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STATUS OF THE SQUID (*LOLIGO PEALEI* AND *ILLEX ILLECEBROSUS*) POPULATIONS OFF THE NORTHEASTERN USA

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by

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Summary

Research survey biomass and abundance estimates and commercial catches for squid, *Loligo pealei* and *Illex illecebrosus*, off the Northeastern USA are updated for 1981. Foreign catches of *I. illecebrosus* were the lowest since the directed fishery began in 1972, while domestic catches were significantly greater than in most years since 1967. Population size estimates for *I. illecebrosus* (primarily the 1980 year class) were the highest of the 1968-81 time series. If average spawning success by the large 1980 year class is assumed to have occurred during January-March 1982, recruitment of *I. illecebrosus* during the summer of 1983 should be well above average.

Total catches of *L. pealei* in 1981 were far below historic (1968-80) levels. *Loligo pealei* population estimates, dominated by the 1981 year class, were comparable to the 1968-80 mean, but well below the high 1980 level. However, abundance should have been sufficient to provide a level of recruitment above the 1.5 billion individuals estimated to be needed to support an annual catch of 44,000 tons, in 1982.

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Introduction

This document updates information regarding the status of the *Loligo pealei* and *Illex illecebrosus* squid stocks (Lange 1981) in the area from the Mid-Atlantic to the Gulf of Maine. Information presented includes catch and length frequency data from the 1981 USA and foreign fisheries, and minimum biomass and abundance estimates and pre-recruit abundance indices for 1981 from NEFC autumn bottom trawl survey data.

Illex illecebrosus

Biology

Illex illecebrosus, the short-finned or summer squid, is generally distributed between Newfoundland and Florida, with fishable concentrations 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 *I. illecebrosus* begin an offshore migration to the edge of and beyond the continental shelf where they spawn during the winter.

Illex illecebrosus is a short lived species which is assumed to die after spawning, at about 12-24 months.

The relationship between *I. illecebrosus* located off the USA coast and those off the Canadian coast has not been fully determined, although there is strong evidence that these squid may represent two components of a single stock (Dawe et al. 1982). If this is the case, the status of *I. illecebrosus* in Canadian waters should be considered in any assessment of this species in USA waters.

Commercial Catch

Provisional 1981 USA *I. illecebrosus* catches taken primarily between July and September, totaled 631 metric tons (Table 1), representing an 81% increase from 1980 and a 24% increase from the 1967-80 average (since the first reported foreign offshore squid catches). USA catches of *I. illecebrosus* during January-June 1982 were much greater than those for the same period in 1981, amounting to 984 tons (vs 1 ton in 1981). This improvement is due to the development of a summer fishery for this species in the Mid-Atlantic area.

Catches of *I. illecebrosus* by Japan, Italy, and Spain (Table 1) totaled 14,723 tons in 1981, the lowest since the directed offshore *I. illecebrosus* fishery began

in 1972. This fishery takes place primarily between July and October.

The international catch of *I. illecebrosus* in Canadian waters continued to decrease from the 1979 high of 153,100 tons to 69,000 tons in 1980 and to 32,500 tons in 1981, although the total allowable catch (TAC) has remained at 150,000 tons annually.

Management

The squid stocks in USA waters are currently managed on an April 1 - March 31 fishing year. Domestic and foreign allocations and catches for both *I. illecebrosus* and *L. pealei* for the 1981-82 fishing year are presented in Table 2. Sixty-one percent of the final total allowable level of foreign fishing (TALFF) and 12% of the domestic annual harvest (DAH) for *I. illecebrosus* were taken during the 1981-82 fishing year. However, allocations of reserve amounts to the foreign fleet late in the fishing year (1 October) are reflected in the final TALFF. Catches may have been higher had reserve amounts been allocated at the start of the fishing year, since the initial TALFF may have been restrictive for some countries. In fact, total *I. illecebrosus* catches by Japan, Italy, and Spain in USA waters were 96% greater than their initial allocations, and catches during January-March

1982 were greater than from the same period in most years.

Length Frequency of Commercial Catch

Length frequencies collected by USA observers in 1981 from the distant water fleet fisheries indicated a single mode representing the 1980 year class for most of the monthly *I. illecebrosus* length frequency distributions. A general increase in modal length from about 20 to 23 cm. (8-9 in) occurred between July and November. In December, this mode increased to 25 cm (10 in), while a second mode at 14 cm (5 in) was also apparent, indicating recruitment of the 1981 year class. This second mode was most apparent in Areas 3 and 4 (Figure 2) and in the catches of Spain and Italy. The individuals of the larger mode (25 cm; 10 in., 19-23 months of age) probably made up the bulk of the spawning stock in the winter-spring of 1982.

Length frequencies pooled over all vessels from the 1981 USA summer-autumn fishery for *I. illecebrosus* conducted in the Gulf of Maine were also examined. As in the offshore fishery, there was a single mode throughout this time period reflecting the growth of the 1980 year class from about 20 cm (8 in; 18 months) in August to over 26 cm in October.

Biomass and Abundance

Minimum biomass and abundance estimates for *I. illecebrosus* in the 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 (Figure 1) area sampled (in square miles), and a = area swept by each tow (0.011 square miles). Diel differences in availability of *I. illecebrosus* to bottom trawl gear have been observed, but were not found to be significant (Sissenwine and Bowman 1978) and were therefore not used here. The 1981 estimates for the USA waters (68,611 tons and 219 million individuals) were the highest observed during the available time series (1968 to present) while substantial decreases in both survey and commercial abundance indices were observed in Canádian waters (NAFO 1982). Biomass was 2.3 times and abundance 2.0 times the 1976-80 average (years when abundance was above historic levels). The increase in abundance in USA waters may be attributable, at least in part, to relatively late (spring vs

winter) spawning in 1980 (Lange 1981), which in turn resulted in later recruitment to the offshore fishery and subsequent lower fishing mortality than in most years. Late spawning in 1980 is further demonstrated by the size composition seen in the 1981 autumn survey, where over 99% of the *I. illecebrosus* caught were greater than 10 cm (4 in.) compared to an average of 84% for that size range during 1973-80 (Table 4). Late spawning may also account for the decrease in abundance in Canadian waters. If a single stock ranges between USA and Canadian waters, environmental conditions during the time larvae would normally be transported northeast may have precluded transport to Canadian waters.

Abundance of pre-recruits ($\leq$10 cm and less than 9 months old) in USA waters continued the decline observed since 1978 with those spawned in 1981 less abundant than the 1967-80 mean (Table 4). Although pre-recruit abundance is probably related to subsequent recruitment, available data does not confirm this. Years with high levels of recruitment tend to be followed by years with high adult abundance, but some of the highest adult indices have been preceded by very low levels of pre-recruit abundance.

Conclusion

The autumn 1981 *I. illecebrosus* survey abundance

index (all sizes) from USA waters was the highest on record, while the number of pre-recruits continued to decline from the 1978 level to below the 1967-80 mean. The great number of adults from the 1980 year class, observed during the 1981 autumn survey, should have resulted in substantial spawning activity during January-March 1982. The 1982 year class should first appear in the fishery in the autumn of 1982 and the winter of 1983 and may result in increased recruitment to the fishery in the summer of 1983.

Restrictions imposed by initial 1981 allocations from TALFF may have accounted, in part, for the low catches of *I. illecebrosus* by the distant water fleet in 1981 (the lowest since 1972). The relative importance of the winter (1980) versus spring (1980) cohort may also have contributed to later recruitment to the fishery in 1981 (Lange 1981).

Although the total catch of *I. illecebrosus* during 1981 was about the lowest seen since the initiation of the directed fishery, foreign catches during the first three months of 1982 were comparable to those for the same period in most previous years. Domestic catches during January-June 1982 were well above past levels. Based on the 1981 autumn research survey abundance estimates and length compositions, a strong year class was produced in early 1982. This year class should be fully recruited during the 1983-84 fishing year.

Loligo pealei

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. *Loligo pealei* undergo seasonal migrations to shallow inshore waters from southern Cape Cod to the Chesapeake Bay in spring and summer to spawn. In late autumn they move offshore to overwinter along the edge of the continental shelf. Like *I. illecebrosus*, *L. pealei* is a short-lived species which is assumed to die after spawning at about 18-36 months of age.

Commercial Catch

Provisional 1981 USA *L. pealei* catches taken primarily between May and September, totaled 2,316 tons (Table 1), representing a 42% decrease from 1980 but a 36% increase from the 1967-80 average. USA catches of *L. pealei* during January-June 1982 were greater than those for the same period in 1981, totaling 1,724 tons (vs 1,558 tons in 1981).

Catches of *L. pealei* by Japan, Italy, and Spain

(Table 1) during 1981 totaled 13,566 tons, representing a 14% decrease from 1980 and a 25% decrease from the 1967-80 mean.

Management

Fifty percent of the final *L. pealei* TALFF and 40% of the DAH were taken during the 1981-82 fishing year (Table 2). Although allocations of reserve amounts were made late in the fishing year, these allocations occurred on November 1, prior to the main fishery (December-February) and, therefore, had less effect on the fishery than noted for *I. illecebrosus*. Final catches of *L. pealei* by the directed fisheries of Japan, Italy, and Spain were 8% greater than initial allocations for those countries.

Length Frequency of Commercial Catch

Length frequency distributions from the distant water fleet fishery in 1981 were skewed toward the lower length groups with a predominant mode in each month between 7 and 11 cm (3 and 4 in). This mode represented recruitment and growth of the 1980 year class during January-March 1981. By August, individuals of the 1980 year class had grown to over 18 cm (7 in.). The 1981 year class was recruited and made up the 7-11 cm mode during August-December 1981. Although additional

modes were not obvious except in March (29 cm; 11 in, 1979 year class), the long tails of these length distributions in 1981 (between 18 and 35 cm; 7-14 in) represented a mixture of the 1980 and 1979 year classes.

Length frequencies were also available for the 1981 USA domestic fisheries for *L. pealei*. In general, *L. pealei* taken in the inshore domestic fishery were larger than those taken offshore since the domestic fishery is directed primarily at concentrations of spawning adults. Large adults (16-22 cm; 6-9 in) from the 1980 year class moved inshore to spawn during the early part of the year (through May). As smaller individuals from the 1980 year class (probably spawned late in the summer) moved inshore in the summer of 1981, a second mode (7-11 cm; 3-4 in) was observed (June - September). Partial recruitment of the 1981 year class was demonstrated by catches of 6 to 14 cm (2 to 5 in.) individuals in November - December of 1981.

Biomass and Abundance

Minimum biomass and abundance estimates for *L. pealei* were calculated, as described for *I. illecebrosus*, from the NEFC autumn research survey (Table 3). *Loligo pealei* 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 represent mostly pre-recruits which will grow considerably in weight by the time they enter to the fishery in January-March. The 1981 minimum biomass estimate for L. pealei was 24,345 tons (Table 3), 29% less than the 1980 level and 25% below the 1968-80 mean. The minimum abundance estimate for this species in 1981 of 3.4 billion individuals (Table 3) was 63% less than the record high in 1980 (9.3 billion) but equal to the 1968-80 average. The proportion of this abundance, by number, comprised of pre-recruits of the current year's year class ($\leq$8 cm) continued to decline from 77% in 1980 to 72% in 1981, compared to the average percentage during 1967-80 of 87% (Table 4). Although this reduced proportion may have indicated lower recruitment of L. pealei to the 1982 fishery than seen in recent years, recruitment should have remained above 1.5 billion individuals, which is the minimum assumed necessary to support an annual catch of 44,000 tons (Lange and Sissenwine 1980). 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

effect the relationship of the abundance estimates from the autumn surveys and availability of *L. pealei* at the onset of the fishery three months later.

Conclusion

The downward trend in *L. pealei* abundance since 1975, stopped in 1980 with record high estimates of numbers of individuals, and the abundance was at the 1968-80 mean level, in 1981. The decline in the proportion of pre-recruits in the autumn of 1981 may have indicated a subsequent decline in recruitment to the 1982 fishery, as noted in the January-March 1982 catches in the offshore fishery. This reduced abundance was not substantial enough to lower recruitment below the 1.5 billion individuals necessary to support an annual catch of 44,000 tons in 1982. Indications from the 1982 domestic fishery are that peak spawning of *L. pealei* may have occurred in late summer. This may result in a relatively high yield per recruit for the USA fishery in the spring of 1983 as the bulk of the year class will not be susceptible to the winter 1982-83 foreign fishery.

Total *L. pealei* catches during 1981 were also below recent levels and while survey abundance estimates were far less than seen in 1980, they were comparable to the 1968-80

mean. Recruitment during the 1982-83 fishing year should be sufficient to support catches at the OY level established in the FMP (44,000 tons).

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Table 1. Annual squid (*L. pealei* and *I. illecebrosus*) catches (in metric tons) from the Northwest Atlantic (Cape Hatteras to Gulf of Maine), by the USA and the distant water fleet (DWF), 1963-1981.

	L. pealei			*I. illecebrosus*		
Year	USA	DWF	Total	USA	DWF	Total
1963	1,294	0	1,294	810	0	810
1964	576	2	578	358	2	360
1965	709	99	808	444	78	522
1966	722	226	948	452	118	570
1967	547	1,130	1,677	707	285	992
1968	1,084	2,327	3,411	678	2,593	3,271
1969	899	8,643	9,542	562	975	1,537
1970	653	16,732	17,385	408	2,418	2,826
1971	727	17,442	18,169	455	159	614
1972	725	29,009	29,734	472	17,169	17,641
1973	1,105	36,508	37,613	530	18,625	19,155
1974	2,274	32,576	34,850	148	20,480	20,628
1975	1,621	32,180	33,801	107	17,819	17,926
1976	3,602	21,682	25,284	229	24,707	24,936
1977	1,088	15,586	16,674	1,024	23,771	24,795
1978	1,291	9,355	10,646	385	17,310	17,695
1979	4,252	13,068	17,320	1,780	15,742	17,522
1980	3,996	19,750	23,746	349	17,529	17,878
1981[1]	2,316	13,566	15,882	631	14,723	15,354

1) Provisional

Table 2. Total domestic and foreign allocations and catches of *Loligo pealei* and *Illex illecebrosus* squid in the 1981-82 fishery (metric tons).

Item	*Loligo pealei*	*Illex illecebrosus*
Optimum Yield	44,000	30,000
Domestic Annual Harvest	7,000	5,000
Reserve	19,000	13,000
Initial TALFF (1)	18,000	12,000
Final TALFF	26,668	24,424
Domestic catch	2,767	598
Foreign catch	13,454	14,982

1) Total Allowable Level of Foreign Fishing applies to all foreign countries, while only Japan, Italy, and Spain actually participated in the fishery. Initial TALFF for these three countries were 12,520 for *L. pealei* and 7,632 for *I. illecebrosus*.

Table 3. *Loligo pealei* and *Illex illecebrosus* minimum biomass (metric tons) and abundance (in millions) estimates (1) for the Mid-Atlantic to Gulf of Maine, 1968-1981.

	Loligo pealei		*Illex illecebrosus*	
Year	Biomass	Abundance	Biomass	Abundance
1968	29,114	1,212	1,845	10
1969	48,055	2,393	419	4
1970	19,640	1,946	1,524	15
1971	14,050	1,106	2,024	10
1972	21,039	1,533	1,716	15
1973	44,252	3,092	1,862	8
1974	46,442	4,757	2,500	18
1975	48,636	7,789	8,306	60
1976	51,436	4,372	42,929	134
1977	27,421	3,157	21,747	73
1978	18,800	1,251	26,435	121
1979	19,333	2,114	41,455	144
1980	34,275	9,314	18,729	80
1981	24,345	3,411	68,611	219

1) From areal expansion of stratified mean weights (kg) and numbers per tow, by strata set. For *L. pealei* night-time catch data were expanded to account for diel diferences in catch (Sissenwine and Bowman 1978).

Table 4. Total abundance and pre-recruit indices (1) of *Loligo pealei* and *Illex illecebrosus* squid, 1967-81.

	Loligo pealei		*Illex illecebrosus*	
Year	All Sizes	≤ 8 cm	All Sizes	≤ 10 cm
1967	134.5	126.9	2.1	0.7
1968	176.5	159.9	2.3	0.6
1969	237.3	217.4	0.8	0.3
1970	85.6	79.3	3.4	0.2
1971	163.3	161.5	1.9	0.6
1972	271.4	258.5	3.5	1.8
1973	372.0	353.9	1.3	0.3
1974	251.7	233.3	3.0	2.1
1975	614.4	593.3	12.4	9.6
1976	410.9	302.5	28.7	0.6
1977	388.5	297.7	15.8	1.1
1978	144.2	93.4	28.4	5.1
1979	193.7	156.5	32.1	2.6
1980	364.1	279.8	17.0	0.7
1981	226.2	161.8	54.8	0.5

1) Stratified mean number per tow of all sizes and of *L. pealei* ≤ 8 cm and *I. illecebrosus* ≤ 10 cm mantle length from autumn bottom trawl surveys, Mid-Atlantic to Georges Bank.

A

B

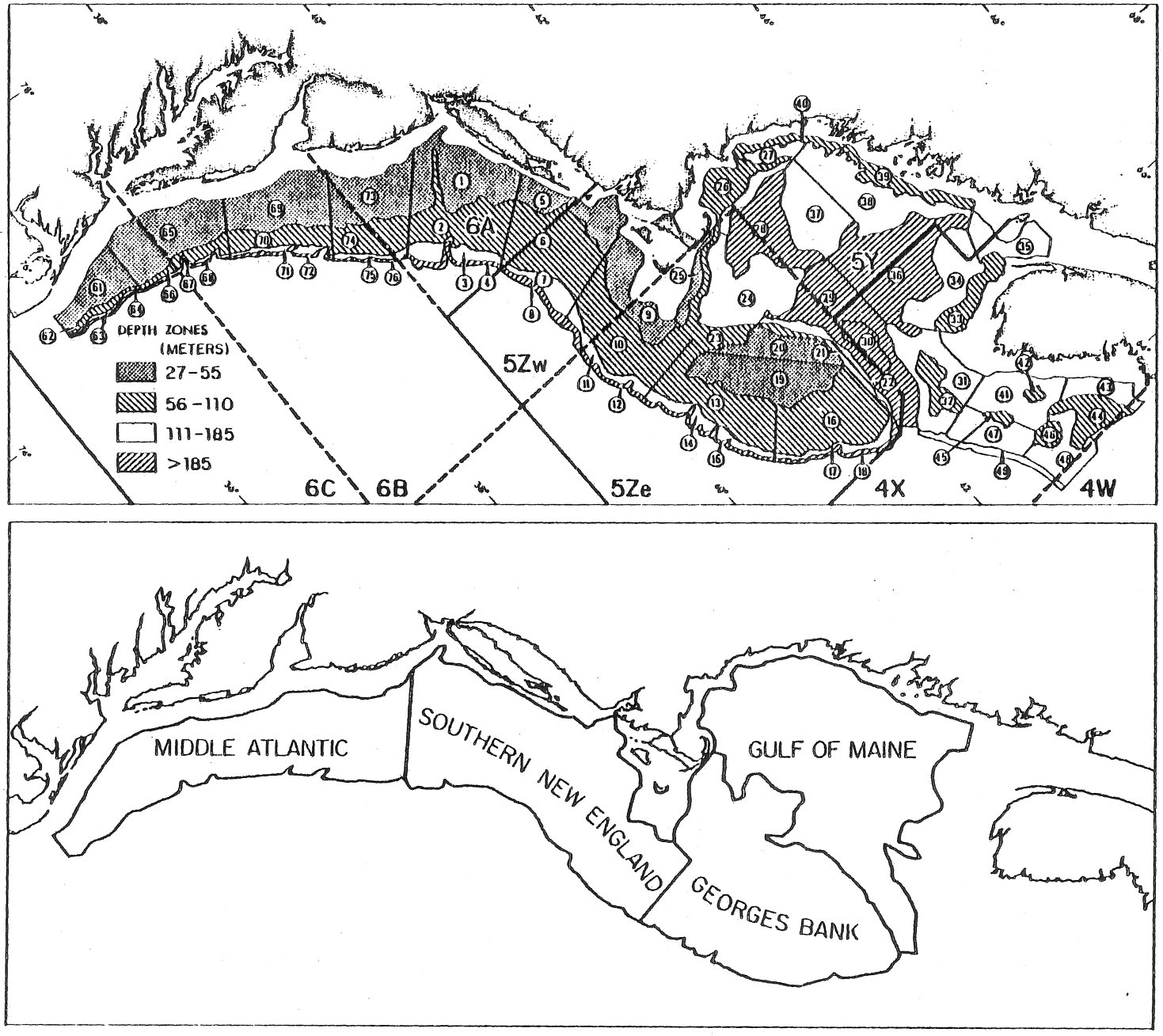

Figure 1. A. USA bottom trawl survey strata and NAFO Subareas 4-6.
B. Geographical areas off the Northeast coast of the United States.

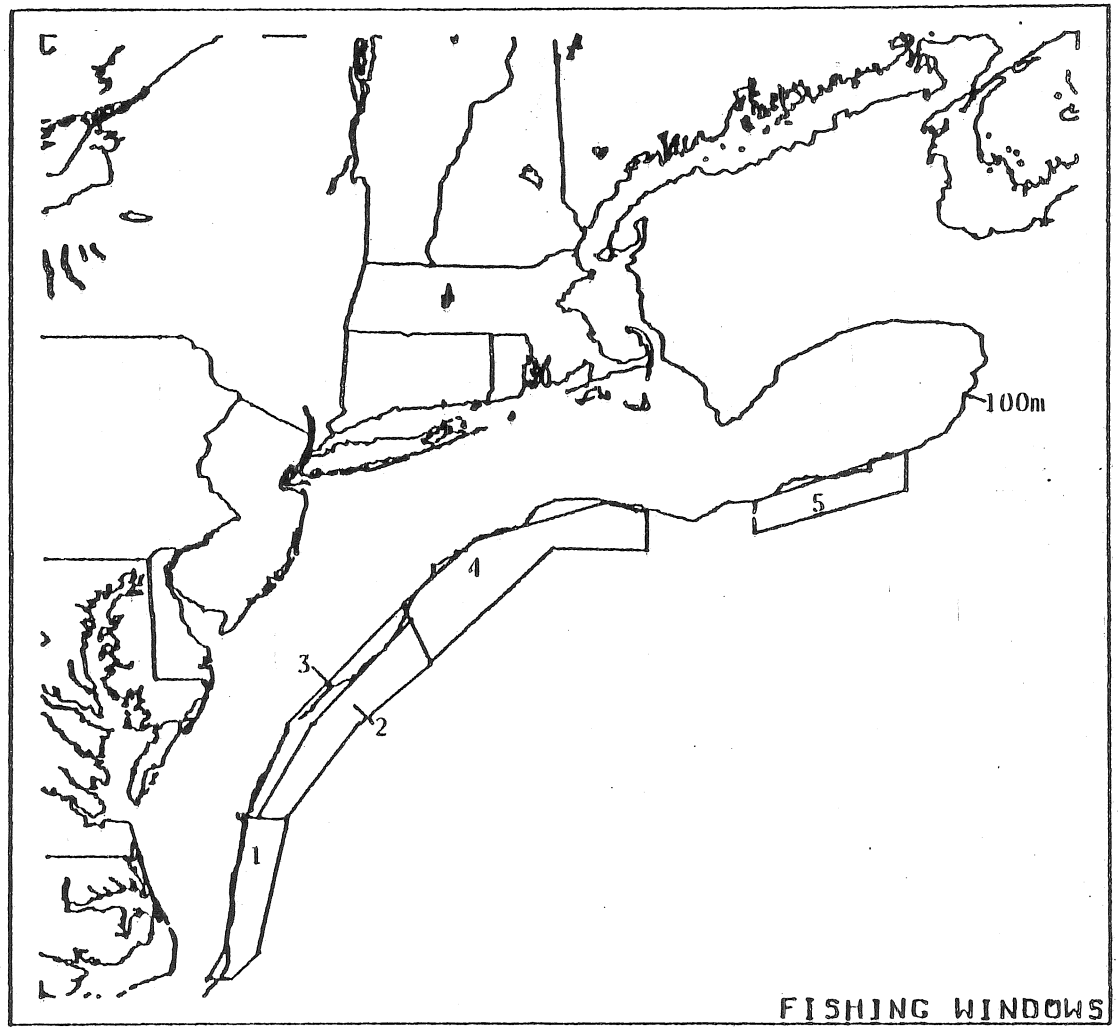

Figure 2. Areas of the Northwest Atlantic designated for foreign fishing.