

The Foreign Squid Fishery Off the Northeast United States Coast

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Introduction

Squid has long been a popular food fish in the foreign market and thus a highly sought marine resource by the foreign fishing fleet. Foreign vessels began reporting incidental catches of squid off the northeast U.S. coast in 1964, with directed fisheries starting in 1968. During the past 5 years, the foreign fleet has taken an average of 50,000 metric tons (t) of squid per year. The 1978 optimum yield of squid has been set at 79,000 t (29,000 t of *Illex*, short-finned squid, and 19,000 t of *Loligo*, long-finned squid, foreign allocation). This leaves 31,000 t of squid for exploitation by the U.S. fishing industry.

A great deal of interest has been generated in the New England and Middle Atlantic area for the development of a domestic squid fishery. The New England Fisheries Development Program (1977) Report of Progress for 1977 outlined the problems of developing a domestic squid fishery. One problem was the limited experience by U.S. fishermen in capturing squid. The following is a presentation of the foreign squid fishery off the northeastern U.S. coast. The objective of these observations is to increase the awareness of foreign squid fishing practices and to abet the development of a domestic squid fishery along the eastern U.S. coast.

Methods

The Fishery Conservation and Management Act (FCMA) of 1976 (U.S. Department of Commerce, 1977a), commonly referred to as the 200-mile limit, took effect on 1 March

1977. This act establishes exclusive fishery management authority for the United States within the sea adjoining territorial waters and extending offshore some 197 miles.

One of the regulations issued under the FCMA requires that each foreign vessel fishing within the U.S. 200-mile limit maintain a detailed daily log of its operations. As a check of the accuracy and completeness of this information, the United States is authorized to place a fishery observer aboard each foreign vessel.

Usually the observer is placed on board for a 2- to 3-week period. During this time he will monitor the compliance of the vessel with U.S. fishery regulations and take biological samples. The total costs of placing an observer aboard foreign vessels are borne by the owners and operators of these vessels. When the observer completes his assigned tasks for the day or the vessel suspends fishing operations, many hours are spent in conversing with the ship's captain and crew. It is through these informal conversations that one becomes familiar with vessel operations and captains' views on squid fishing.

In addition to observer-generated data, information pertaining to the characteristics of foreign fishing vessels was obtained from the required vessel permit forms. Data provided by U.S. Coast Guard surveillance operations

were used to determine the seasonal fishing vessel concentrations. Catch and effort data were gathered from the biweekly and weekly catch reports required of each vessel.

Historical Background

United States fishermen have been landing squid on its northeast coast since the 1880's. According to Lyles (1968), most squid have been taken incidental to fishing for other species. These catches were and still are primarily taken on inshore grounds. In the earlier fishery, otter trawls and fish traps were the principal harvesting gear, but with the declining trap fishery, otter trawls have become the dominant capture gear.

The American fishermen have yet to exploit the offshore squid stocks. Probable cause for this is the lack of a substantial domestic market. In fact squid were thrown out on the farm fields as fertilizer or used for bait in the early 1900's. Even today a good portion of the squid landings is used for bait. With landing restrictions being placed on cod, haddock, and other finfish, fishermen are now considering the development of a directed squid fishery.

Documentation of U.S. squid landings prior to 1928 is sparse. As typical in any fishery, the landings and ex-vessel value fluctuate from year to year. However, the squid fishery has shown a general increase in value over the past 5 years (Table 1). From New England waters in 1976, 6.2 million pounds were harvested and were valued at \$1.1 million (New England Fisheries Development Program, 1977).

In 1958 Soviet research vessels began

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Table 1.—Northeast United States commercial landings of squid, 1928-77¹ in thousands of pounds and thousands of dollars.

Year	Quantity	Value	Year	Quantity	Value
1928	² 7,927	² 157	1953	5,619	281
1929	6,731	170	1954	3,619	152
1930	7,505	175	1955	4,135	178
1931	5,415	116	1956	3,047	169
1932	5,634	83	1957	6,012	240
1933	2,012	38	1958	4,333	204
1934	² 114	² 4	1959	3,644	226
1935	6,256	129	1960	3,602	263
1936	² 122	² 4	1961	3,336	250
1937	5,833	111	1962	4,734	295
1938	4,563	66	1963	4,642	280
1939	6,142	123	1964	2,175	167
1940	4,673	76	1965	2,522	193
1941	² 283	² 4	1966	2,606	217
1942	2,003	103	1967	3,795	216
1943	² 132	² 168	1968	3,666	236
1944	2,021	159	1969	3,224	313
1945	3,402	207	1970	2,283	280
1946	² 1,186	² 66	1971	2,705	354
1947	2,482	163	1972	2,888	427
1948	4,555	349	1973	3,862	764
1949	6,924	225	1974	5,325	987
1950	2,435	123	1975	³ 3,602	³ 390
1951	5,595	275	1976	³ 3,381	³ 1,549
			1977	³ 5,337	³ 1,390

¹Adapted from Lyles (1968) for 1928-1967 and National Marine Fisheries Service (1971-77 1976-78).

²Partial totals.

³Preliminary totals.

making exploratory cruises to investigate the possibility of a directed squid fishery off the northeastern U.S. coast (Ucinski, 1973). The actual exploitation of squid did not begin until 1964 when the U.S.S.R. reported taking 4 t of squid as incidental catch. The Soviets remained the only foreign national fishing squid off our coast until 1967 when they were joined by the Japanese. In 1969 Spain entered the fishery, and was joined by Poland and Italy in 1972. These five countries became the major harvesters of squid off our northeast coast, with Spain and Japan being dominant. Bulgaria, Canada, Cuba, the Federal Republic of Germany, the German Democratic Republic, Ireland, and Romania have also reported taking smaller amounts of squid (Table 2).

Loligo is the preferred squid over *Illex* because of its better taste and

texture qualities. This is reflected by the greater catches of *Loligo* over *Illex* by foreign vessels (Tables 3, 4). Also, *Loligo* brings two to three times the price of *Illex* on the foreign market.

Foreign Vessels

In 1977 (after 1 July), 95 vessels representing 5 foreign nations were engaged in the squid fishery off the northeast U.S. coast. All but 10 of these vessels were stern trawlers, with Spain being the only country to use side trawlers. The Japanese had the oldest vessels working here, which were 18 years of age, while Spain and Italy added some newer vessels. Figures 1 through 5 depict the design of fishing vessels used by certain countries. Poland had the largest vessel in the fleet measuring 285 feet (87 m) long, while a Soviet BMRT had a gross tonnage of 3,697 t. Spain had the smallest vessel, being 112 feet (34 m) long. The Soviet Union was the only nation to have women aboard their vessels, and they comprised 10 percent of the crew on a BMRT class vessel. Characteristics for each type of foreign fishing vessel mentioned in this section are given in Table 5.

Trawl Gear

Trawl gear used in the squid fishery off the northeast U.S. coast varied as the national background of the fishermen themselves. Documentation of the exact types of nets used has been

Table 2.—Reported squid (no species) landings in metric tons off the northeastern U.S. coast¹.

Year	Spain	Italy	Japan	U.S.S.R.	Poland	U.S.A.	Other	Total
1963						2,111		2,111
1964				4		989		993
1965				176		1,161		1,337
1966				389		1,173		1,562
1967			7	833		1,829		2,669
1968			1,734	3,176		1,762	10	6,682
1969	566		7,711	1,340		1,461	1	11,079
1970	4,426		13,639	1,065		1,061	20	20,211
1971	6,770		10,602	6,138		1,182	91	24,783
1972	10,545	3,200	18,691	6,976	5,428	1,197	1,338	47,375
1973	14,932	3,165	15,526	8,977	9,199	1,635	3,334	56,768
1974	16,144	4,260	16,820	8,495	6,709	2,422	628	55,478
1975	9,902	4,234	13,985	8,928	6,836	1,728	6,074	51,687
1976	13,200	4,421	8,285	7,644	6,756	3,831	6,083	50,220
1977	13,438	4,183	12,734	8,010	888	2,553	² 102	41,908

¹As reported to ICNAF (1966-1977, 1978a, b).

²Taken prior to 1 July 1977

Table 3.—Reported *Loligo* landings in metric tons off the northeastern U.S. coast¹.

Year	Spain	Italy	Japan	U.S.S.R.	Poland	U.S.A.	Other
1963				² (4)		² (2,110)	
1964				² (4)		(989)	
1965				(176)		(1,161)	
1966				(389)		(1,173)	
1967			5	(833)		(1,829)	
1968			177	(3,176)		(1,762)	
1969	438		7,125	(1,340)		(1,461)	
1970	2,790		13,250	(1,065)		653	
1971	3,446		10,426	(6,138)		727	10
1972	5,667	2,000	16,293	(6,976)	164	725	837
1973	11,148	2,360	14,459	(8,977)	911	1,105	2,630
1974	9,375	3,280	13,493	(8,495)	1,706	2,274	202
1975	7,698	3,390	10,748	(8,928)	3,785	1,621	1,767
1976	9,137	3,304	5,029	832	1,706	3,602	1,674
1977	5,236	2,237	7,814	7	232	(2,553)	³ 60

¹As reported to ICNAF (1966-1977, 1978a, b).

²Breakdown of *Loligo* and *Illex* separately not provided for total squid catches in parenthesis.

³Taken prior to 1 July 1977

Table 4.—Reported *Illex* landings in metric tons off the northeastern U.S. coast¹.

Year	Spain	Italy	Japan	U.S.S.R.	Poland	U.S.A.	Other	
1963						² (2,111)		
1964					² (4)	(989)		
1965					(176)	(1,161)		
1966					(389)	(1,173)		
1967			2		(833)	(1,829)		
1968			1,557		(3,176)	(1,762)	10	
1969	128		586		(1,340)	(1,461)	1	
1970	1,636		389		(1,065)	408	20	
1971	3,324		176		(6,138)	455	81	
1972	4,878	1,200	2,398		(6,976)	5,264	472	501
1973	3,784	805	1,067		(8,977)	8,288	530	704
1974	6,769	980	3,327		(8,495)	5,003	148	426
1975	2,204	844	3,237		(8,928)	3,051	107	4,307
1976	4,063	1,117	3,256		6,812	5,050	229	4,409
1977	8,202	1,946	4,920		8,003	656	(2,553)	³ 42

¹As reported to ICNAF (1966-1977, 1978a, b).

²Breakdown of *Loligo* and *Illex* separately not provided for total squid catches in parenthesis.

³Taken prior to 1 July 1977



Figure 1.—Spanish side trawler, 44 m in length.



Figure 2.—Spanish stern trawler built in 1973, 35.6 m in length.



Figure 3.—Italian stern trawler built in 1974, 107 m in length, and entered the fishery in 1978.



Figure 4.—Japanese stern trawler built in 1964, 84 m in length.



Figure 5.—Soviet BMRT class stern trawler built in 1965, 85 m in length.

provided by Koyama (1976) and Engel (1976). Prior to 1977-78, foreign production was derived using heavy duty bottom tending gear, but current U.S. regulations require that foreign vessels use bottom and off-bottom trawl gear in designated areas at certain times. Not only are there restrictions on types of trawl gear, but also on mesh size and chafing gear. In 1977, foreign vessels engaged in the squid fishery were permitted to use bottom trawl gear with a minimum mesh size of 40

mm in the bag end. For 1978, foreign vessels could use bottom trawls having a minimum mesh size of 60 mm in the bag end and, in designated pelagic gear areas, off-bottom nets having a minimum mesh size of 45 mm in the bag end. Vessels were permitted to use chafing gear in 1977 and 1978, provided it did not obstruct the mesh in the cod end. No chafing gear may be used on off-bottom trawls but a net strengthener of at least double the mesh size is permitted.

A wide variety of basic net types is used in the fishery. Frequently, conventional whitefish trawls are used with suitable modification in the mesh size. Where two-panel, four-panel, and six-panel nets are required, emphasis has been placed on high opening nets where head rope height over the bottom may vary from 5 to 15 m. Mesh size in the trawls varies from 60-400 mm (stretched mesh) in the wings and fore part of the net to 45-60 mm in the cod end.

Table 5.—Characteristics of foreign fishing vessels working off the northeast U.S. coast in 1977.

Item	Spain side trawlers (10) ¹	Spain stern trawlers (48)	Italy stern trawlers (8)	Japan stern trawlers (12)	U.S.S.R. BMRT Class (7)	U.S.S.R. SRTM Class (6)	Poland stern trawlers (4)
Years vessels built	1962-75	1962-76	1969-74	1960-67	1962-73	1969-71	1965-68
Length in meters (feet)	36(118)-53(174)	34(112)-58(190)	67(220)-75(246)	75(246)-85(279)	75(246)-85(279)	50(164)	72(236)-87(285)
Breadth in meters (feet)	7.4(24.2)-9.3(30.5)	8.0(26.2)-10.5(34.4)	10.4(34.1)-12.5(41.0)	11.8(38.7)-13.5(44.3)	14(45.9)	9.8(32.2)	12.7(41.7)-14.7(48.2)
Draft in meters (feet)	3.6(11.8)-6.3(20.7)	3.5(11.5)-4.9(16.1)	4.0(13.1)-6.9(22.6)	5.1(16.7)-5.8(19.0)	4.2(13.8)-6.2(20.3)	2.7(8.9)	5.1(16.7)-5.4(17.7)
GRT (metric tons)	298-749	308-1046	889-1584	1407-2529	2706-3697	775	1,481-3,096
NRT (metric tons)	110-346	179-549	403-831	722-1359	997-1344	227	582-1,041
Number of crew	18-31	18-46	32-38	43-54	93-94	29	60-80
Main engine horsepower	800-1500	870-1910	1700-2900	2090-3500	2000	1000	2250-2500
Type	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
Service speed (knots)	9-13	11-15	11-13	12	11-12	11	12-14
Trawling speed (knots) ²	2-5	2-5	3-5	3-4	3.5-5.0	2-5	4.0-4.7
Fuel consumption (tons/day)							
Service	—	3.5-4.9	—	12	10	—	—
Trawling	—	2.5-4.0	—	9	—	—	—
Propeller	Fixed	Fixed and variable	4 blade fixed and variable pitch	Fixed	Variable pitch	Fixed	Variable pitch
Flash freezing units	2-4	2-4	4-8	15	4	4	3
Type	Blast freezer	Blast freezer	Blast freezer Plate freezer	Plate freezing cabinets	Blast freezer (mechanized)	Blast freezer	Vertical plate
Daily capacity (metric tons)	8-24	8-24	20-40	45	30-40	12	30-40
Temperature of unit (°C)	-30 to -40	-30 to -40	-30	-30	-40	—	—
Refrigerant	Freon	Freon	Ammonia and freon	Ammonia	Ammonia	Ammonia	Ammonia
Frozen hold capacity (metric tons)	265-637	240-420	500-650	600-860	380-700	198-207	450-750
Temperature of hold (°C)	-25	-20 to -25	-25	-27	-28	-25 to -30	—
Trawl warp in mm (diameter)	20-24	20-24	24	26	24	24	—
Warp length/drum (meters)	—	800-1500	914	2652	2000	—	—

¹Number of vessels engaged in squid fishery for 1977 beginning 1 July.

²Trawling speeds in the squid fishery.

The following is quoted from Engle (1976):

“The best trawl gear seems to be a medium opening bottom trawl six to seven meter vertical opening with long wings and mesh sizes from 120 mm stretched decreasing to 50 mm stretched in the cod end. The size of the trawl, of course, has to be suitable to the towing power of the vessel.”

Trawls are typically rigged with ground cables and with either heavily wrapped sweep lines or bobbin gear. Depending upon the power of the vessel, trawl speeds of up to 5 knots are sometimes employed. Otter doors, floats, and rollers generally reflect national preference (Fig. 6, 7).

Depth Sounders and Net Recorders

Since the Japanese and Spanish have been dominant in the squid fishery, it seems logical to discuss their

use of electronic fishing devices.

Japanese stern trawlers typically

have the following electronic equipment: two echo sounders, one a

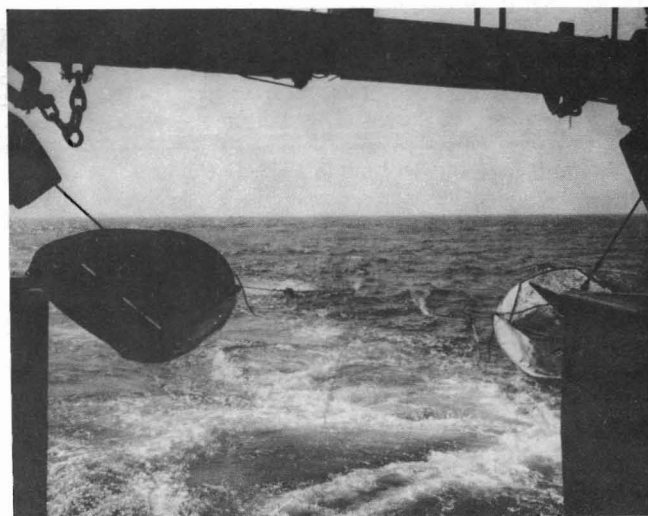


Figure 6.—Oval doors (1,200 kg) being payed out on a Spanish trawler.

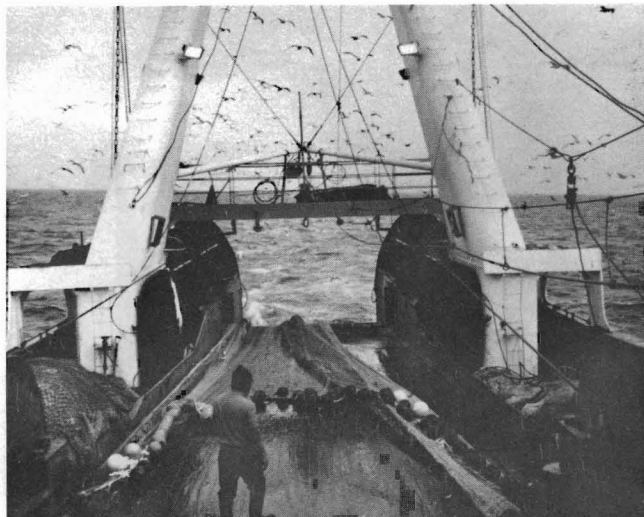


Figure 7.—Shooting the net on an Italian stern trawler. Note the heavy sweep lines running to the trawl doors and plastic floats on the net.

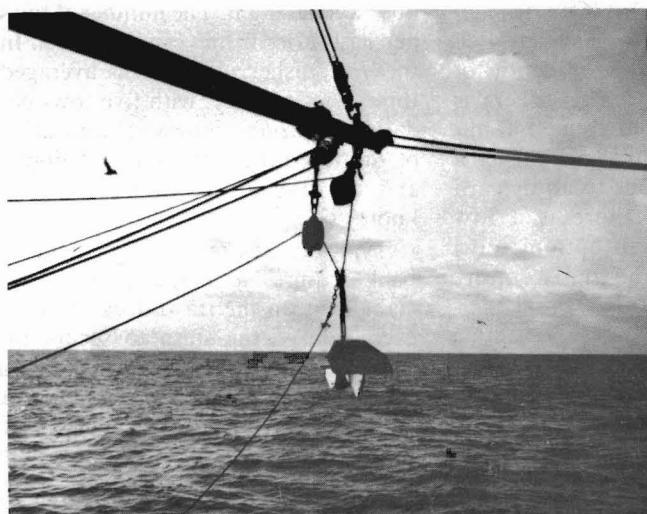


Figure 8.—Towed receiver for net monitor. This unit receives signals from the transducer on the head rope giving the distance of the head rope from the bottom, depth, bottom water temperature, and markings that indicate fish entering the net.



Figure 9.—Battery powered transducer for Koden net monitor.

Furuno¹ depth recorder with switchable transmitting frequencies of 28, 75, or 200 kc, and a Sanken or Kaijo 6-inch wet paper recorder with switchable frequencies of 28, 75, or 200 kc, along

¹Reference to trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

with a Furuno FNT 50/200 cableless net recorder with 6-inch wet paper display. Receiver units are mounted on port, starboard, and center of the hull at the stern, or a towed receiver is used (Fig. 8). The battery-powered transducer is fitted on a small board on the head rope (Fig. 9). The net recorder gives the head rope distance from the

seabed, the bottom water temperature, and markings that indicate schools of fish and squid entering the net. The wet paper recorder is very sensitive when the proper power and frequency in relation to depth are used in conjunction with a net recorder. Experienced captains are capable of adjusting vessel speed, direction, and net height to

maximize squid catches and minimize by-catch species.

The Spanish stern trawlers typically carry two echo sounders such as the Krupp Atlas Echograph 450 or others manufactured by Furuno, Simrad, and Elac. Some Spanish vessels are equipped with a net monitor like the Koden Net Monitor NM850AT (Fig. 10).

The detection of squid using net recorders has met with varied success. Uncertainties exist in interpreting markings on the net recorder paper. Some captains say a particular marking is squid while others are not sure if the marking is actually squid or baitfish associated with squid. One Japanese captain claimed that small pin dots very close to the bottom on a wet paper echo sounder were *Loligo* indications.

In general Spanish vessels do not depend on net recorders as heavily as the Japanese. They seem to rely more on their knowledge of past offshore productive areas.

Preferred Squid Fishing Conditions

Foreign squid fishing observations are in general accord with scientific data on the optimal conditions for locating squid. A strong relationship exists between squid distribution and bottom water temperatures. Preferred bottom temperatures for *Loligo* are 8°-12°C and for *Illex* 9°-14°C. Serchuk and Rathjen (1974) reported that large research survey catches of *Loligo* were taken in the spring at temperatures from 10° to 12°C, and in the fall at 10°-14°C.

The preferable bottom type is a mud-sand substrate with a gentle contour. Occasionally large deposits of shell and rock are encountered, and although these areas may be productive for squid, they are detrimental to the trawl gear and when excessive shell and rock are taken in the net, they hamper the culling operation. The quality of the squid is also affected due to compression in the cod end with shells that tend to cut and mangle.

Most foreign squid fishing is conducted in depths from 90 to 200 m. The *Illex* fishery is concentrated between

165 and 200 m, since catches are much larger at these depths. One foreign captain stated that large catches of *Illex* can be found down to depths of 270 m. The foreign *Loligo* fishery is conducted in depths of about 140 m.

Catches of squid are greater in the day than at night. Due to an upward vertical migration there is a low availability of squid to bottom trawl gear at night. Accordingly, many vessels make longer tows at night or cease fishing in the evening and resume 1 or 2 hours before sunrise. Observations indicate that the tow taken during the first hours of daylight is usually the most productive of the day.

Some foreign captains believe that *Loligo* aggregate more closely to the bottom in rough seas. Therefore, rarely will fishing be suspended during storms. In the *Illex* fishery a light south-southwest wind is believed to increase catches. Also, foreign captains think *Illex* are vulnerable to water currents. Experienced captains will monitor water currents to predict such movements (i.e., *Illex* move along the currents edge in the same direction of the current in conjunction with water temperature).

Fishing Operations

In the *Illex* fishery the vessels primarily fished during the daylight

hours. The *Loligo* fishery is continuous day and night. The number of tows per day varies from vessel to vessel. In the *Illex* fishery the vessels averaged three tows per day, with five tows per day in the *Loligo* fishery. The duration of the tow ranges from 1 to 5 hours, and the trawling speed from 2 to 5 knots.

Typically the process of hauling back requires a minimum of six to eight men on the trawl deck: Two on each side of the stern to secure the doors, a winch operator (Fig. 11), a trawl master, and two men on the gypsy heads. Once the doors have been detached from the trawl warps and secured to the stern, the men on the stern assist in bringing the net on board. The sweep lines are coiled on the winch drums until the bridles reach the winches. The remainder of the net is brought up in sections by using a series of portable rope or wire straps that are wrapped around a section of the net and are pulled in by wire cables that lead to the gypsy heads (Fig. 12). The net is brought in at deck length sections until the cod end is brought on board. Should a large haul be encountered, the vessels are equipped with blocks located to the rear of the pilothouse on which cables run to the winches (Fig. 13, 14). Once the cod end is on deck, it is opened and the catch is either culled



Figure 10.—Two Furuno echo sounders and a Koden net monitor.

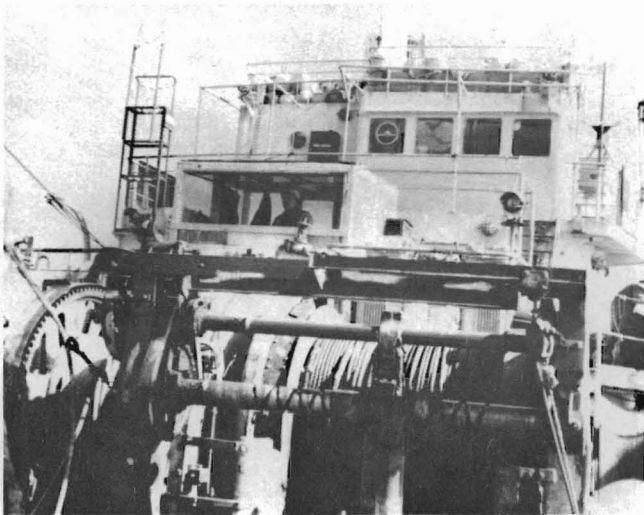


Figure 11.—Trawl winch with level wind in foreground and winch operator in the background on a Japanese stern trawler.

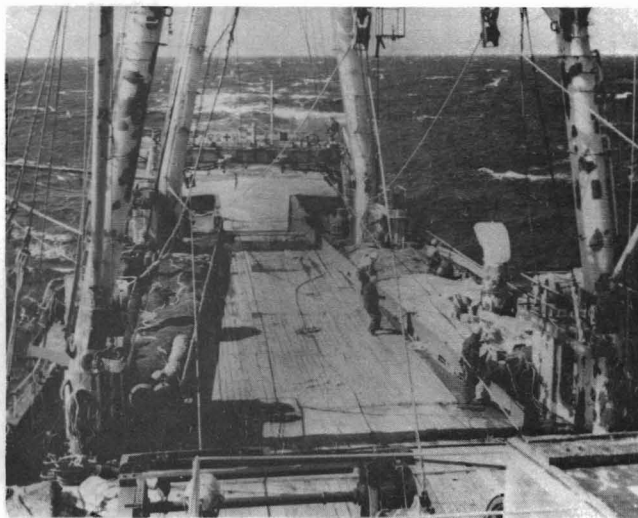


Figure 13.—Trawl deck of a Japanese stern trawler. Note blocks in the top of the picture, with cable running to the winches for hauling heavy cod ends.



Figure 12.—Taking another bight to haul the cod end on board a Spanish trawler.

on deck or dropped below to a holding pen (Fig. 15, 16). During inclement weather and winter months the catch is dropped below deck to be culled.

Processing of the Catch

Handling of the squid catch involves manual labor. There are no automated devices used in the processing of squid, although some vessels have conveyor

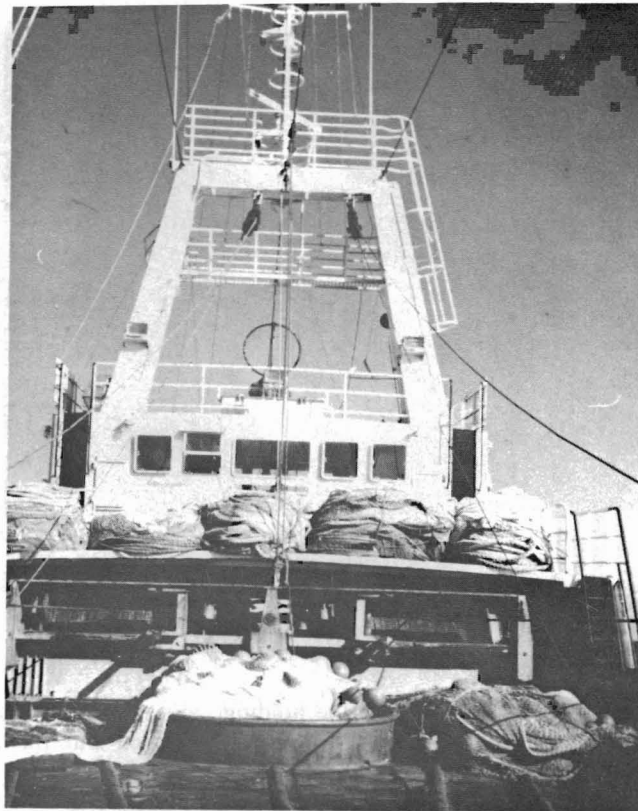


Figure 14.—Spare net bin located on the deck between the winches, and blocks suspended from the H frame over the rear of the pilothouse on a Spanish trawler.

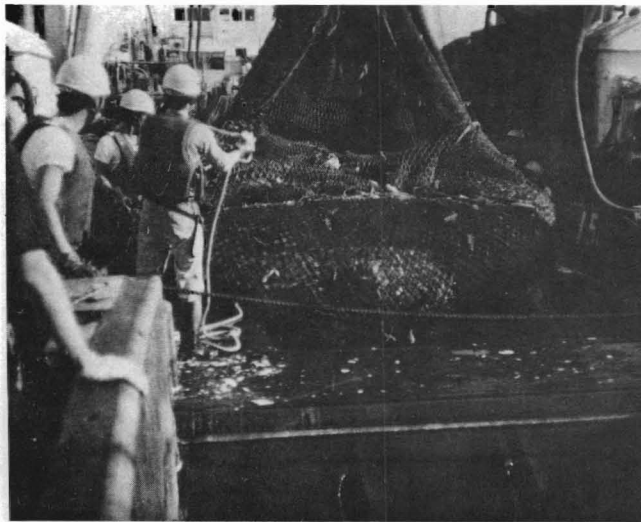


Figure 15.—Dumping of catch through the trawl deck hatch on a Japanese stern trawler.

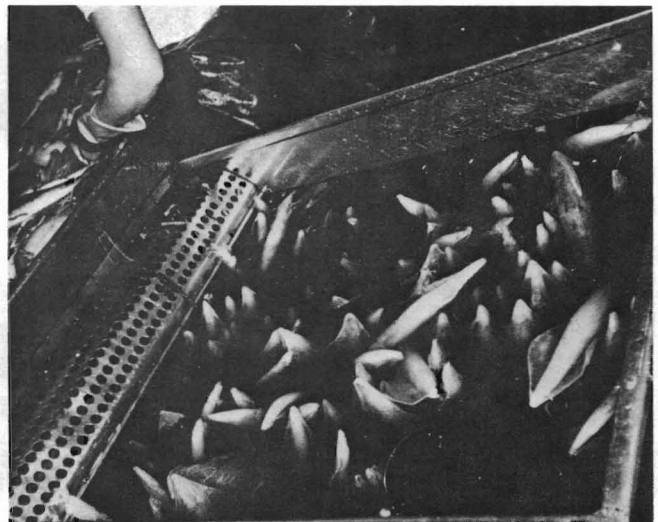


Figure 17.—Culling and washing of *Loligo* in a stainless steel bin with circulating seawater.



Figure 16.—Five and a half metric ton haulback on a Spanish stern trawler in the *Loligo* fishery.



Figure 18.—Spanish crewmen sorting squid into size categories. Metal gauges hanging overhead are used for measuring mantle length.

belts to carry squid from the holding pen to the sorting and packing tables.

When the catch is sorted on deck, the crew shovels the squid into a hatch leading to the below deck holding pen, and the remaining by-catch is discarded overboard. The culling process below deck usually involves two to four men, but in catches having excessive by-catch the entire deck crew will sort

out the discards. The discards are flushed out through the below deck scuppers.

The culled squid are placed in baskets, washed, and then emptied onto a sorting table (Fig. 17). Here they are quickly sorted into the following size categories by length of mantle: for *Loligo*, #1= 27 cm and longer, #2=22-27 cm, #3 = 18-22 cm, #4 = 14-18 cm,

#5 = 10-14 cm, and #6 = shorter than 10 cm; for *Illex*, #1 = 18 cm and longer, #2 = 14-18 cm, and #3 = shorter than 14 cm. This sorting is usually done by eye with occasional reference to metal or wood gauges hung overhead (Fig. 18). As the squid are sorted, severely mangled individuals are discarded. However, squid with tears in the skin, cuts in the flesh, or



Figure 19.—Packing *Loligo* in 26-kg trays on Spanish trawler. The two doors in the background are 2 ton flash freezing units.

missing arms are processed. After sorting, the squid are placed into trays according to size category (Fig. 19). Sometimes the trays are lined with a plastic sheet, or the squid are separated into layers by using this sheet. The trays vary in size; the smallest holds 10 kg, and the largest 30 kg. The larger trays are divided into two or four sections by removable metal plates. Size category is indicated by placing a plastic or paper label on top of the squid in the tray (Fig. 20). These trays are then slid into flash freezing units, where the squid are frozen at -30°C for 4-8 hours, depending on the freezing unit (Fig. 21). The temperature of the resulting frozen blocks is -18° to -20°C . When these units are loaded to capacity and operating, excess squid are placed into a second set of trays and stored off to one side at room temperature until they can be frozen. Upon completion of freezing, the trays are removed from the unit, dipped in a water bath, and the blocks of squid knocked out of the tray. Additionally some vessels will freshwater glaze the blocks. The frozen squid blocks are then placed in plastic bags; some nationalities additionally box the blocks in cardboard containers (Fig. 22). The packages are slid down a chute into the freezing hold (Fig. 23). Two crewmen receive the frozen blocks



Figure 20.—A 26-kg tray partially filled with "No. 2" *Loligo* (22-27 cm mantle length).



Figure 21.—Italian crewman sliding a 16-kg tray of *Loligo* into a flash freezing unit.



Figure 22.—Twelve-kilogram frozen blocks of squid being packaged in plastic bags.



Figure 23.—Italian crewman sliding a 16-kg carton of frozen squid into freezer hold.

from the chute and hand-lay them in the hold. The temperature of the freezer hold is around -25°C .

In addition to freezing squid, Soviet BMRT class vessels have canning facilities. The squid mantle is filleted and skinned. Fillets are cut into 4-6 cm squares and placed in 240 g cans with a small amount of salt. The cans are mechanically sealed and cooked in an autoclave. No water or liquid is added since squid form a natural broth when pressure cooked. After cooking, the cans are labeled, dated, and packed in cardboard containers.

Fishing Areas

The U.S. Foreign Fishing Regulations (U.S. Department of Commerce, 1977b) require foreign vessels to fish for squid within specified areas at designated times. In 1977, five areas were established for the foreign squid fishery, based on historical fishing patterns of the foreign fleet. In 1978, five areas existed in which foreigners could fish for any species for which they had an allocation. Slight modifications were made in the 1978 areas to facilitate the reduction of by-catch, minimize gear conflicts, and minimize fishing conflicts between United States

and foreign vessels (Fig. 24, 25). In 1977 all foreign vessels were prohibited from fishing between 100 and 200 fathom (183 and 366 m) depths for the avoidance of fixed gear. For the first 3 months of 1978, the 100-200 fathom restriction was lifted on a trial basis, but was reinstated due to the apparent increase in fixed gear conflicts caused by the foreign fleets.

United States Coast Guard surveillance operations in 1977 and 1978 provide information of the foreign fishing vessel activities. During the summer, 90 percent of the foreign vessels fishing for squid were sighted between Hudson and Wilmington Canyons, however, four Polish vessels reported taking squid while fishing in the Herring Area (Fig. 26). In the autumn, the fishery shifted south with the majority of the fleet fishing between Wilmington and Washington canyons (Fig. 27). There was no major fleet concentration during the winter months; vessels were scattered from Atlantis Canyon to Wilmington Canyon (Fig. 28). In the spring, limited fishing activity transpired around Veatch Canyon until Area I opened (15 June), after which the foreign fleet increased and moved its operations to the

summer fishing grounds (Fig. 29).

It should be noted that during the winter and spring, the Soviet squid catch was incidental to their hake fishery. In 1978 Mexico began to employ Spanish vessels to harvest their squid allocation. Also, throughout the year foreign vessels had limited maneuverability due to fixed gear and 100-200 fathoms restrictions.

Catch and Effort

During the first year of U.S. fishery management authority, foreign squid catches off the northeastern coast dropped considerably. There was a 20 percent reduction in foreign squid catches in 1977 compared with the 52,306 t average during 1972-76. Within a 1-year period beginning 1 July 1977 and ending 30 June 1978, the monthly catch for *Loligo* exhibited a sharp decrease when compared with the same monthly averages for 1974 through 1976. The monthly catch for *Illex*, when compared with the same monthly averages for 1974 through 1976, shows an increase for June through November, but a sharp decrease for December through May (Fig. 30, 31). (The values used for the 1974-76 monthly averages were derived

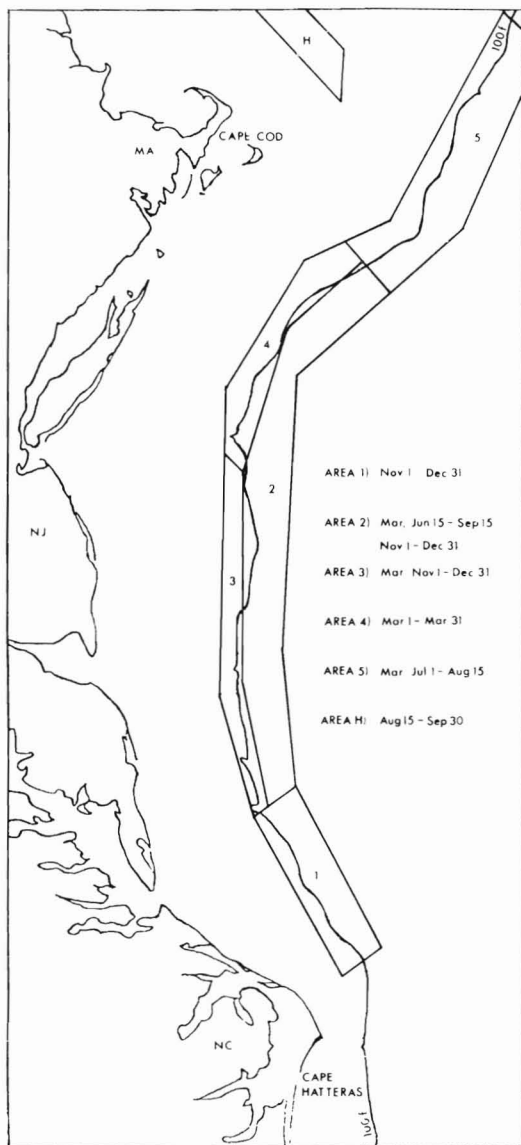


Figure 24.—Designated fishing areas and times for 1977.

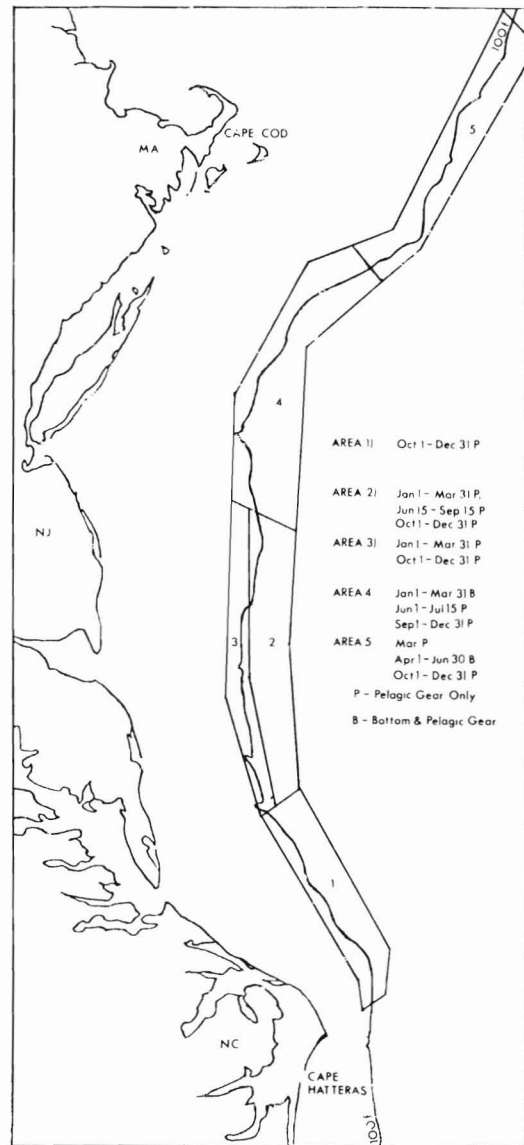


Figure 25.—Designated fishing areas and times for 1978.

from the monthly nominal catches as reported to ICNAF².)

²The ICNAF data for these years were broken into three categories: Catch of *Illex*, catch of *Loligo*, and catch of "squid" (which included both species). The catch reported by species accounted for about 80 percent of the totals reported. For the purpose of this illustration the catches reported as "squid," (no species), were apportioned into the species categories in the same proportions as these species were reported.

catch can be attributed to the restricted fishing areas, the designated times allowed to fish, and the severely limited areas due to fixed gear.

Effort during July 1977-June 1978 was recorded as number of vessel days actually fished (Table 6). During this period foreign vessels fished a total of 7,073 days and harvested 32,756 t of squid. Fishing effort for this period cannot be compared with fishing effort

in past years due to insufficient information reported to ICNAF in the past. The foreign fleet normally increases its effort during the traditional periods of abundance for *Loligo* and *Illex*. However, in April 1978 the *Loligo* catch per vessel day peaked at 2.868 t with the lowest number of vessel days fished—114. The *Illex* catch per vessel day peaked in July 1977 at 11.091 t with 1,036 vessel days fished.

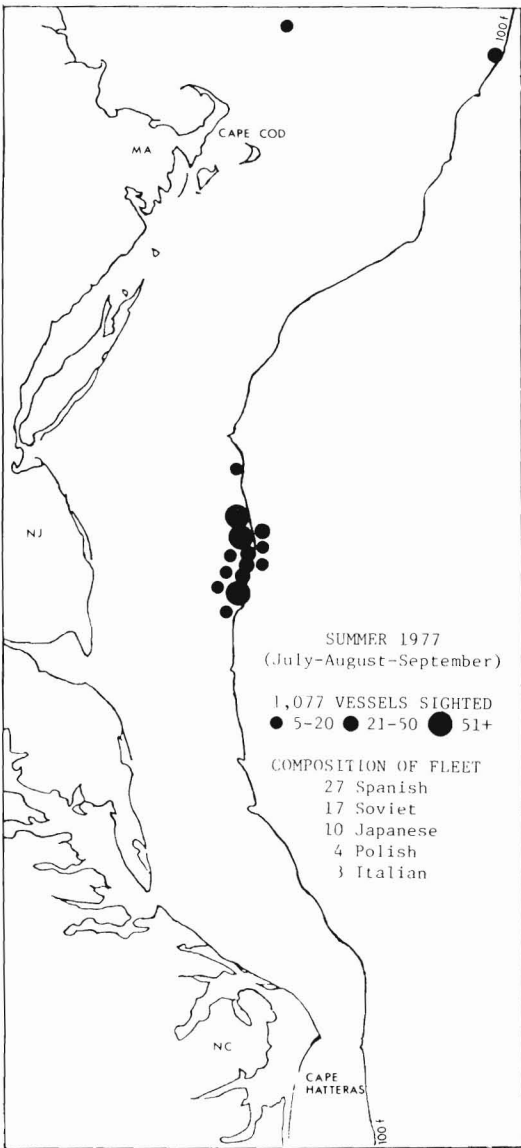


Figure 26.—Concentration of foreign fleet during the summer of 1977.

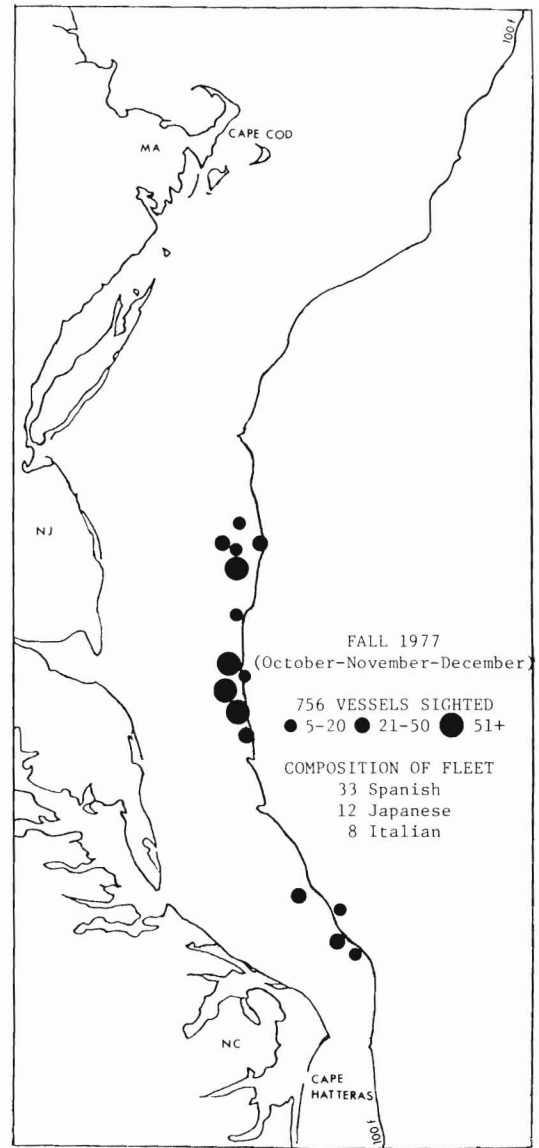


Figure 27.—Concentration of foreign fleet during the fall of 1977.

By-Catch

Since the advent of the Fisheries Management and Conservation Act, there has been increased emphasis by the United States in controlling the amount of "by-catch" taken in the squid fisheries. By-catch is essentially fish or marine life other than squid taken in the net.

During the 1977-78 *Illex* fishery,

foreign fishery observers witnessed haulbacks that contained by-catch levels between less than 1 and 20 percent of the total catch. In contrast, levels of by-catch observed in the *Loligo* fishery ranged from 3 to 98 percent of the total. On the average, a by-catch of about 30 percent can be expected in the *Loligo* fishery. The species most frequently encountered as by-catch were as follows: butterfish,

American angler, fourspot flounder, summer flounder, silver hake, red hake, spotted hake, spiny dogfish, rock crab, Jonah crab, and northern lobster. The species and amounts vary with season and areas fished. Most by-catch is discarded as there is little or no market for these species in the various foreign countries. The Japanese vessels, however, do process butterfish and summer flounder. American

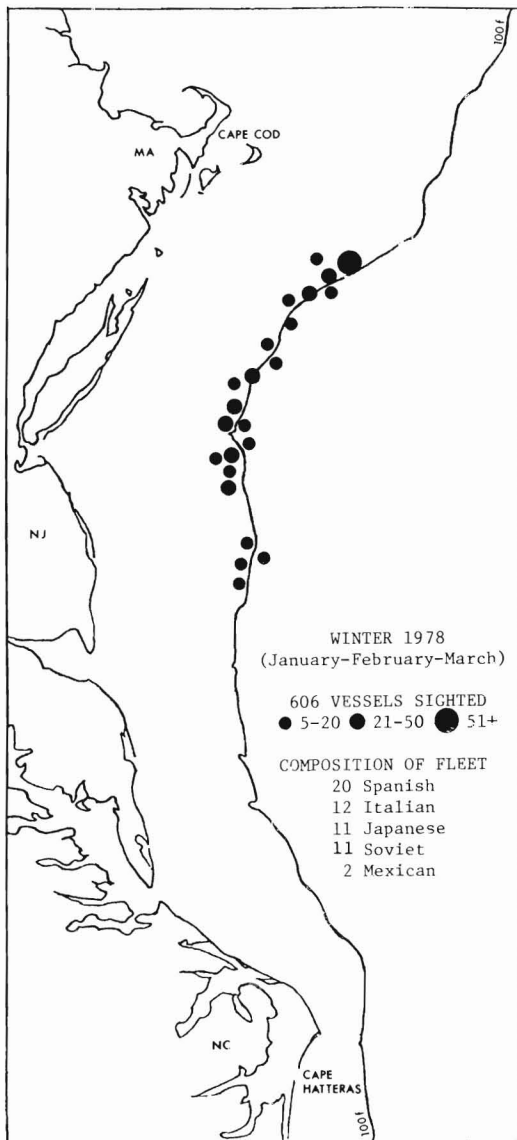


Figure 28.—Concentration of foreign fleet during the winter of 1978.

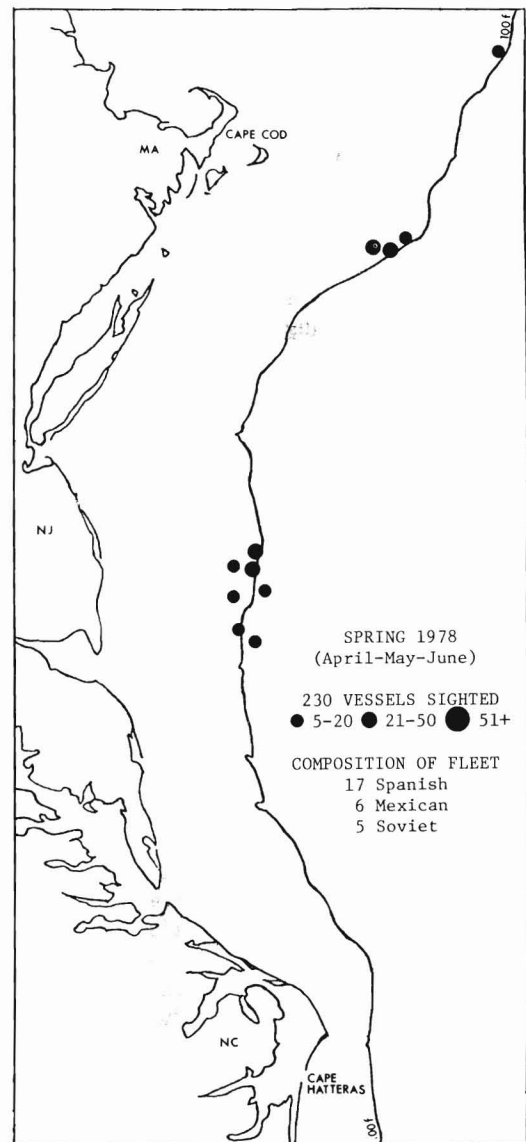


Figure 29.—Concentration of foreign fleet during the spring of 1978.

angler is processed on Spanish and Italian trawlers. In addition to American angler, Italian vessels will also process silver hake, flounders, and Atlantic mackerel when large quantities are encountered.

During 1977 and 1978 several research cruises aboard Japanese, Spanish, Soviet, French, and other vessels have sought solutions to the problem of excessive by-catch. The

research results indicated that by raising the footrope off the bottom, the amount of by-catch can be reduced. This is not completely satisfactory, however, since squid catches also decreased.

Feasibility of a Domestic Offshore Squid Fishery

As previously mentioned, the objective of this paper is to increase the

American fisherman's awareness of foreign squid fishing practices. However, the fishing fleet of the northeastern United States, as we know it today, does not compare with the foreign vessels fishing in the northwest Atlantic Ocean. The U.S. vessels lack the modern technological advances, particularly flash freezing units and freezer holds, commonly found on foreign vessels. Whether it is economically

feasible for U.S. fishermen to engage in an offshore squid fishery is virtually unknown.

In 1974 the New England Fisheries Development Program (1977) chartered the 30-m (99-foot) *Valkyrie*, of New Bedford, Mass., to test the feasibility of a directed squid fishery on offshore concentrations. This commercial stern trawler made four 1-week trips along the shelf edge of both sides of the Hudson Canyon during January and February of 1974. The squid caught were heavily iced, and quality tests showed a shelf life of 9 days. Lux et al. (1974), reporting on the *Valkyrie* cruises, stated: "The ex-vessel value of the squid and incidental fish catch in the four charter trips amounted to \$29,800, or about \$1,250 per 24-hour fishing day. Vessels similar to the *Valkyrie* were grossing about \$1,500-\$3,000 per day on groundfish (cod, haddock, and associated species) at this same time. Fishing for these traditional species, therefore, was clearly more attractive to fishermen than fishing for squid."

That was 4 years ago, before the government began placing quotas on groundfish. With the current conservation quotas on groundfish coupled with a large world demand and the possibility of an expanded domestic market, the question of how and when to develop a domestic offshore squid fishery is left to the U.S. fishermen to determine for themselves.

Acknowledgment

The authors of this paper wish to take this opportunity to thank all who contributed information: The NMFS Northeast Region Foreign Fisheries Observer Program; John Davies of the Law Enforcement Division; David Crestin, Staff Assistant for International Fisheries; Robert Hall, Chief, Market News Branch; Paul Earl of the Fisheries Development Services Branch; and Fredric Serchuk of the Woods Hole Laboratory. A special thanks goes to Warren Rathjen, Chief of the Fisheries Development Services Branch, without whose insight and guidance this paper would not have been possible.

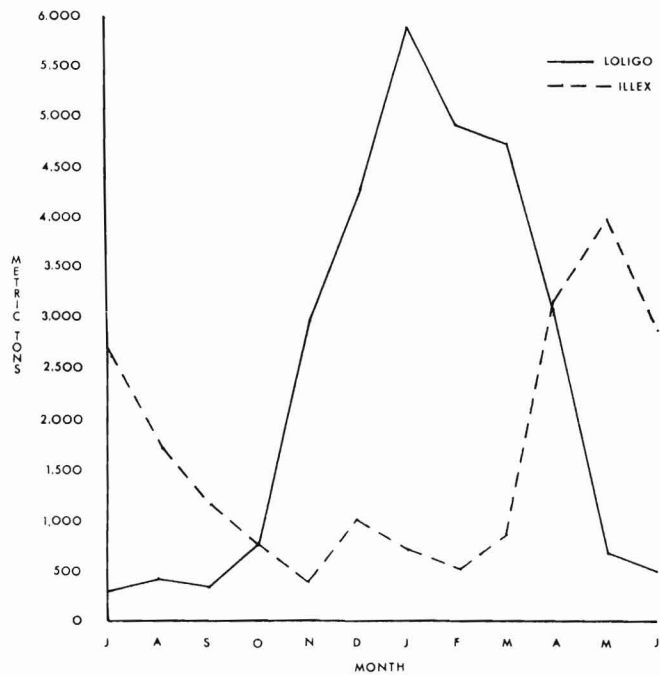


Figure 30.—Three-year foreign monthly catch averages of *Loligo* and *Illex* off the northeast U.S. coast for 1974 through 1978.

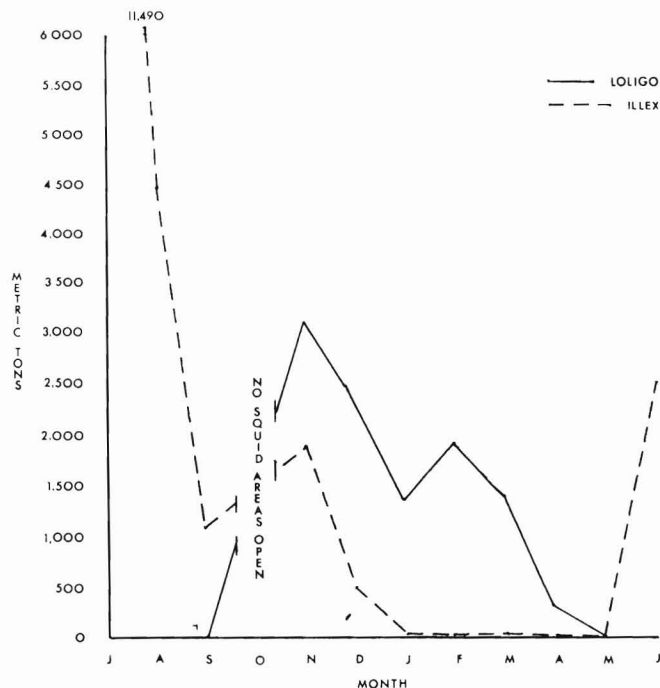


Figure 31.—Foreign monthly catch of *Loligo* and *Illex* off the northeast U.S. coast from 1 July 1977 to 30 June 1978.

Table 6.—Foreign monthly catch, effort, and catch per vessel day for July 1977 to June 1978¹

	<i>Loligo</i> ²	<i>Illex</i> ²	Vessel days fished	Catch per vessel day ²	
				<i>Loligo</i>	<i>Illex</i>
July 1977		11,490	1,036		11 091
August 1977		4,522	468		9 662
September 1977	1	1,130	299	0 003	3 779
October 1977			(No areas open for squid)		
November 1977	3,128	1,900	1,294	2 417	1 468
December 1977	2,393	516	1,339	1 787	0 385
January 1978	1,367	18	710	1 925	0 025
February 1978	1,940	17	870	2 230	0 020
March 1978	1,401	32	565	2 480	0 057
April 1978	327	5	114	2 868	0 044
May 1978		23	45		0 511
June 1978		2,546	303		8 403

¹Derived from weekly and biweekly catch reports as reported to NMFS by designated foreign officials

²Weights in metric tons

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