fishing (TALFF). These specifications are amounts that the Regional Director, Northeast

Region of the National Marine Fisheries Service (NMFS), in consultation with the Mid-Atlantic and New England Fishery Management Councils, has determined to be appropriate for each sector of the fishery. Foreign fishing is restricted to 5 windows (Figure 2) in the offshore waters of the Mid-Atlantic and southern New England areas, and is limited to specific seasons within each window. Domestic fishermen landing their catch on shore or transferring it to foreign processing vessels involved in joint ventures, are not restricted to fishing within the windows.

Domestic and DWF allocations and catches of short-finned squid for the 1983-84 fishing year and preliminary values for the 1984-85 fishing year are presented in Table 1. Fourteen percent of the allocated portion of the final total allowable level of foreign fishing (TALFF) and six percent of the domestic annual harvest (DAH) were taken during the 1983-84 fishing year (37% of the DAH when joint venture catches are included). USA catches during April - November 1984 amounted to 77% of the 1984-85 DAH of 13,500 mt, while DWF catches for this time period were only 13% of that allocated (as of October 1). Significant reductions in the number of DWF vessels fishing for short-finned squid may account for their low catch.

The short-finned squid fishery during the 1984-85 fishing year has reflected the continuing trend toward a primarily domestic fishery. As during the 1983-84 fishing year, most of the catch has been taken by the domestic fleet, but 41% of the domestic harvest during the 1984-85 fishery was attributed to shoreside landings compared to 16% during 1983-84.

The international catch of I. illecebrosus in Canadian waters has decreased sharply each year from the 1979 high of 162,100 mt to 422 mt in 1983. These decreases are due to low availability of short-finned squid in Northwest Atlantic Fisheries Organization (NAFO) Subareas 3 and 4. In spite of these reductions, the annual total allowable catch (TAC) established by NAFO has remained at 150,000 mt since 1980, based on the determination that in only 11 of the last 16 years (1968-83) would this TAC have exceeded 50% of the estimated biomass in Subareas 3 and 4 and in only 6 of the last 16 years would this level have exceeded 90% of the estimated biomass (NAFO 1984).

Catch

The provisional international catch (nominal) off the northeastern USA in 1983 was 11,720 metric tons (mt) (Table 2, Figure 3), a 36% decrease from 1982 and the lowest since 1971. Projected 1984 landings will be about 13,000 mt assuming that the DWF takes the entire remainder of the 1984-85 fishing year allocation during October-December. The provisional 1983 USA catch, taken primarily between July and September, totaled 9,944 mt (Table 2), 68% greater than the 1982 annual total, and about 11 times the 1967-82 mean (since the first reported DWF offshore catches). The 1983 USA catch included about 8,340 mt taken in joint ventures with foreign companies. The USA catch during January - November 1984 (10,410 mt) was greater than in any

previous year. This increase was due to continued joint venture activity which accounted for 6,010 mt in the Mid-Atlantic area, compared with 8,344 mt during all of 1983, and record catches landed at shoreside facilities (4,400 mt). The projected total USA catch for 1984 is about 11,000 mt.

Catches by the DWF, primarily Japan, Spain, and Italy, (Table 2), totaled 1,776 mt (preliminary) in 1983, down 86% from 1982 and the lowest since the directed offshore fishery began in 1972. Catches during January - October 1984 totaled only 600 mt.

Composition of commercial catch

Length frequencies obtained from the USA domestic and joint venture fisheries and the foreign directed fishery during 1984 were examined to determine which cohorts contributed to each fishery. Domestic fishery samples were obtained by NEFC Fishery Statistics personnel from shoreside landings. USA joint venture and foreign directed fishery (DWF) length samples were obtained by NMFS Foreign Fishery Observer Program personnel aboard foreign processing or fishing vessels.

Catch of short-finned squid taken as by-catch in the foreign directed long-finned squid fishery operating in the fishing windows during January - March 1984, was comprised primarily of individuals from the winter 1983 cohort (12-14 cm), with the spring 1982 cohort contributing significantly to the catch during January. The winter 1983 cohort also represented the greatest

portion of the USA catch, both domestic and joint venture, during April - September 1984, ranging in size from about 14 cm in April to 21 cm in September. The foreign directed short-finned squid fishery resumed in August 1984 and the winter 1983 cohort continued to be the dominant cohort in samples available through October, increasing in size from 18 cm in August to 20 cm in October.

BIOMASS AND ABUNDANCE

Minimum biomass and abundance estimates for short-finned squid in USA waters were derived by areal expansion of stratified mean weight and numbers per tow calculated from NEFC autumn bottom trawl survey data (Table 3). 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 area (Figure 4) sampled (in square miles), and a = area swept by each tow (0.011 square miles). These are minimum estimates in that they assume 100% catchability of short-finned squid in the path of the trawl and do not account for individuals which escaped the net or were in the water column above the net opening. This is a significant point for species such as Illex which are not always in contact with the bottom. Actual catchability by the survey trawl is not

known. Another consideration is that the surveys do not cover the entire range of short-finned squid distribution, and that an unknown portion of the stock may be outside the survey area. We assume, however, that the survey provides a consistent estimate in that the stock is distributed similarly during the autumn of each year.

The 1983 minimum biomass and abundance estimates (1,237 mt and 10 million individuals) were 63% and 52% below the 1982 levels and were the lowest since 1969 and 1973, respectively. Substantial decreases in both survey and commercial abundance indices were also observed in Canadian waters in 1981 through 1983 (NAFO 1984).

The 1983 overall abundance index (stratified mean number per tow, Table 3, Figure 5) was the lowest since 1973, and the pre-recruit index (catch per tow of individuals $\leq$10 cm, or about 9 months old) was lowest of the entire time series (since 1968). Pre-recruits represented only 7% of the total abundance, compared with the 1967-82 median of 23%.

Preliminary minimum biomass and abundance estimates for 1984 were about 3 times higher than in 1983 (3,787 mt and 32 million individuals); 75% and 46% below the 1968-83 means. The 1984 pre-recruit abundance index was about double the 1983 value but 76% below the 1968-83 mean, with only about 4% of the 1984 abundance index attributed to individuals $\leq$10 cm (Table 3). Minimum estimated total abundance of pre-recruits (total minimum

abundance times the ratio of pre-recruit to total catch-per-tow, Table 3), was estimated to be 1.4 million individuals in 1984. This is the third lowest level on record, and represents the portion of the stock which will provide the bulk of the catch in 1985.

Estimated minimum pre-recruit abundance during 1968-83 and adult abundance (total minimum abundance - pre-recruit abundance) in the following year (1969-84) were compared using the Spearman rank correleation coefficient (Siegel 1956). The results (for N=16; r =0.44) were significant at the $p < 0.05$ level, indicating that pre-recruit abundance in one year is associated with adult abundance in the following year. However, while years with high recruitment indices tend to be followed by years with high adult abundance indices, some of the highest adult indices have been preceded by very low levels of pre-recruit abundance.

CONCLUSIONS

The short-finned squid fishery has been shifting from a primarily DWF fishery to a predominantly USA fishery since 1982. USA catches in 1982 accounted for 32% of the total. In 1983, USA catches increased to 85% and will approach 95% of the total in 1984. This shift has been associated with management measures which favor joint ventures as they encourage domestic harvest of the product and often provide markets for domestically processed

squitd as part of the joint venture arrangement.

The 1984 autumn survey abundance index (all sizes) from USA waters was about 3 times greater than the 1983 index but about 33% below than the 1968-83 mean. The pre-recruit abundance index in 1984 was double the 1983 value but only about 76% below 1968-83 median and the second lowest since 1973. These pre-recruits will comprise the bulk of the 1985 catch.

The current optimum yield is based on analyses (Sissenwine and Tibbetts 1977) which indicated that over the long-term an annual catch of 42,000 mt would be reasonable, given the stock size estimates available in 1971. Uncertainty in those estimates and in the magnitude of annual fluctuations in population size prompted a reduction in optimum yield to 30,000 mt to protect the stock during years of reduced abundance. Minimum population size estimated from the 1984 autumn survey was about 3 times the comparable estimate for 1971. However, minimum pre-recruit abundance in 1984 was only about one-half the 1971 estimate and the third lowest of the time series. If the NEFC survey estimates are a consistent measure of both relative population size and the relative proportion of pre-recruits to total abundance as seen in the survey, then current abundance may not be adequate to support the present 30,000 mt optimum yield. There is no evidence to indicate, however, that the stock in 1985 will not support a total harvest comparable to that seen in recent years. If DWF allocations remain low, increases of up to 50% in domestic and

joint venture catches could possibly be realized if catch-per-effort remained as in 1984.

DISCUSSION

In assessing the short-finned squid stock off the Northeastern USA we rely primarily on data from the NEFC autumn bottom trawl surveys since the fishery provides no consistant measure of relative status for this stock. The fishery has been under regulation since overall catch quotas were established in 1974; directed foreign catches have been restricted by both allocations and areal and seasonal closures, since 1976. Any changes in catch rates or total catches may be associated with these regulations rather than the abundance or availability of squid. The USA fishery has not been restricted by the regulations, thus far, but has only operated as a directed fishery for about 2 years so there is no time series with which current catches or catch rates may be compared.

The survey data provide a relative measure of the size of incoming year classes but only a minimum estimate of the actual size of those year classes. The surveys cover only a portion of the range of this species and an unknown proportion of the stock may be outside of the survey area during a given survey. Short-finned squid are distributed up into the water column, not always on the bottom, so catchability by the survey gear is not

100% as assumed in the estimates of minimum abundance which were discussed previously.

Short-finned squid are a short-lived species. The year class or cohorts seen in one autumn survey will provide both the spawning biomass and the catch in the following year and during the winter of the next year; only a small proportion will be alive after that. Survey data indicate that there is an association between the number of pre-recruits available in one year and the number of adults available in the next. Therefore, while no estimates of total population size or the effect of fishing on the population are available, changes in survey abundance estimates in conjunction with observed catch levels may be used to suggest what might reasonably be expected to be taken in the fishery in the following year.

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Table 1. Total domestic and distant-water-fleet (DWF) allocations and catches of short-finned squid in the 1983-84 and 1984-85 (preliminary) fisheries (metric tons).

Item	1983-84	1984-85[1]
Optimum yield	30,000	30,000
Domestic annual harvest	27,100	13,500
Initial reserve	2,900	0
Initial TALFF	500	2,250
Final TALFF	2,900	2,250
Final DWF allocation	2,886	2,250
Domestic landings	9,950	10,404
shoreside	1,606	4,394
joint venture	8,344	6,010
DWF catch	408	300

1 Values as of 1 November 1984

Table 2. Annual short-finned squid landings (in metric tons) from the Northwest Atlantic (Cape Hatteras to Gulf of Maine) by the USA and the distant-water-fleet (DWF), 1963-84.

Year	USA	DWF	Total
1963	810	0	810
1964	358	2	360
1965	444	78	522
1966	452	118	570
1967	707	285	992
1968	678	2,593	3,271
1969	562	975	1,537
1970	408	2,418	2,826
1971	455	159	614
1972	472	17,169	17,641
1973	530	18,625	19,155
1974	148	20,480	20,628
1975	107	17,819	17,926
1976	229	24,707	24,936
1977	1,024	23,771	24,795
1978	385	17,310	17,695
1979	1,780	15,742	17,522
1980	349	17,529	17,878
1981	631	14,723	15,354
1982	5,902	12,350	18,252
1983	9,944	1,776	11,720
1984[1]	10,410	600	11,010
1968-82 mean	911	13,758	14,669

1 Preliminary, though November 1984.

Table 3. Short-finned squid biomass and abundance indices and minimum estimates from survey catch per tow data, including pre-recruit abundance, 1968-84.

Year	No. per tow[1] total	p.r.	Pre-recruit[2] ratio	Abundance[3] total	p.r.	Biomass[3] (MT)
1968	2.3	0.6	0.26	10	2.6	1,845
1969	0.8	0.3	0.38	4	1.5	419
1970	3.4	0.2	0.06	15	0.9	1,524
1971	1.9	0.6	0.32	10	3.2	2,024
1972	3.5	1.8	0.51	15	7.7	1,716
1973	1.3	0.3	0.23	8	1.8	1,862
1974	3.0	2.1	0.70	18	12.6	2,500
1975	12.4	9.6	0.77	60	46.5	8,306
1976	28.7	0.6	0.02	134	2.8	42,929
1977	15.8	1.1	0.07	73	5.1	21,747
1978	28.4	5.1	0.18	121	21.7	26,435
1979	32.1	2.6	0.08	144	11.7	41,455
1980	17.0	0.7	0.04	80	3.3	18,729
1981	54.8	0.5	0.01	219	2.0	68,611
1982	4.3	1.0	0.23	21	4.9	3,319
1983	2.8	0.2	0.07	10	0.7	1,237
1984	8.9	0.4	0.04	32	1.4	3,787
1968-83 mean	13.3	1.7		59	8.1	15,291

1 Stratified mean number per tow of all size individuals (total) and of pre-recruits (p.r., $\leq$10 cm), Mid-Atlantic to Georges Bank.

2 Ratio of pre-recruit to total mean numbers per tow.

3 From areal expansion of stratified mean numbers and weights per tow, summed over strata sets. Pre-recruits estimated by multiplying total minimum abundance estimate by ratio (2).

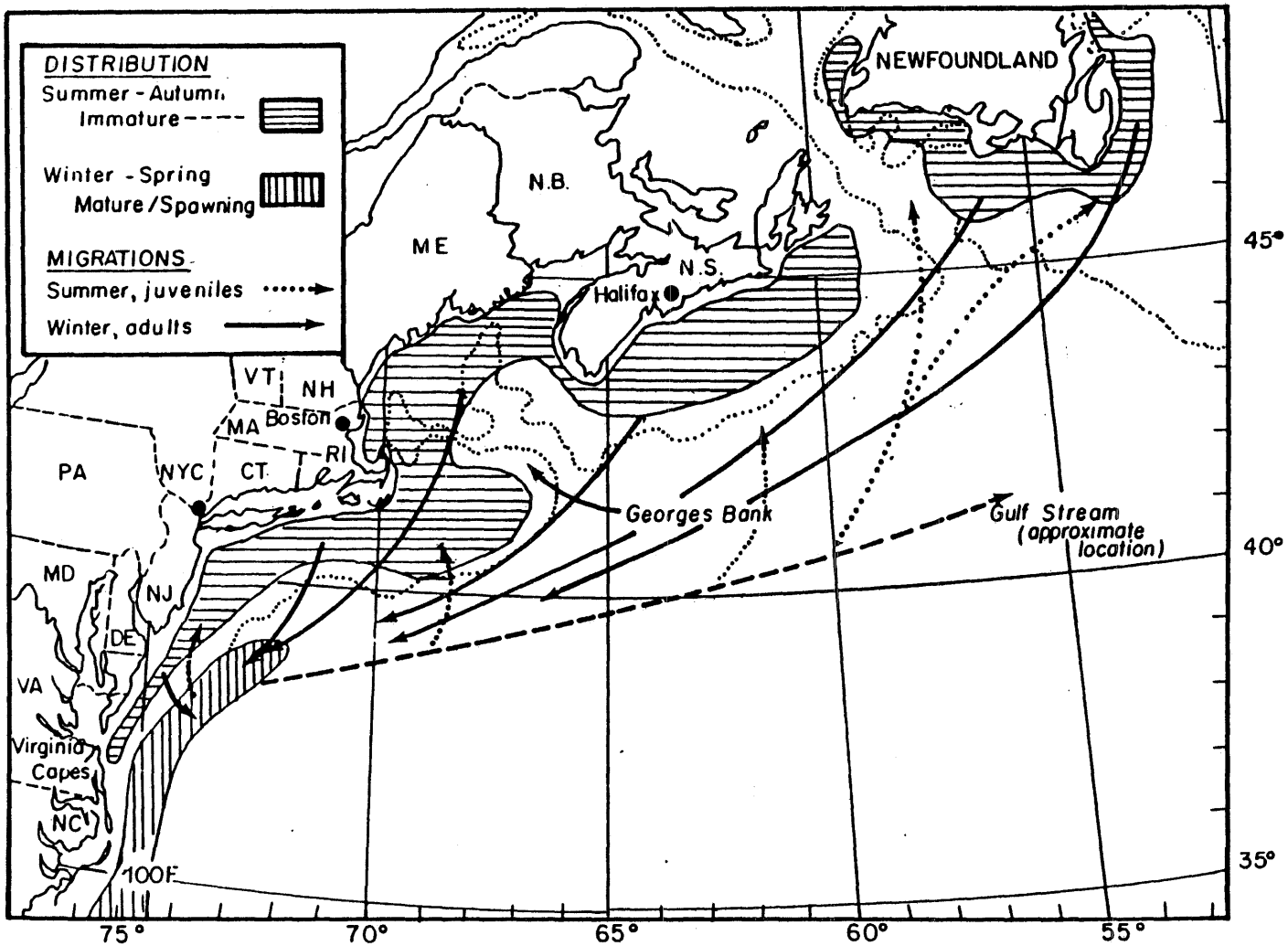

Figure 1. Migration patterns of the short-finned squid (Illex illecebrosus), including inshore feeding and offshore spawning locations.

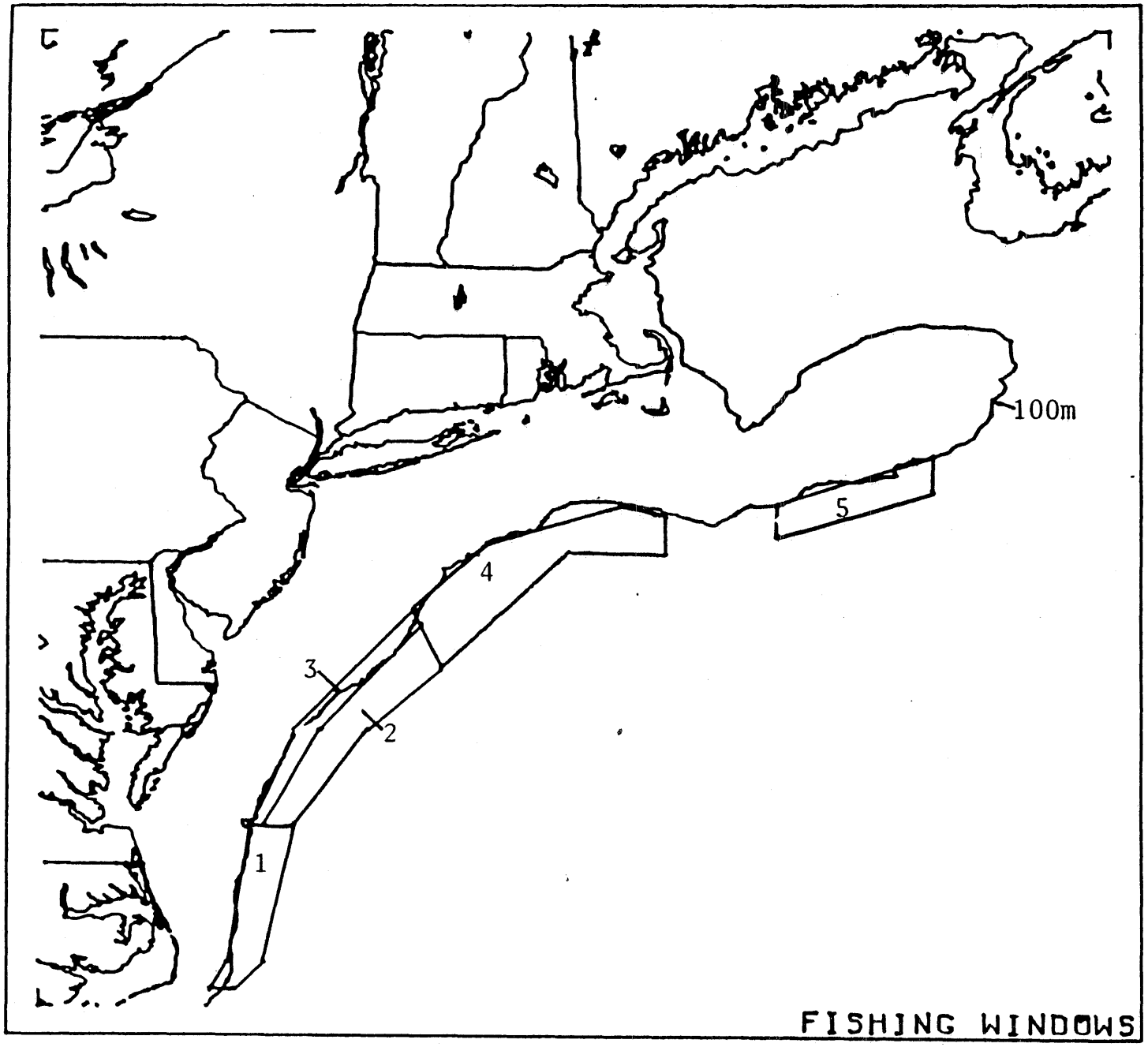

Figure 2. Areas of the Northwest Atlantic, off the USA, which are open to foreign fishing during authorized fishing seasons.

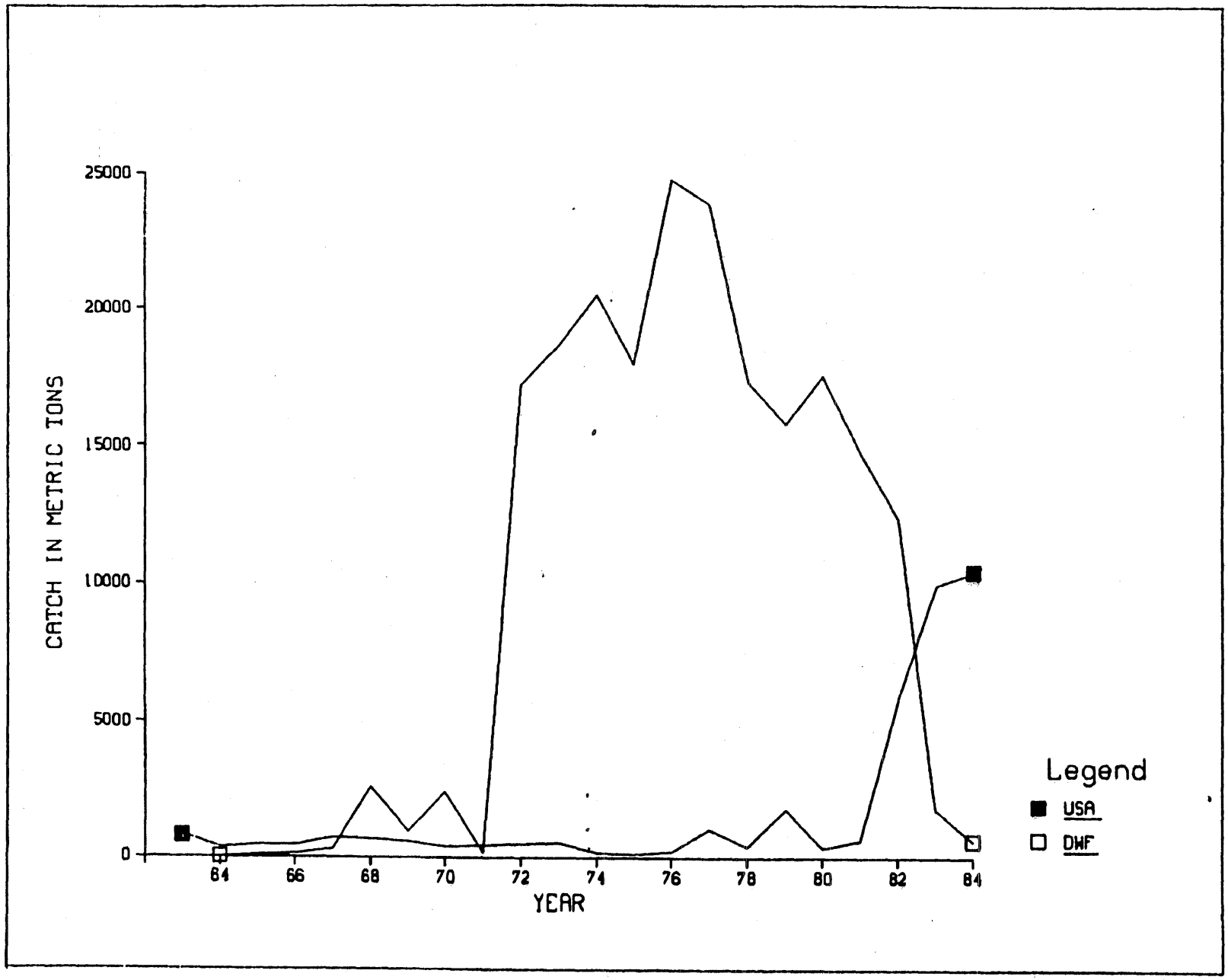

Figure 3. Short-finned squid catches from the waters off the Northeastern USA, Cape Hatteras to the Gulf of Maine, by the USA and the distant-water-fleet (DWF), 1963-84.

A

B

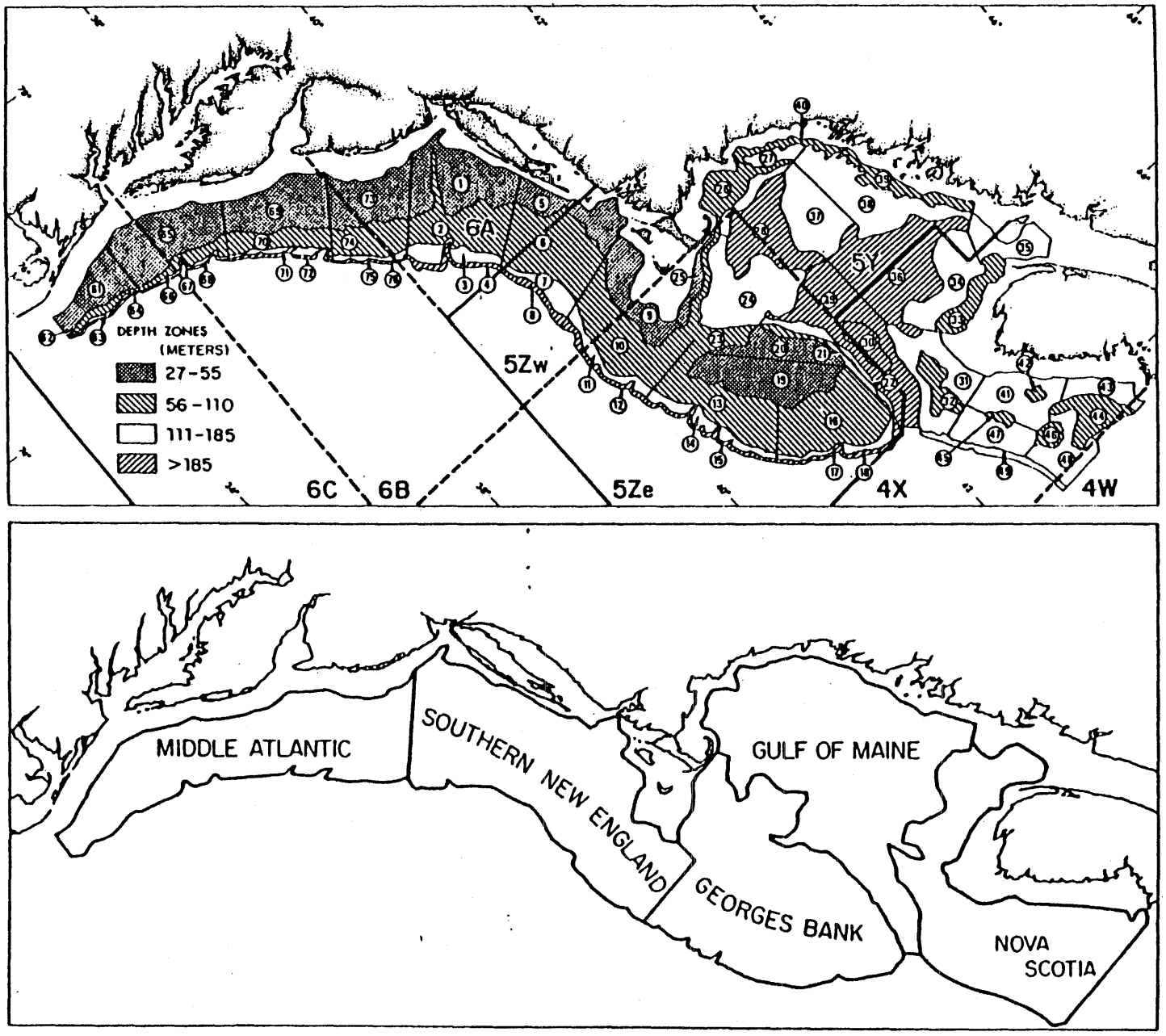

Figure 4. A. USA bottom trawl survey strata and NAFO Subareas 4-6.
B. Geographical areas off the Northeast coast of the United States.

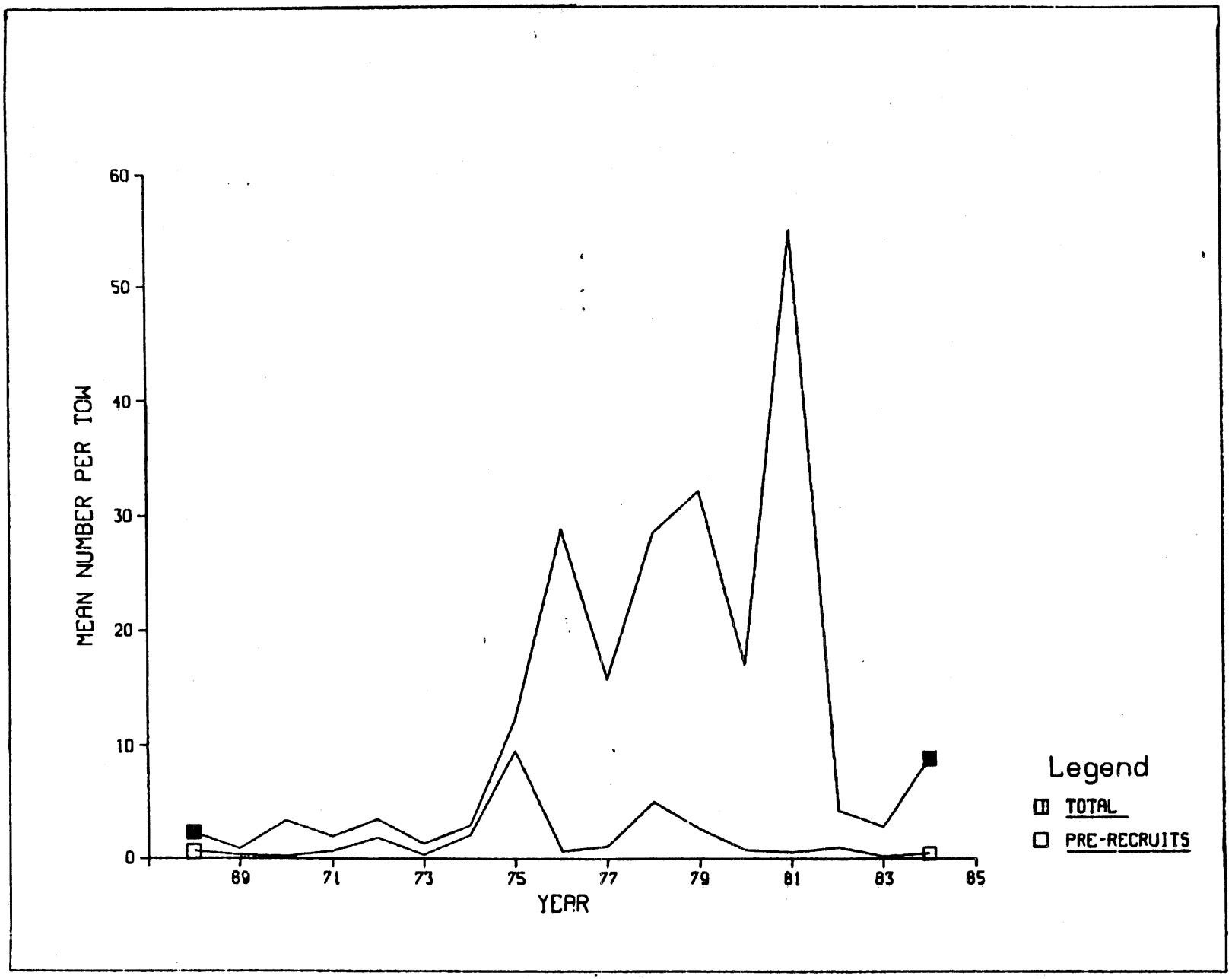

Figure 5. Short-finned squid total and pre-recruit abundance indices (stratified mean number per tow) from USA autumn surveys in the Mid-Atlantic through Georges Bank areas (strata 1-25; 61-76).