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DISTRIBUTION AND ABUNDANCE OF BLUEFIN TUNA LARVAE IN THE GULF OF MEXICO IN 1977 AND 1978

W. J. Richards, T. Potthoff

SUMMARY

Ichthyoplankton surveys were made in the Gulf of Mexico and Straits of Florida during April and May, 1977 and May, 1978, by the FRV OREGON II. Results from the surveys delineated the distribution of bluefin tuna larvae in those areas. The distributions were similar to those found in previous years indicating that this is the major area for bluefin tuna spawning in the western North Atlantic Ocean. Bluefin tuna larvae were more abundant in 1978 and over 1,400 larvae were collected. Several estimates of the size of the bluefin tuna larvae population are made based on the larval capture data.

RESUME

Des prospections d'ichtyoplancton ont été effectuées dans le golfe du Mexique et les détroits de Floride en avril-mai 1977 et mai 1978 par le navire de recherche "FRV Orégon II." Les résultats de cette prospection ont permis de délimiter la répartition des larves de thon rouge dans ces secteurs. La répartition se rapproche de celle qui avait été observée les années précédentes, ce qui indiquerait qu'il s'agit de la principale frayère de thon rouge dans l'Atlantique nord-ouest. Les larves de cette espèce étaient plus abondantes en 1978; plus de 1.400 ont été collectées. Plusieurs estimations de l'importance de la population de larves de thon rouge ont été calculées à partir des données sur les prélèvements de larves.

RESUMEN

Se hicieron inspecciones de ictioplancton en el Golfo de México y estrecho de Florida durante Abril y Mayo 1977 y Mayo 1988 por FRV Oregon II . Los resultados de las prospecciones definieron la distribución de las larvas del atún rojo en esas zonas. Las distribuciones fueron similares a aquellas encontradas en años precedentes, y que indicaban que ésta, es la mayor zona para el desove del atún rojo en el Oeste del Océano Atlántico Norte. Las larvas del atún rojo fueron más abundantes en 1978 y se recogieron alrededor de 1400. Se hicieron varias estimaciones de la talla de la población larvárea del atún rojo, basados en los datos de las capturas de las mismas.

METHODS AND MATERIALS

Collection Methods

The ichthyoplankton surveys were conducted from the FRV OREGON II from 29 April to 24 May, 1977 in the Gulf of Mexico and Straits of Florida (cruise 7705) and from 1 May to 31 May, 1978 in the Gulf of Mexico (cruise 7803). Station locations are shown in Figures 1 to 4. Forty-eight stations were occupied in 1977 and 135 in 1978. At each station a double oblique plankton tow to 200 meters was made using paired 61-cm Bongo net plankton sampler. Meshes used on the Bongo sampler were 0.505 mm and 0.333 mm. For a description of the net see Posgay, Marak and Hennemuth (1968). The double oblique tows were made at prescribed rates of 50 m/min payout and 20 m/min retrieval. The intended maximum depth was to be within 5 m of the bottom or to a maximum of 200 m. Ship speed during the tow was to be held about 1.5 knots to maintain a 45° wire angle. During the 1977 cruise (7705), the winch used on the OREGON II was not designed for this type of towing and consequently the winch speed on retrieval often exceeded 20 m/min to about 25 to 30 m/min. During the 1978 cruise the desired retrieval speed was maintained through use of a different winch. A flow meter was placed inside the mouth of the sampler fitted with 0.505 mm mesh. The nets were 3.33 m long and had mouth opening to total net aperture ratios of 1:8.8 (0.505 mm net) and 1:7.8 (0.333 mm net).

In addition to the Bongo tow, a neuston net tow was made at each station. This was a surface tow taken at a ship's speed of 1.5 knots for 10 minutes duration. The net was fished from the side of the vessel outside of the wake. The net frame was a 1 by 2 m rectangle, the net was 0.947 mm mesh, and the net length was 9.4 m. The total net length to aperture ratio was 1:11. The paid out wire was adjusted so that the net fished the upper 0.5 m of water.

The time of day or night that each station was occupied depended on the ship's arrival at a station which was a predetermined geographic location. In addition to the plankton sampling, a surface temperature was taken at each station in 1977 and 1978. Expendable bathythermograph (XBT) casts were made at each station in the 1978 cruise. Other observations taken during the 1978 survey, but not reported here, were 10 hydrocasts and 66 surface productivity measurements.

Sorting, Identification, and Enumeration Methods

The 0.505 mm bongo samples and the neuston samples were sorted manually for fish eggs, larvae and juveniles. The 0.333 mm bongo samples were used for volumetric determination of zooplankton abundance and were also sorted for eggs and larvae from the replicate tows taken in the 1978 survey.

All bluefin tuna larvae were removed from each sample and the standard or notochord length was measured to the nearest 0.1 mm with a calibrated ocular micrometer. Standard length and notochord lengths are defined by Berry and Richards (1973). Identification methods follow Potthoff and Richards (1970), Potthoff (1974) and Richards and Potthoff (1974).

Bluefin tuna larvae captured by bongo nets are expressed as the number of larvae under 10 square meters of sea surface. This is determined by the following expression

$$N = \frac{C}{V} \cdot 10d$$

where N is the number of larvae under 10 square meters of sea surface, C is the catch of larvae, V is the volume of water filtered by the net in cubic meters and d is the depth of the tow in meters. Bluefin larvae captured by neuston nets are presented by actual numbers in the figures

because each tow was uniform. However, for the estimates of larval abundance, the surface area sampled by the net was calculated from the width of the net, towing speed, and time duration of the tow.

Methods used to estimate larval abundance and population

Larval bluefin tuna abundance was estimated by assigning an area of sea surface to each station. This area was determined by measuring half the distance to the next station in each cardinal direction. The area obtained for each station was then multiplied by the calculated number of bluefin tuna larvae per unit area for that station to obtain estimated larval abundance. The sum of the estimated larval abundance (catch) for each station of the bongo and neuston net gives a total estimated abundance for each net type (Table 1). Population estimates are then determined using the expression

$$P = \frac{c \times t}{d}$$

where P = larval population estimate, c = total estimated larval abundance (catch), t = spawning time in days and d = average length of larval life in days. Based on Richards (1976), we assume that the spawning season for bluefin tuna has a 60 day duration. The age of the larvae is estimated to be between 3 and 10 days based on rearing studies and daily growth rings observed in larval otoliths. Although rearing of bluefin larvae has not been carried out, we believe that age-length relationships are equivalent to Thunnus albacares which have been reared by Harada et al. (1971) and Mori et al. (1971). Rearing work doné on Euthynnus alletteratus larvae by Houde and Richards (1969) yielded similar age-length relationships. Recently we obtained 10 bluefin tuna larvae from the Florida Straits of Miami and examined their otoliths for the presence of daily growth rings. These larvae ranged from 3 to 5 mm SL and had 6 to 7, what we considered to be, daily growth rings.

RESULTS

1977 Survey

Distribution and abundance of bluefin tuna larvae from bongo net catches and neuston net catches are shown in Figures 1 and 2. A total of 34 bluefin larvae were collected by the bongo net which is only 0.5 percent of the total catch of 6,440 fish larvae. The total neuston bluefin tuna larvae catch of 246 is 5.5 percent of the total catch of 4,434 fish larvae and juveniles and is much higher than the bongo catch. Larvae of an intermediate length of 3.5 to 5.5 mm in standard length are most common in both nets, but the size distribution of the larvae is different between the two nets (Figure 5). Bluefin larvae from bongo nets ranged in length from 2.7 mm to 8.1 mm with a mean length of 4.6 mm. Whereas in the neuston net tows, the lengths ranged from 3.5 to 8.6 with a mean of 5.1 mm.

Bluefin tuna larval population estimates are given in table 1. The estimates are given for three different lengths of larval life.

1978 Survey

Distribution of bluefin tuna larvae for bongo and neuston nets are shown in figures 3 and 4. A total of 292 bluefin larvae were collected by the bongo nets which is 1.3 percent of the total catch of 22,984 fish larva. The total neuston bluefin tuna larvae catch of 1,184 is 6.6 percent of the total catch of 17,957 fish larvae and juveniles. Size distribution between the two nets is different as with the 1977 survey (Figure 5), but lengths of 3.5 to 5.5 mm SL are most common in both nets. Bluefin larvae from bongo nets ranged in length from 2.4 mm to 9.5 mm SL (mean of 4.1 mm SL) while from neuston nets they ranged from 3.0 mm to 11.8 mm SL (mean of 5.2 mm SL).

DISCUSSION

Spawning Time and Area

We assume that spawning takes place in the Gulf of Mexico for about 60 days (15 April to 15 June) according to Richards (1976). On our surveys, bluefin tuna larvae were collected between April 29 and May 31 well within the expected time frame. Giant bluefin tuna are caught by Japanese longliners as early as February and as late as June in the Gulf of Mexico with highest catch rates in April and May.

The spawning area is widespread in the Gulf of Mexico and Straits of Florida as shown in Figures 1-4. This spawning area is expanded from the spawning area found in the 1974 Cuban survey (Montolio and Juarez, 1977). The 1973 Cuban survey covered only a small portion of the central Gulf of Mexico. An unusual feature of the 1977 and 1978 surveys is the presence of larvae at a station made near the northeastern tip of the Yucatan peninsula off Isla Contoy. Presence of larvae here may indicate that spawning occurs in the Cayman Sea area. Bluefin tuna are caught just to the south of this area around Cozumel Island by sport fishermen (L.R. Rivas, personal communication). Because bluefin larvae are not so common in bongo collections, their absence cannot be considered a valid assumption for not occurring in an area. However, the presence of bluefin larvae is correlated with areas of fishing by Japanese longliners. Plots of longline sets by two Japanese vessels between April 25 and May 25 are concentrated in the 5 degree square bounded by longitude 85° and 90° W and latitude 25° and 30° N (Figure 6). In this square all sets are in the spawning area.

We were surprised by the presence of larvae in the southwestern part of the Gulf. In 1977 no larvae were taken in that area which accounts for our planned paucity of stations in that area in the 1978 survey. We concentrated stations in 1978 in areas we believed would be productive based on the 1977 survey. Future surveys should consider the Cayman Sea, the entire Gulf of Mexico and the Florida Straits. Houde et al. (1979) has shown the distribution of larvae in the eastern Gulf of Mexico which we also found. One other area in the western Atlantic where bluefin larvae have been found is off Cape Hatteras on the edge of the continental shelf (Berrien et al., 1978). A total of three larvae were collected - one on April 20th 1966 and two on June 23rd 1966. Their presence here could be the result of northward drift in the Gulf Stream from spawning in the Straits of Florida or the possibility that bluefin spawn in the Carolina Bight area as well as the areas already discussed. An ichthyoplankton survey in this area would answer this question.

Abundance of Larvae

The catch of larvae in the 1978 survey was considerably greater than found in 1977 and quite a bit higher than that found in the 1973 and 1974 Cuban surveys (Richards, 1976; Montolio and Juarez, 1977). Both bongo and neuston net catches were quite similar with concentrations occurring at the same stations or in the same areas. The estimates of the size of the total larval catch and population for the 1977 and 1978 surveys is given in table 1. Even though the individual sample size is low in comparison with the area it represents, the estimated abundances probably reflect true abundance. The neuston net catches do not sample the entire depth distribution of the larvae, thus they are not used in the population

estimates, but estimates based on the neuston net are given for comparison in Table 1. Based on the size distribution of the larvae, the estimates of larval age are quite accurate.

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Table 1. Estimates of total bluefin tuna larval abundance (catch) and population from the 1977 and 1978 surveys in the Gulf of Mexico. Population estimates derived from catch (c) times length of spawning season (t) divided by age of larvae (d). (Larval population estimate = $\frac{c \times t}{d}$).

	1977		1978	
Total larval	Bongo	Neuston	Bongo	Neuston
catch	3.232×10^{11}	2.753×10^{9}	7.859×10^{11}	6.214×10^{9}
Larval population estimate				
Days				
5	3.878×10^{12}	3.303×10^{10}	9.431×10^{12}	7.456×10^{10}
7	2.770×10^{12}	2.360×10^{10}	6.736×10^{12}	5.326×10^{10}
10	1.939×10^{12}	1.652×10^{10}	4.715×10^{12}	3.728×10^{10}

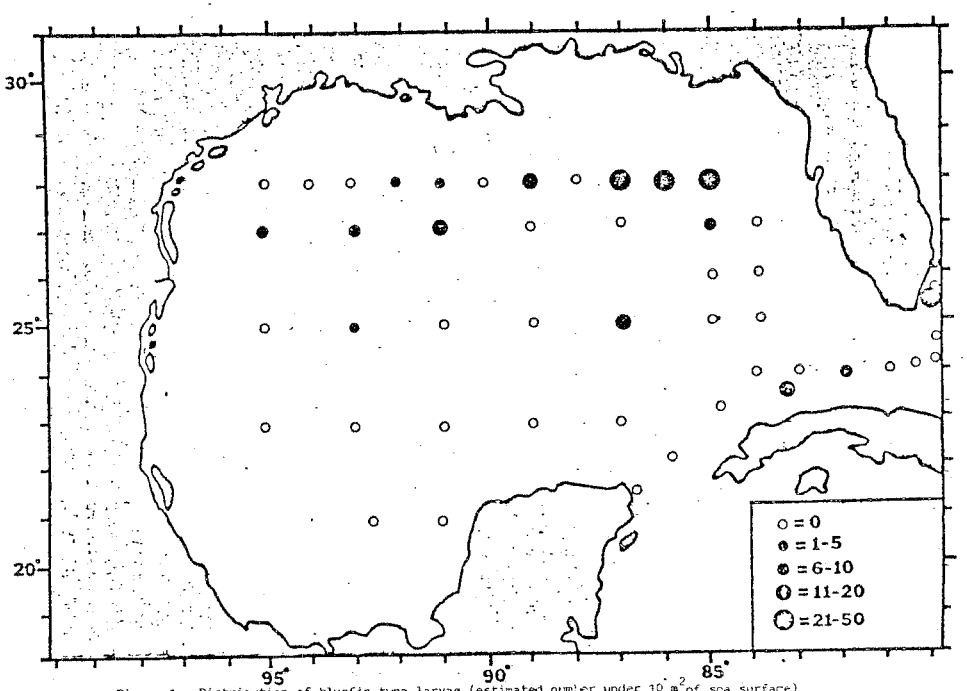

Figure 1 - Distribution of bluefin tuna larvae (estimated number under 10 m^2 of sea surface) from bongo net tows made during CREAM II cruise 7705 in the Gulf of Mexico and the Straits of Florida.

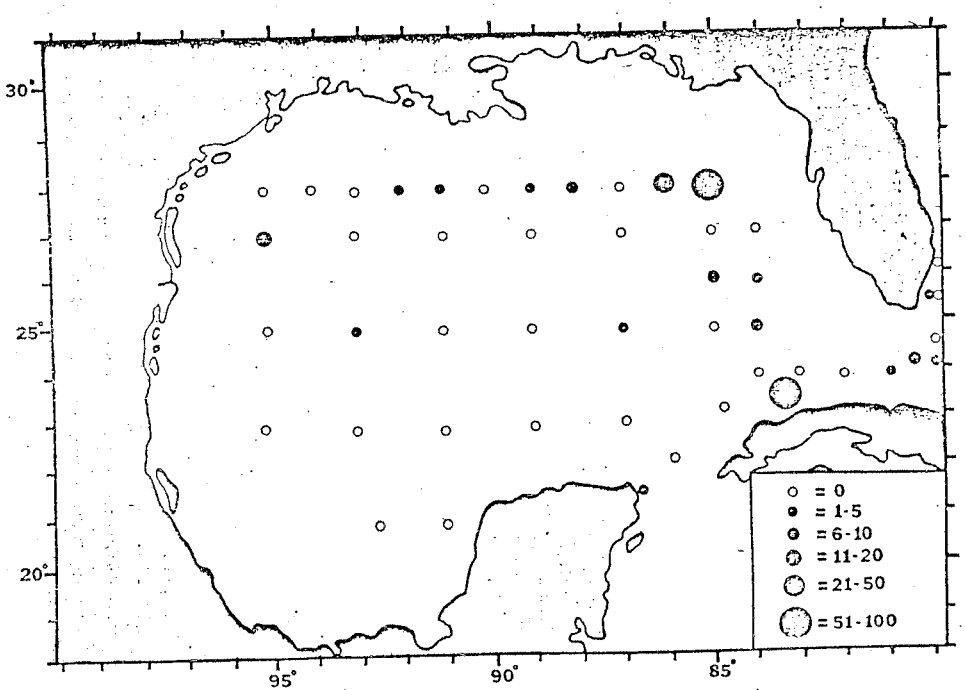

Figure 2.- Distribution of bluefin tuna larvae from neuston net tows (actual capture) conducted during OREGON II cruise 7705 in the Gulf of Mexico and Straits of Florida.

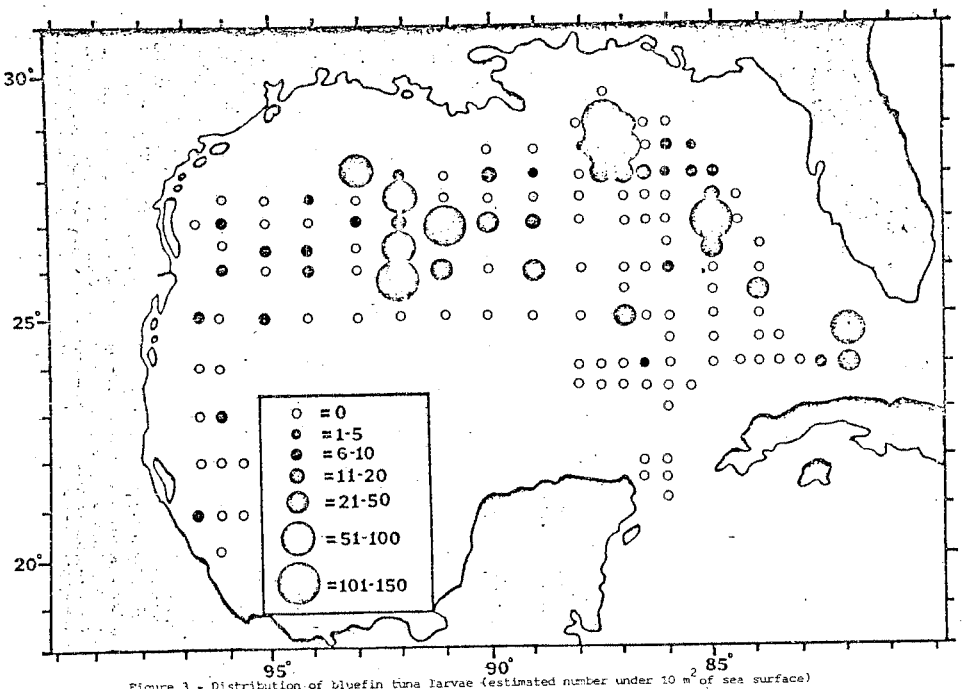

Figure 3 - Distribution of bluefin tuna larvae (estimated number under 10 m^2 of sea surface) from bongo net tows conducted during OREGON II 7803 in the Gulf of Mexico.

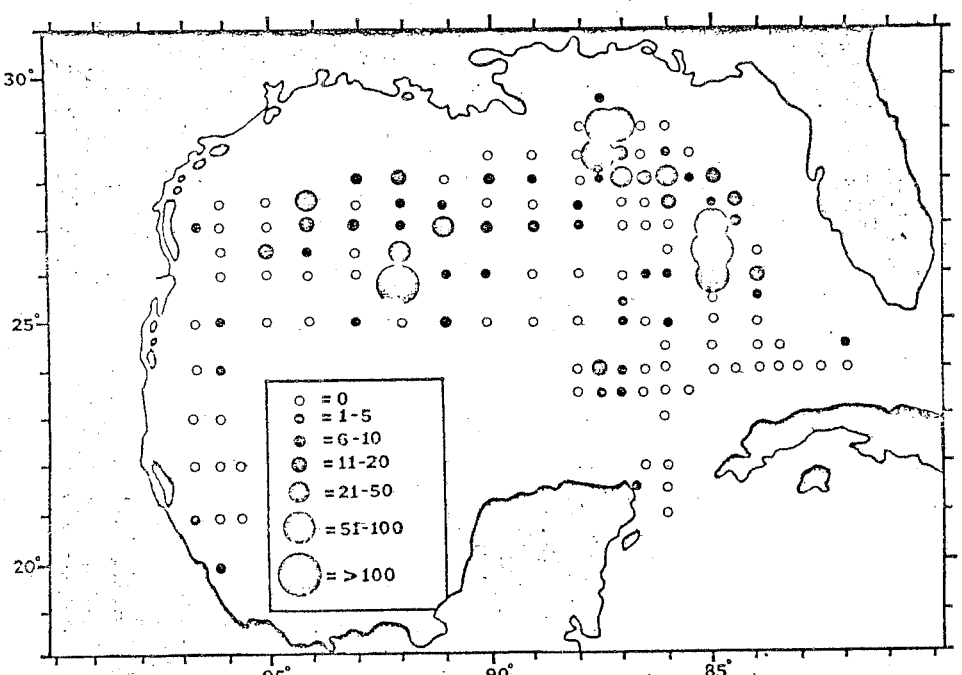

Figure 4 - Distribution of bluefin tuna larvae from neuston net tows (actual capture) conducted during OREGON II cruise 7803 in the Gulf of Mexico.

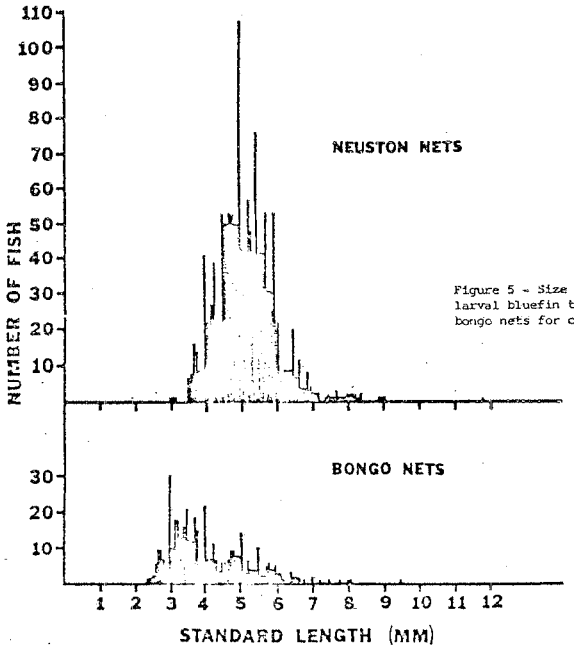

Figure 5 - Size frequency distribution of larval bluefin tuna taken by neuston and bongo nets for cruises 7705 and 7803 combined.

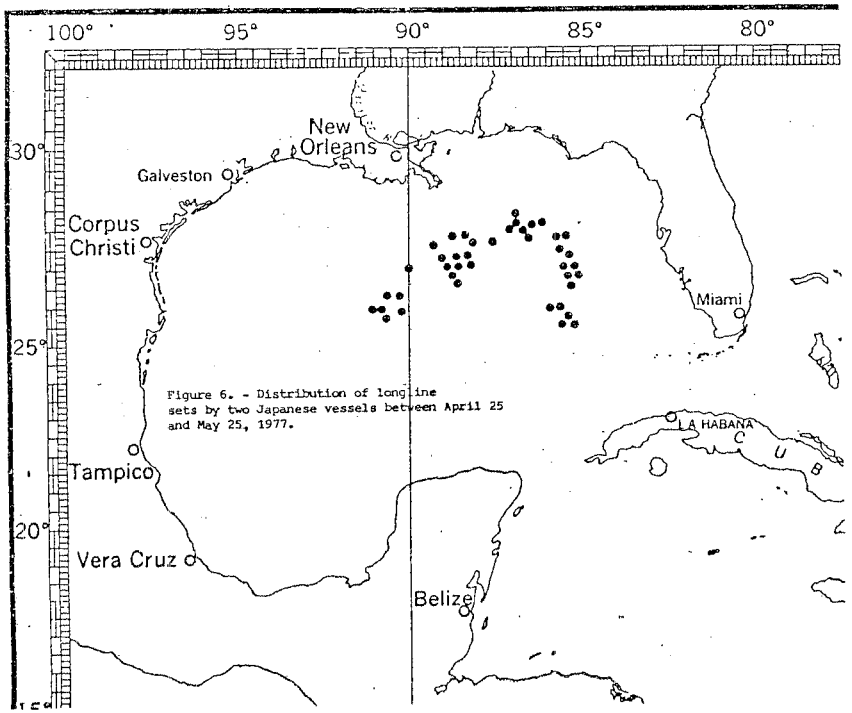

Figure 6. - Distribution of long line sets by two Japanese vessels between April 25 and May 25, 1977.