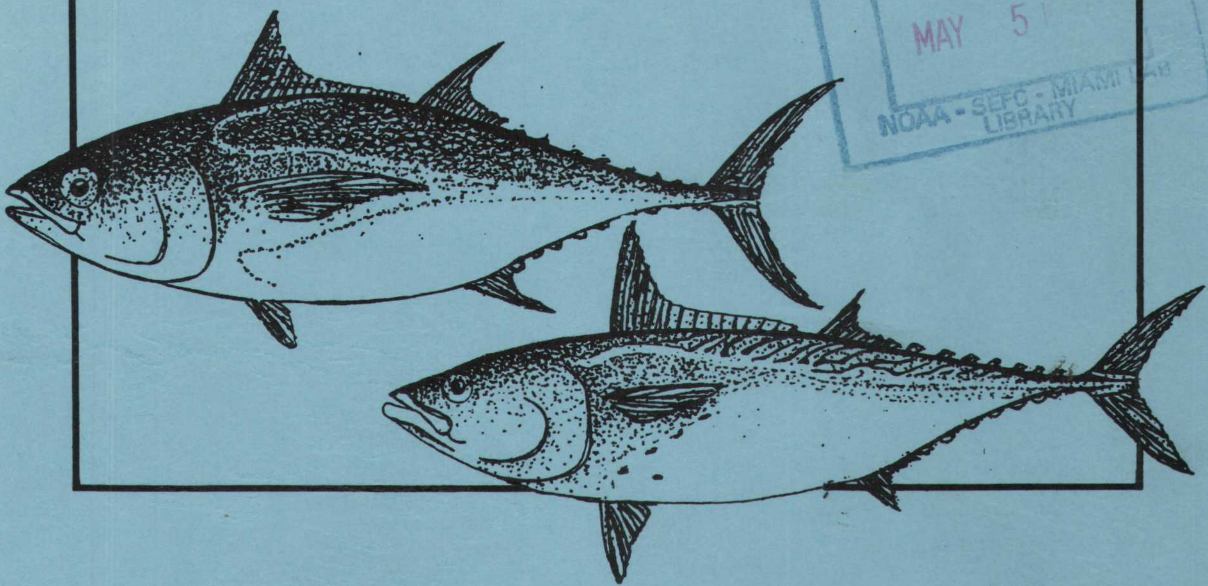
NOAA Technical Memorandum NMFS-SEFC-191

FISHERIES DEVELOPMENT FOR UNDERUTILIZED ATLANTIC TUNAS:

BLACKFIN AND LITTLE TUNNY



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MARCH 1987

U.S. DEPARTMENT OF COMMERCE
Malcom Baldridge, Secretary
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Anthony J. Calio, Administrator
NATIONAL MARINE FISHERIES SERVICE
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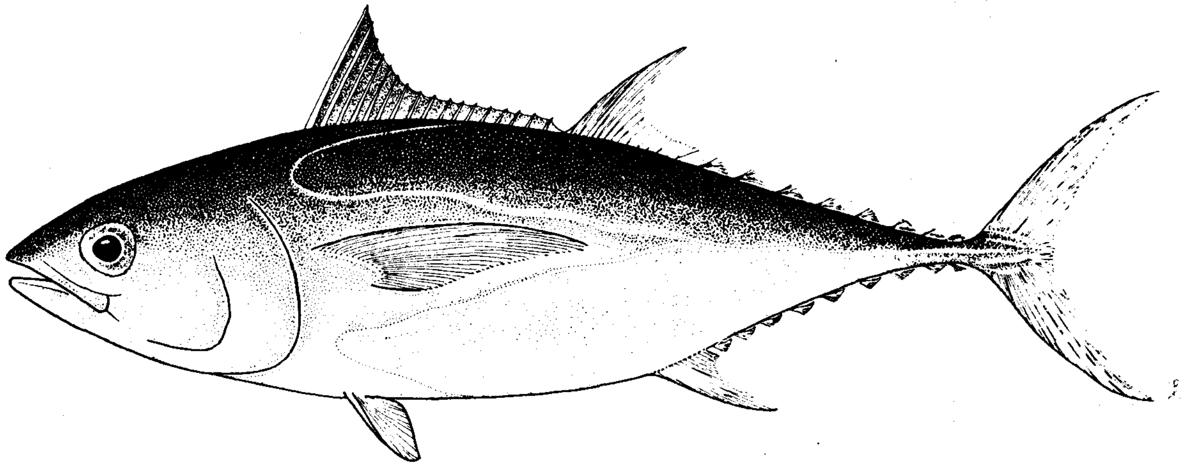
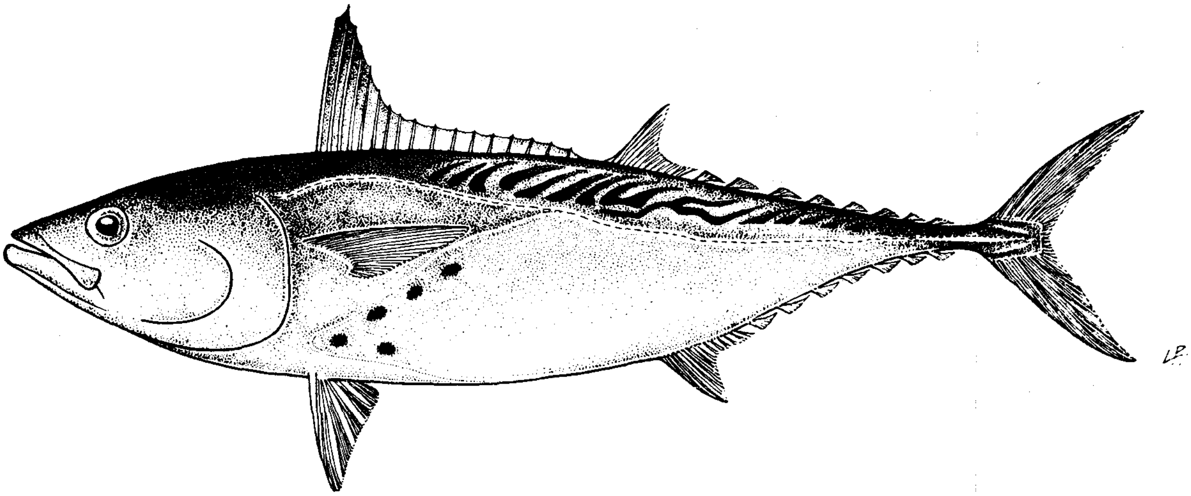


(a) Blackfin tuna, Thunnus atlanticus (Lesson)



Little tunny, Euthynnus alletteratus Rafinesque

(from Collette and Nauen, 1983)

B. **Executive summary**

A search of over 600 source documents, each of which dealt with some aspects of the biology or fisheries or for identifying blackfin tuna, Thunnus atlanticus, and little tunny, Euthynnus alletteratus, was conducted through the computerized search-systems available through the library of the Rosenstiel School of Marine and Atmospheric Science of the University of Miami. Additional material was extracted from the sources available to the collaborating authors, as well as from some additional data from the research documents of the Southeast Fisheries Center of the National Marine Fisheries Service. As a result of this analysis, separate species-profiles were developed for each of these tuna species.

In addition, commercial fisheries activities which include the target species were reviewed for the following areas: Cuba, Puerto Rico, Lesser Antilles, Hispaniola, Venezuela, Brazil, West Africa, and the United States. Recreational fisheries in the U.S. and adjacent areas were also reviewed.

Available information on artisanal fishery techniques and utilization was included. Some topics treated in the species-profiles have included nomenclature, distribution, and migration, age and growth, fecundity, spawning season and larval distribution, behavior, environmental responses, and food and feeding habits. Predators and competitors were also reviewed.

A bibliography of over six hundred citations was developed, covering all aspects of biology and fisheries-related information of these and closely related species.

Also presented is an appendix section which provides selected tabular material and graphic depictions of computer-generated information of important catch data.

The entire document provides a working point of departure for present and future researches, managers, commercial and recreational fisheries representatives, and others who may wish to develop the presently underutilized fishery for "small" tunas of the world.

Recommendations by potential users for future review and orientation of effort as follows:

This project's requirements did not call for an analysis of present or future use of "small" tunas. however, it is clearly evident to the present authors that there is a tremendous potential for these fish, which may broadly include the following:

1. Upgrading and analysis of statistical data on "small tuna".
2. Conducting intensive shore-based interviews with present resource-users.
3. Satellite location of commercial concentrations.
4. Development of fisheries oceanography and fisheries ecology.
5. Development of experimental attracting systems (FADS).
6. Evaluation of demonstration of fishing methods.
7. Product development, such as:

   sashimi/sushi/surimi

   Specialty products, i.e., "blackened" tuna; smoked "beer" tuna

   Pet food

   Blended product forms

   Speciality-can packs, such as spiced vegetable/tuna packs

   Investigations of present and potential foreign market opportunities.
8. Test marketing. i.e., taste-tests in various countries and/or cultures.

C. <u>Introduction and acknowledgments</u>

This constitutes a report to the U.S. National Marine Fisheries Service to summarize existing published literature, and includes unpublished field observations and catch data on the blackfin tuna and little tunny.

The present study reflects a wide spectrum of communication and cooperation from a diverse group of contributors. The work was supported through a U.S. Department of Commerce contract, NOAA Number 50-WCNF-6-06045, dated 1-22-86. The NOAA representative Mr. William J. Becker of the Central Administrative Support Center, Kansas City, MO, extended himself to accommodate special requirements which evolved during the contract period. The contractor's technical representative, Mr. Rolf Juhl of the Southeast Fisheries Center (NMFS), was extremely helpful in identifying obscure sources of information and assisting in obtaining manuscripts and data. Others from the Southeast Fisheries Center who were particularly helpful include William Richards, Grant Beardsley, Eugene Nakamura, Harold Brusher, Barbara Palko, Lloyd Regier, Rick Minkler, and Charles Manooch, III, also from NMFS. Appreciation is expressed to Howard Yoshida, James Squire, Paul Sund, and Sus Kato of the Southwest Fisheries Center, to Bruce Collette of the National Systematics Laboratory, and to Alan Peterson and Merton Ingham of the Northeast Fisheries Center. William Jerome of the NMFS Northeast Region Staff also contributed valuable information.

The authors are particularly grateful for helpful sources and literature from John P. Wise of ICCAT, W.L. Klawe and William Bayliff of the IATTC, S.R. Madhu of the UNDP Bay of Bengal Program, Omar Muñoz-Roure of the Caribbean Fishery Management Council, and Terrance P. Leary of the Gulf of Mexico Fishery Management Council.

Special appreciation is offered to Bruce Coblentz of Oregon State University and Ed Scott, Southeast Fisheries Center, NMFS, Miami, for sharing unpublished information. Ms. Kay Hale and her staff at the University of Miami RSMAS Library gave unstinting and selfless assistance in identifying and locating obscure references. We thank Marilyn Greene, Marleen Gordon, and Margaret Brown for their able assistance in typing this manuscript.

D. Species profile for the blackfin tuna, Thunnus atlanticus

1. Taxonomy

a. Introduction

The blackfin tuna is a relatively small, common tuna inhabiting the tropical blue waters of the western Atlantic Ocean. It presently is not an important commercial species, but is widely caught in recreational fisheries.

b. Identity

1) Taxonomic classification of the blackfin tuna

The taxonomy and morphology of the blackfin tuna has been exhaustively treated by Gibbs and Collette (1967). A summary of diagnostic features is given by Collette and Nauen (1983) as follows:

Diagnostic features: A small species of tuna, deepest near middle of first dorsal fin base. Gillrakers few, 19 to 25 on first arch. Pectoral fins moderate in length, usually 22 to 31% of fork length. Ventral surface of liver not striated, right lobe longer than center and left lobes. Small swimbladder present. Vertebrae 19 precaudal plus 20 caudal. Color: back metallic dark blue, lower sides uniformly silvery grey or with pale streaks and spots at least partly in vertical rows, belly milky white; first dorsal fin dusky, second dorsal and anal fins dusky with a silvery luster; finlets dusky with a trace of yellow.

2) Species nomenclature

The blackfin tuna's scientific name is Thunnus atlanticus (Lesson, 1830). Various synonyms used by other authors, based upon Collette and Nauen (1983), are as follows:

Thynnus coretta Cuvier, 1831

Thynnus balteatus Cuvier, 1831

Thunnus balteatus South, 1845

Thunnus coretta South, 1845

Orcynus balteatus Poey, 1868

Parathunnus rosengarteni Fowler, 1934

Parathunnus ambiguus Mowbray, 1935

Parathunnus atlanticus Beebe and Hollister, 1935

Thunnus atlanticus Rivas, 1951

3) Standard common names and vernacular names

a) FAO names: En - blackfin tuna; Fr - thon à nageoires noires; Sp - atún aleta negra.

b) Other vernacular names

United States -	Atlantic blackfin tuna
	blackfin tuna
	albacore
	albacora
	Bermuda tuna
Brazil -	albacora preta
British Guiana -	blackfin bonito
West Indies -	blackfin tuna
	blackfinned tuna
	blackfin bonito
	blackfin albacore
	bonito
	thon
	thon nuit

	thon noir
	baillolet
	petit thon (Patois)
Haiti -	bonite
	deep-bodied tunny
Bermuda -	bigeye tuna (confused with *T. obesus*)?
Martinique -	petit thon
	bonite noir
Saintes -	thon noir
Guadeloupe -	thon noir
	giromon
St. Lucia -	thon nuit
Cuba -	albacora

(largely from Rosa, 1950, and Morice and Cadenat, 1952).

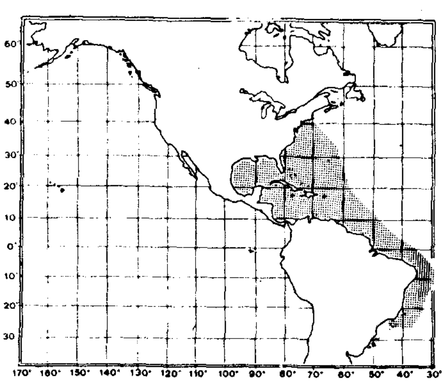
2. Biology

a. Distribution

1) Range

The blackfin tuna is apparently limited to the tropical western Atlantic from Rio de Janeiro and Trinidade Island (Brazil), northward to Cape Cod, Bermuda, and throughout the Caribbean and the Gulf of Mexico (Rosa 1950; Morice and Cadenat, 1952; Mather and Gibbs, 1957; Springer and Bullis, 1956). According to Rivas (1961:131), a blackfin tuna identified by the International Game Fish Association from off Capetown, South Africa, may be in reality a bigeye tuna, *Thunnus obesus* (Lowe). In the western South Atlantic and in the eastern Atlantic, confusion of the blackfin with *T. obesus*, and even small individuals of *T. albacares*, may have occurred. A report from FAO (1976) stated that "The Committee (on small tunas) recommends that FAO instruct the Working Party on Tuna and Billfish Taxonomy to verify the suspected occurrence of blackfin tuna in the eastern Atlantic Ocean."

Figure 1. Distribution of the blackfin tuna.



2) Seasonal Changes

Adults occur commonly throughout the western North Atlantic at least as far north as Ocean City, Maryland. Off Miami, Florida, blackfin tuna occur most commonly in anglers' catches in the fall (November and December) and spring (April and May) (de Sylva, unpublished).[1] Large schools of blackfin tuna are observed throughout the Gulf and Caribbean areas (Springer, 1957; Wathne, 1959). Rawlings (1951) discussed the occurrence of blackfin tuna off Cuba, which is now more fully documented by Suárez-Caabro and Duarte-Bello (1961 and elsewhere in the present report.

In Florida and Cuba, the blackfin tuna occurs throughout the year in anglers' and commercial catches, respectively (de Sylva, unpublished data; Suárez-Caabro and Duarte-Bello, 1961). Morice and Cadenat (1952) gave information for the occurrence of blackfin tuna in the Caribbean. They added that it is common around Barbados and the west coast of Tobago, and that it is one of the most commonly found tuna in the Lesser Antilles. Springer (1957) noted large concentrations of blackfin tuna past the 200-fathom curve from Pascagoula, Mississippi. Compact schools of tuna were estimated at 4- to 10-pound fish.

[1]These data were destroyed in a fire at the University of Miami in 1967.

The following translation of Marcille (1985) sheds light on seasonal changes in the Lesser Antilles:

"This blackfin tuna is common to all the west-central Atlantic. In the Lesser Antilles, it is present year round but more specially in the Caribbean around the banks of Aves Island and at the openings of the channels which separate the islands. It is generally fished from Barbados, in the northwest of Tobago, to Grenada and St. Lucia, but the greatest concentrations are found in the north of the lesser Antilles to the east of Puerto Rico. The observation of shoals of blackfin, generally of medium importance and very migratory, is almost always facilitated by their activity at the surface or by the presence of birds; they descend to great depths and constitute an important contribution to the troll fishery up to the beginning of the summer, but they can be occasionally captured by beach seines at St. Lucia and the Virgin Islands (Morice and Cadenat, 1952). According to Maghan and Rivas (1971), the greatest concentrations are observed over depths of 20 to 700 meters, with a peak approaching 40-50 meters."

3) Movement/migration patterns

Seasonal changes in distribution can be analyzed quantitatively to obtain information on migratory patterns analyzed from three sources: a) exploratory fishing for potential sources for commercial purposes; b) recreational catch statistics; and c) tag returns. The exploratory fishing information is best in the Gulf of Mexico, based upon surveys carried out by various vessels of the National Marine Fisheries Service and cooperating vessels (see, for example, Commercial Fisheries Review, 1952 *et seq.*).

a) Exploratory fishing

Some of these data have been analyzed by Maghan and Rivas (1971) for the Gulf of Mexico, Caribbean Sea, and adjacent areas. Their data indicate five major areas of occurrence: off the Mississippi River Delta, Nicaraguan shelf, Cuban coast, northern Lesser Antilles to the west coast of Puerto Rico, and northeast coast of Brazil (Figs. 2-6). A general northward movement is indicated from the central Caribbean during winter progressively northward with spring-summer, followed by a return by winter to the central Caribbean. See also the Appendix tables.

b) Recreational catch statistics

Data have been taken from Williams et al. (1985) report on catch and effort data from the charterboat sport fishery in the United States. These data are discussed in the section on catch statistics under Part F,2, Recreational fisheries. See also the Appendix tables.

c) Tag returns

(1) Results of commercial tuna tagging in Cuba (summarized from Suárez-Caabro and Duarte-Bello, 1961).

In 1959, a total of 1999 tuna of two species were tagged off southwestern Cuba in nine areas of the commercial fishing zone (Fig. 7). Here, 1458 blackfin tuna, or 73% of the total tuna were tagged. No distinction was made by the fishermen between the two species, and, unfortunately, when the tags were recovered the authors could not obtain information from the fishermen on which fish recovered were blackfin tuna or skipjack.

They recovered 89 tags or 4.5%. Areas from which tuna were tagged and returned are shown in Figure 7. The tagging was done in April, May, June, and July of 1959. They noted that 50% of the recovered fish traveled more than one mile daily. About 25% include those which traveled less than one mile daily and belong to the group of fish recovered six months after tagging. Figure 7 and Table 1 show the distance traveled and the number of days between tagging and recovery:

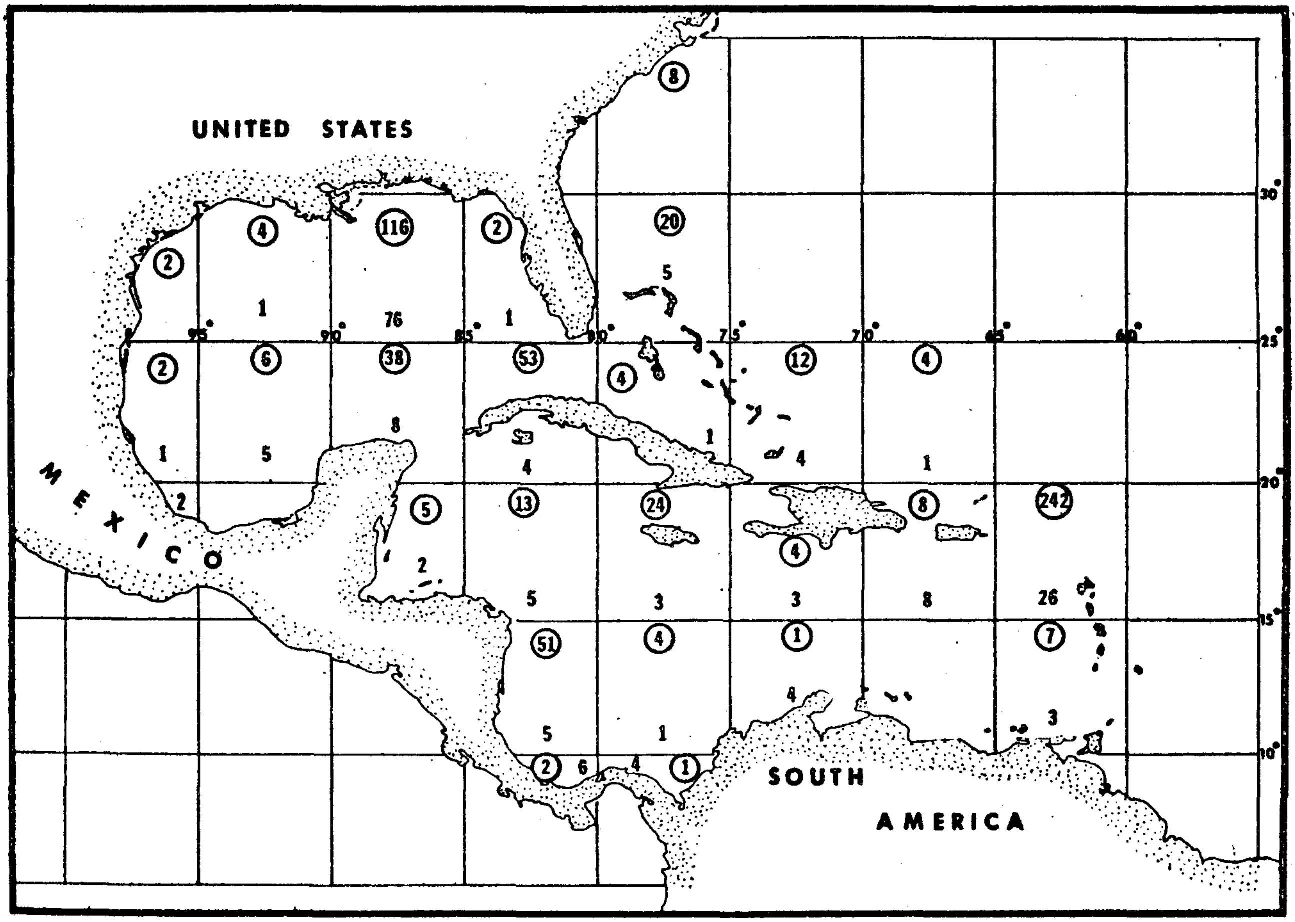


Figure 2. Total catches (circled numbers) and sighting of blackfin tuna in the Gulf of Mexico, Caribbean Sea, and adjacent areas, 1950-68. (Maghan and Rivas, 1971).

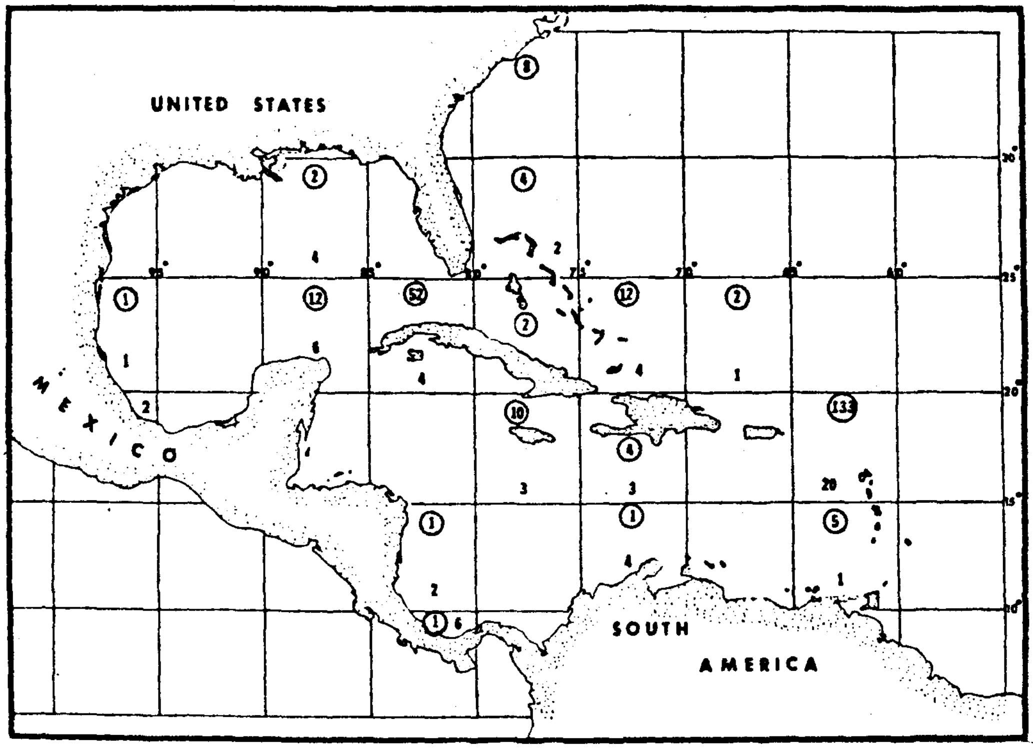


Figure 3 Spring catches (circled numbers) and sighting of blackfin tuna in the Gulf of Mexico, Caribbean Sea, and adjacent areas, 1950-68. (Maghan and Rivas, 1971)

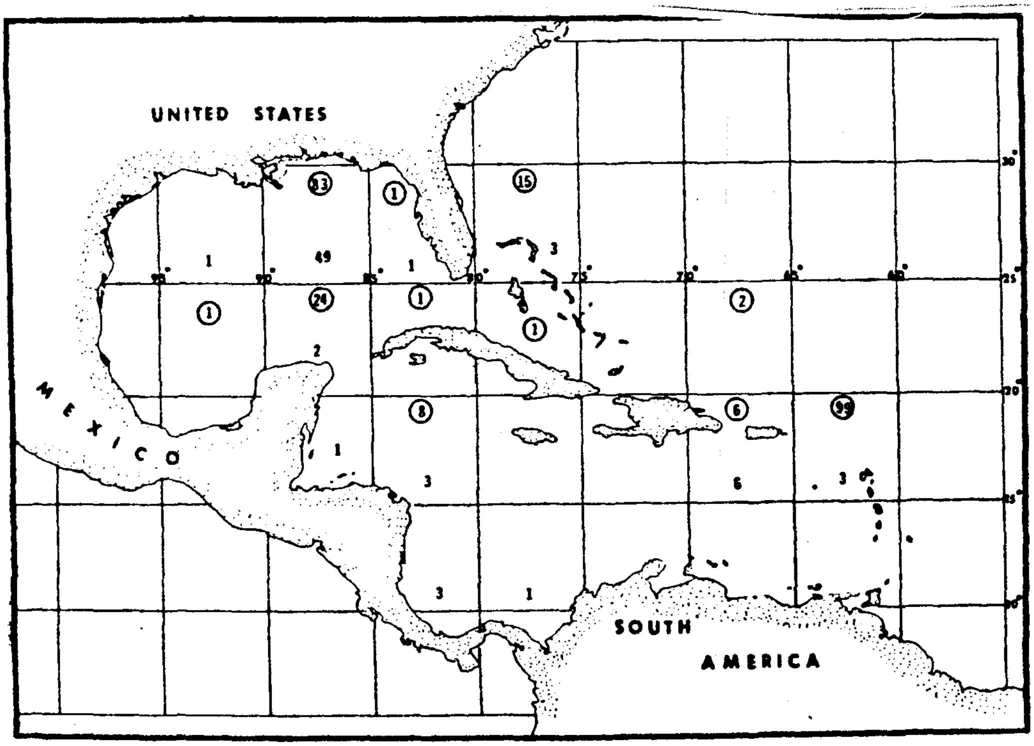


Figure 4. Summer catches (circled numbers) and sighting of blackfin tuna in the Gulf of Mexico, Caribbean Sea, and adjacent areas, 1950-68. (Maghan and Rivas, 1976).

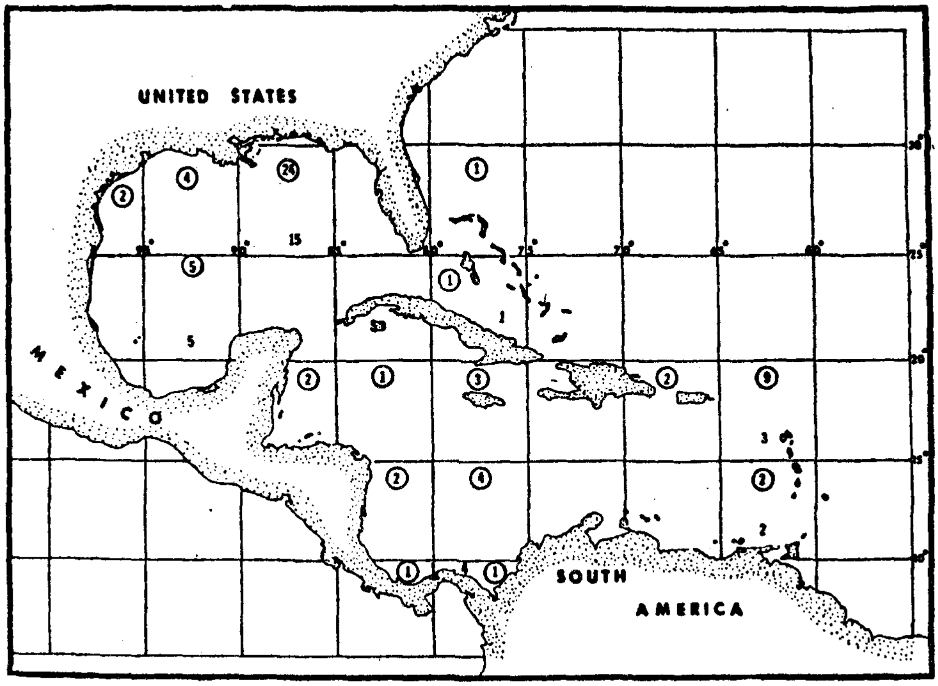


Figure 5. Autumn catches (circled numbers) and sightings of blackfin tuna in the Gulf of Mexico, Caribbean Sea, and adjacent areas, 1950-68. (Maghan

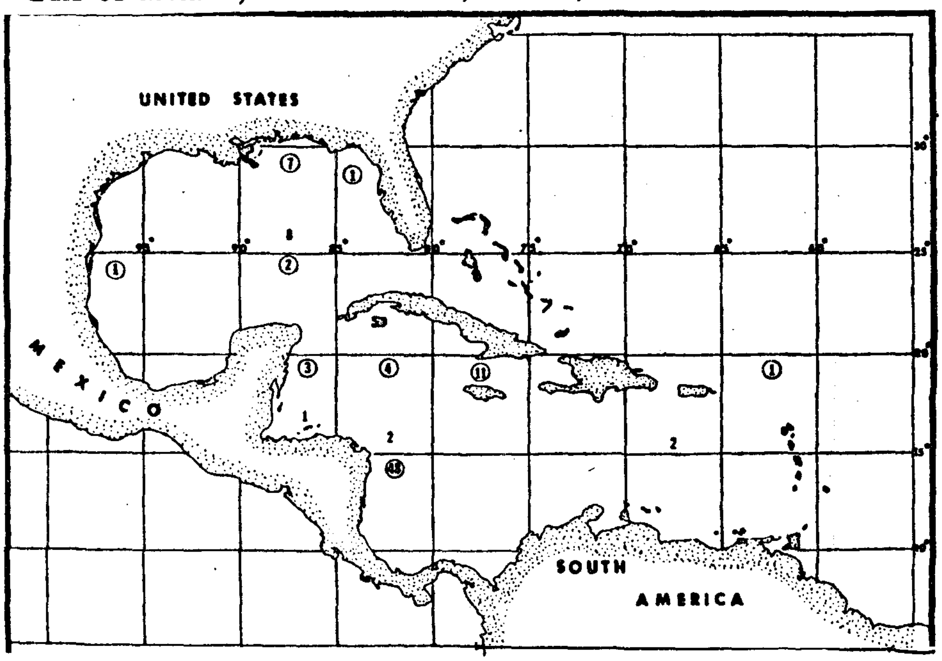


Figure 6. Winter catches (circled numbers) and sightings of blackfin tuna in the Gulf of Mexico, Caribbean Sea, and adjacent area, 1950-68. (Maghan and Rivas, 1971).

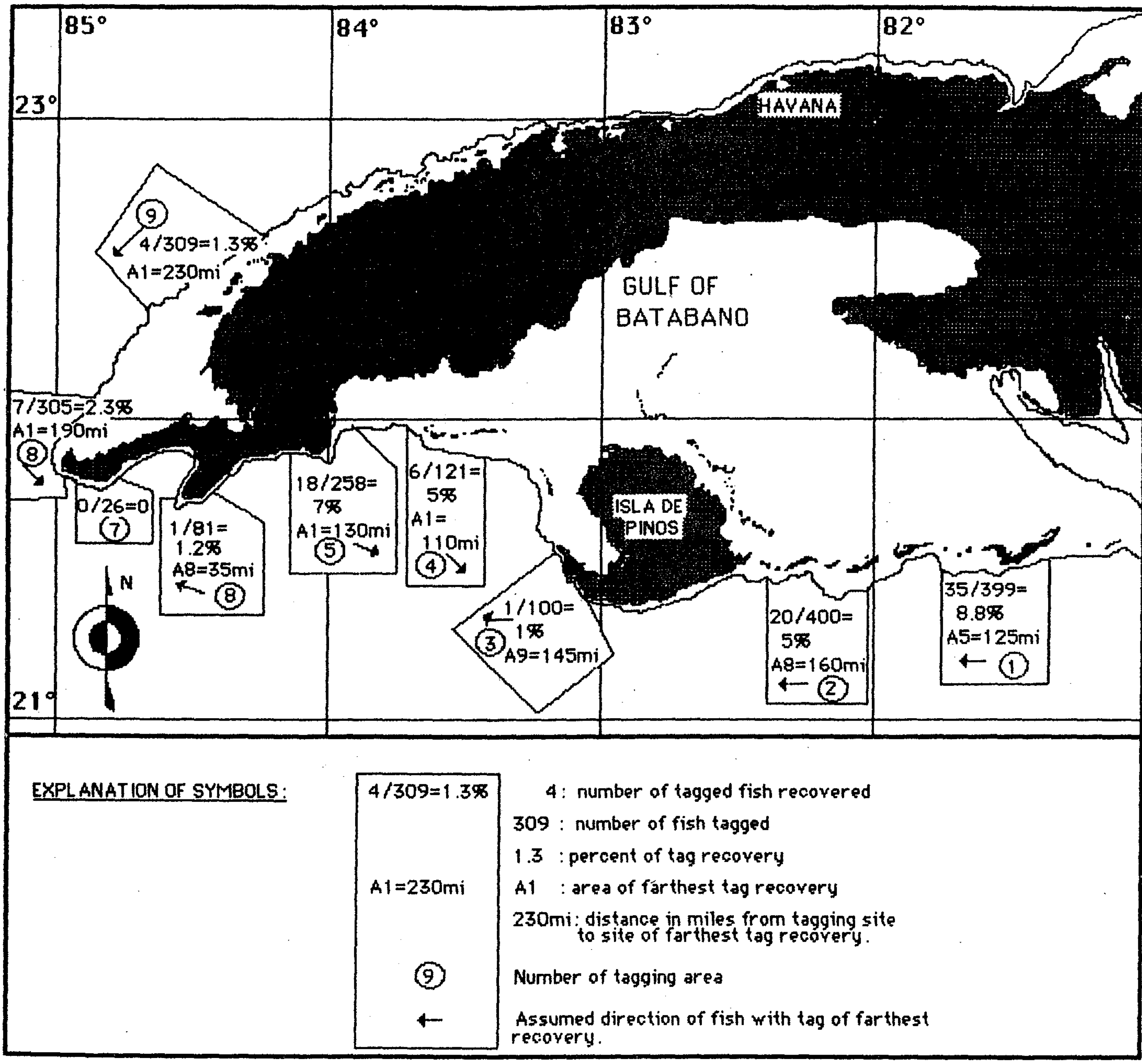


Figure 7. Map of tuna tagging in Cuba in 1959.

Table 1
Days blackfin tuna recovered after tagging

Distance traveled in miles	1-15	16-30	31-45	46-60	61-75	76-90	91-105	More than 105
Less than 50 miles	25[1]	13	8	9	1	3	2	9
More than 50 miles	2	1	3	1	1	1	3	7

[1] Number of fish

Almost 70% of the fish tagged were recovered within 60 days after tagging. According to the information gathered from the tags recovered, the schools of tuna in that area usually travelled about 15 to 20 miles a day. This does not means that this was the maximum distance a fish could travel in that time as the distance was considered to be a straight line from the point of tagging to the place of recovery. We consider that no tags were recovered in other areas around the island because there was no commercial fishery for tuna at that time elsewhere in Cuba.

(2) <u>Results of blackfin tuna tagging in the recreational fishery</u>

Mr. Ed Scott, Southeast Fisheries Center, NMFS, Miami, kindly supplied a printout of his records of the SEFC tagging program for oceanic pelagics. During this period (1973-85), 1234 blackfin tuna were tagged, and 22 (1.8%) were recovered (Tables 2 and 3). Of the total tagged, 272 were tagged in the vicinity to Bermuda, and 18 (6.6%) were recaptured, all of them around Bermuda. This rather high tag rate here suggests a high mortality due to sport fishing.

Table 2

Results of tagging of blackfin tuna in and around Bermuda, 1973-1985. Data courtesy of Southeast Fisheries Center, NMFS, Miami. All fishes tagged were recovered in the same sport fishing area.

Date tagged	Date recaptured	Est. size (lbs) at release	Size (lbs) at recapture	Days at large
08/06/84	27/07/85	10	13	414
31/07/85	31/07/85	15	26	0
31/07/84	16/09/84	19	20	47
24/06/84	22/06/85	15	20	363
05/07/83	09/06/84	15	19	340
05/07/83	01/08/84	12	15	393
01/07/83	22/06/84	18	20	357
01/07/83	24/06/84	10	11	359
01/07/83	08/11/83	-	-	130
06/08/83	09/10/83	2	3	64
26/05/84	22/07/84	18	20	57
21/09/80	27/08/81	20	22	340
22/05/85	11/06/85	5	10	20
19/06/83	21/06/84	8	10	368
13/06/83	22/06/83	-	18	9
18/06/83	20/07/83	-	8	32
20/01/74	14/06/74	15	16	145
11/11/73	09/06/74	15	19	210
				3,648

Table 3

Results of tagging of blackfin tuna in the western North Atlantic, exclusive of Bermuda, 1973-1985. Data courtesy of Southeast Fisheries Center, NMFS, Miami

Tagging location	Recapture location	Date tagged	Date recaptured	Est size (lbs) at release	Size at recapture	Days at large
27°00'N 79°50'W	26°40'N 79°50'W	12/12/75	24/04/76	-	8	134
25°'N 80°00'N	28°00'N 80°00'N	14/12/74	12/11/82	1	1	2,890
24°00'N 80°00'W	26°50'N 80°00'W	12/06/73	28/05/74	6	10	350
24°50'W 80°20'N	20°50'W 80°20'W	01/01/73	10/01/73	12	25	10

Data are presented for blackfin tuna recaptured around Bermuda (Table 2). Time at large ranged from 0 to 393 days, with an average of 203 days.

Data on recaptures of tagged blackfin tuna from elsewhere in the western Atlantic are limited. Of the 962 blackfin tuna tagged between New England and Cozumel (Mexico), four were recaptured (Table 3). These fish were tagged and recaptured in Southeast Florida.

(4) Age and growth

a) Age and size/weight relationships

Preliminary studies (de Sylva, unpublished data) show that on the basis of scale analysis (Idyll and de Sylva, 1963) a blackfin tuna of 15 pounds and about 70 cm fork length is five years old. Since the species reaches a weight of at least 42 pounds (IFGA, 1986), this species attains an age greater than five years. Carlés (1974) studied age and growth of blackfin tuna from the Cuban coasts using annular rings on vertebrate, and reported the results as follows:

Age, years	Mean lengths, cm
I	40
II	51
III	58
IV	64

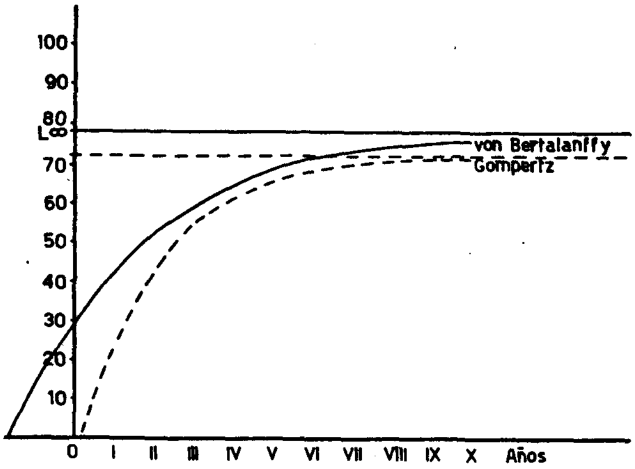


Figure 8. Growth curve of the blackfin tuna (Carlés, 1974).

From the above graph, it can be seen that the blackfin tuna attains at least 10 years of age. The length-weight relationship given by Maghan and Rivas (1971), based upon the Cuban fishery (Suárez-Caabro and Duarte-Bello, 1961) and upon the Brazilian fishery (da Cruz, 1965), shows that the longest fish was nearly 80 cm fork length (FL) and a weight of 24 pounds. Because the largest blackfin tuna known (taken by sport fishing) is 42 pounds (IGFA, 1986), this species must live much older than 10 years. Reports that this species exceeds 60 pounds (Mowbray, cited by Rivas, 1951: 220) probably are due to misidentifications with other tuna species, especially the bigeye tuna, Thunnus obesus.

The von Bertalanffy growth curve is given as:

K = 0.33, L_∞ = 72 cm, y axis intercept = -1.57 years.

The Gompertz growth curve is:

K = 0.52, L_∞ = 72 cm, y axis intercept = 0.2963 years.

Carlés (1974) gave the following table:

Composition by groups by age of capture

Age, years	No.	Error	Confidence limits (95%)	
I	46,417	1,584	43,312	49,523
II	358,589	6,876	34,512	372,065
III	77,296	2,162	73,058	81,534
IV	15,738	1,576	12,650	18,826

b) Length and weight relationship

For the size range 28-26 cm, the length-weight relationships (Suárez-Caabro and Duarte-Bello, 1961)for blackfin tuna of both sexes from Cuba is:

$$P = 1.376 \times 10^{-2} L^{3.10404}$$

For blackfin tuna from Brazil, Nomura and da Cruz (1967) gave the following regression based upon 611 eviscerated specimens over a size range of 45 to 79 cm:

$$\log W = -2.183 + 3.248 \log L$$

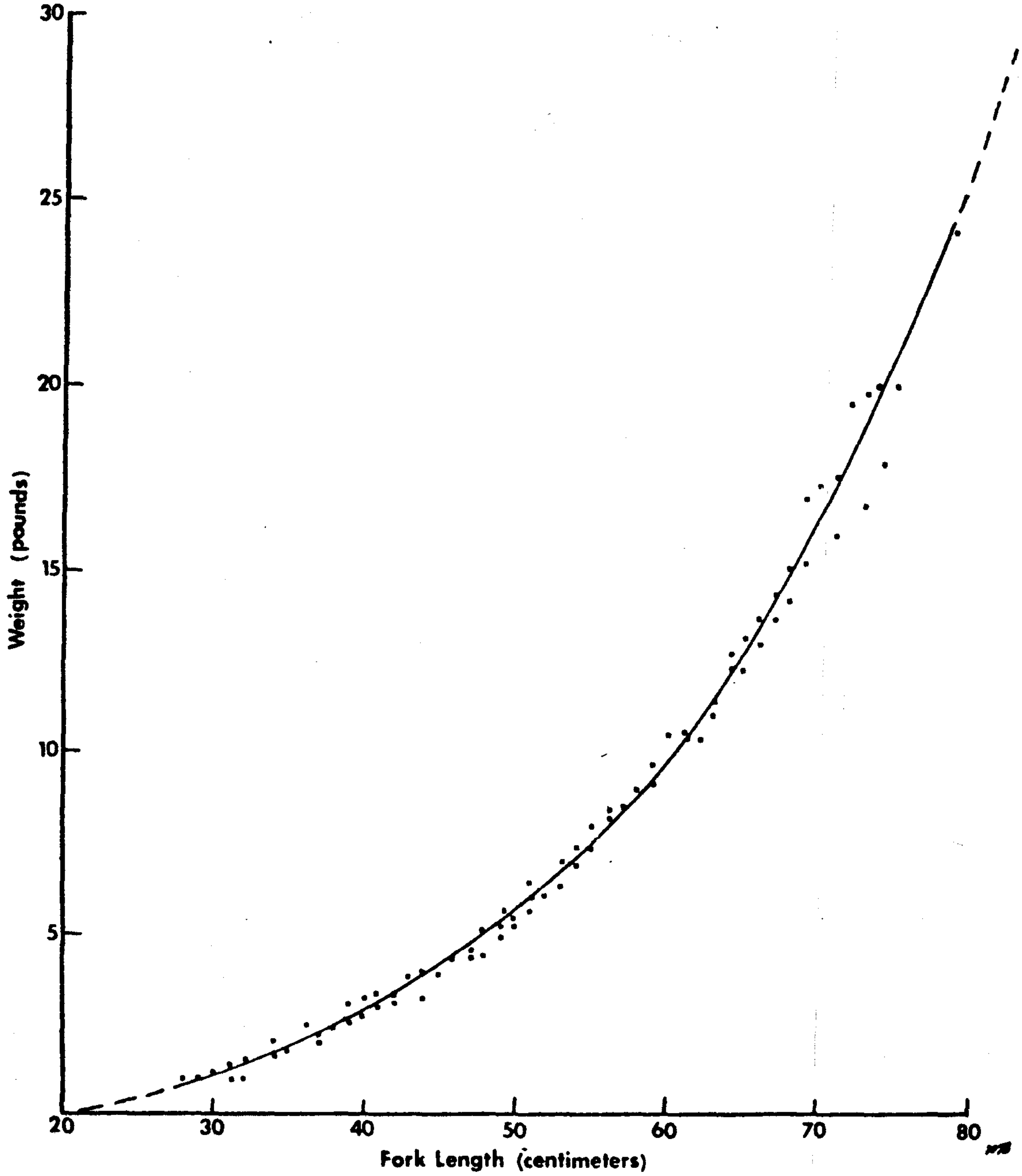
They also gave an equation for the conversion of eviscerated weight to total weight as:

$$Y = 37.681 + 0.836 X,$$

where Y = the eviscerated weight and X is the total weight. The correlation coefficient r for this equation is 0.985.

In Fig. 9 note that data for fish larger than 24 pounds are not available, even though this species reaches 42 pounds (IGFA, 1986).

Figure 9. Length-weight relation of blackfin tuna (Thunnus atlanticus) based on 1895 specimens, 28 to 79 cm in fork length (1-24 lb), from U.S. Bureau of Commerical Fisheries exploratory data, the Cuban Fishery (Suárez-Caabro and Duarte-Bello, 1961:78) and the Brazilian fishery (da Cruz, 1965:35).



5) Reproduction

a) Age at sexual maturity

"Ripe females have been taken off Miami, Florida, in April at a fork length of 52 cm, corresponding to a weight of about 6 pounds, and an age of two years; ripe males have been found at a length of 48 cm. A weight of 4 1/2 pounds occurs at an age of about two years (de Sylva, unpublished data). Larger fish apparently ripen earlier in the year" (Idyll and de Sylva, 1963).

b) Sex ratio

"No information is available on the ratio of males to females at actual spawning time, but there are twice as many males as females in the anglers' catches off Miami, Florida, even during the spawning season (de Sylva, unpublished data" (Idyll and de Sylva). Suárez-Caabro and Duarte-Bello (1961) found a slight predominance of males in the commercial catch from Cuba.

c) Fecundity

Monté (1964) did not find a relation between length and fecundity over the size range of 58-66 cm FL, but Richards and Bullis (1974) noted that this was not surprising in view of the short size range of Monté's sample. Monté's fecundity values are shown in Table 4.

Table 4. Number of eggs per gram and per individual of blackfin tuna (after Monté, 1964).

Fork length (cm)	Weight of gonads (g)	Number of eggs per gram	Number of eggs per individual
58	75	3,800	285,000
58	60	3,200	192,000
60	76	3,800	288,800
60	70	3,700	259,000
61	64	3,300	211,200
61	71	3,800	269,800
62	60	3,250	195,000
62	70	3,600	252,000
65	68	3,500	238,000
65	65	3,400	221,000
65	70	3,700	259,000
66	80	4,000	320,000

The average fecundity for the 58-66 cm (FL) females was 249,333 eggs per individual from Monté's data. These are very high values due to Monté's method of including very small eggs in the counts (Richards and Bullis, 1974).

d) Spawning areas and seasons

The spawning season off Miami, Florida is from April to November (Idyll and de Sylva, 1963). Klawe and Shimada (1959) found small juveniles in the western and northern Gulf of Mexico in June; Potthoff and Richards (1970) found juveniles in the southeastern Gulf in June and July; Juárez (1972, 1974a, 1974b) and Juárez and Montolio (1975) have collected larvae from May to October in the Gulf of Mexico. Richards (unpublished data)[2] has taken larvae in the Straits of Florida from early April to mid-October, with peaks of abundance in the summer months. Richards, Jossi, and McKenney (1974) showed larval occurrences in the northern Caribbean in July and August and reported on two larvae in early March, also in the Caribbean. Two distribution charts each from Juárez (ms)[3] and Richards _et al._ (1984) are shown here as Figures 10, 11, 12, and 13.

Juárez (1978) collected tuna larvae around the Bahama Banks in August, 1976, and stated that the blackfin larvae represented 61% of the tuna larvae sampled, primarily in the Straits of Florida. Blackfin tuna were taken in nearly all stations (69.5%) (see Figure 14).

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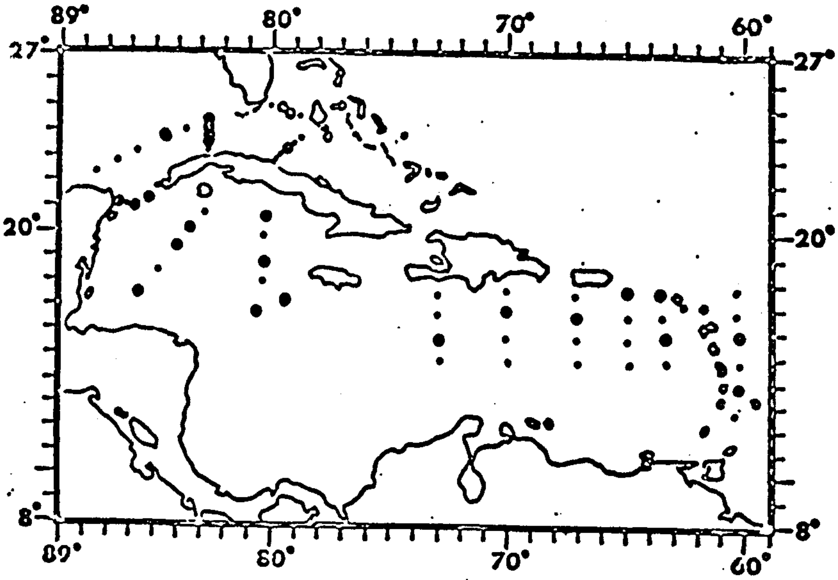
[2]W.J. Richards, National Marine Fisheries Service, Miami Laboratory, has these data in the data book of the laboratory.

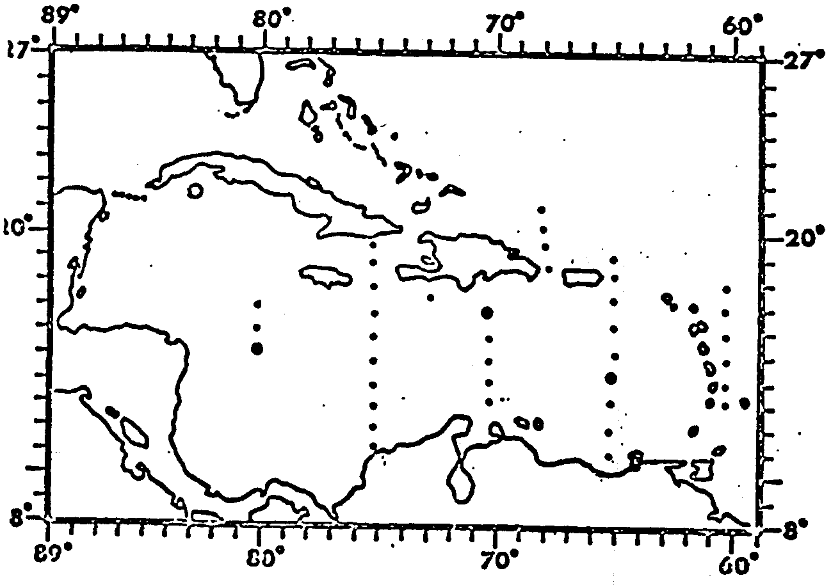
[3]Juárez, Mar. 1974. Distribución de las formas larvárias de algunas especies de la familia Scombridae en aguas del Golfo de México. Centro de Investigaciones Pesqueras, Cuba. Typescript manuscript.

Figure 10. Distribution of blackfin tuna larvae collected during MARMAP OTP 1, July-August 1972 by the FRV OREGON II. Small circles depict stations, large circles depict larvae.



OREGON II CRUISE 72-39

Figure 11. Distribution of blackfin tuna collecting during MARMAP STP II, January-March 1973 by the FRV OREGON II. Small circles depict stations, large circles depicit larvae.



OREGON II CRUISE 73-43

Figure 12. Distribution of blackfin tuna larvae in the Gulf of Mexico in August and September. Abundances are in numbers under 1 m^2 of sea surface (From Juárez, M.S.).

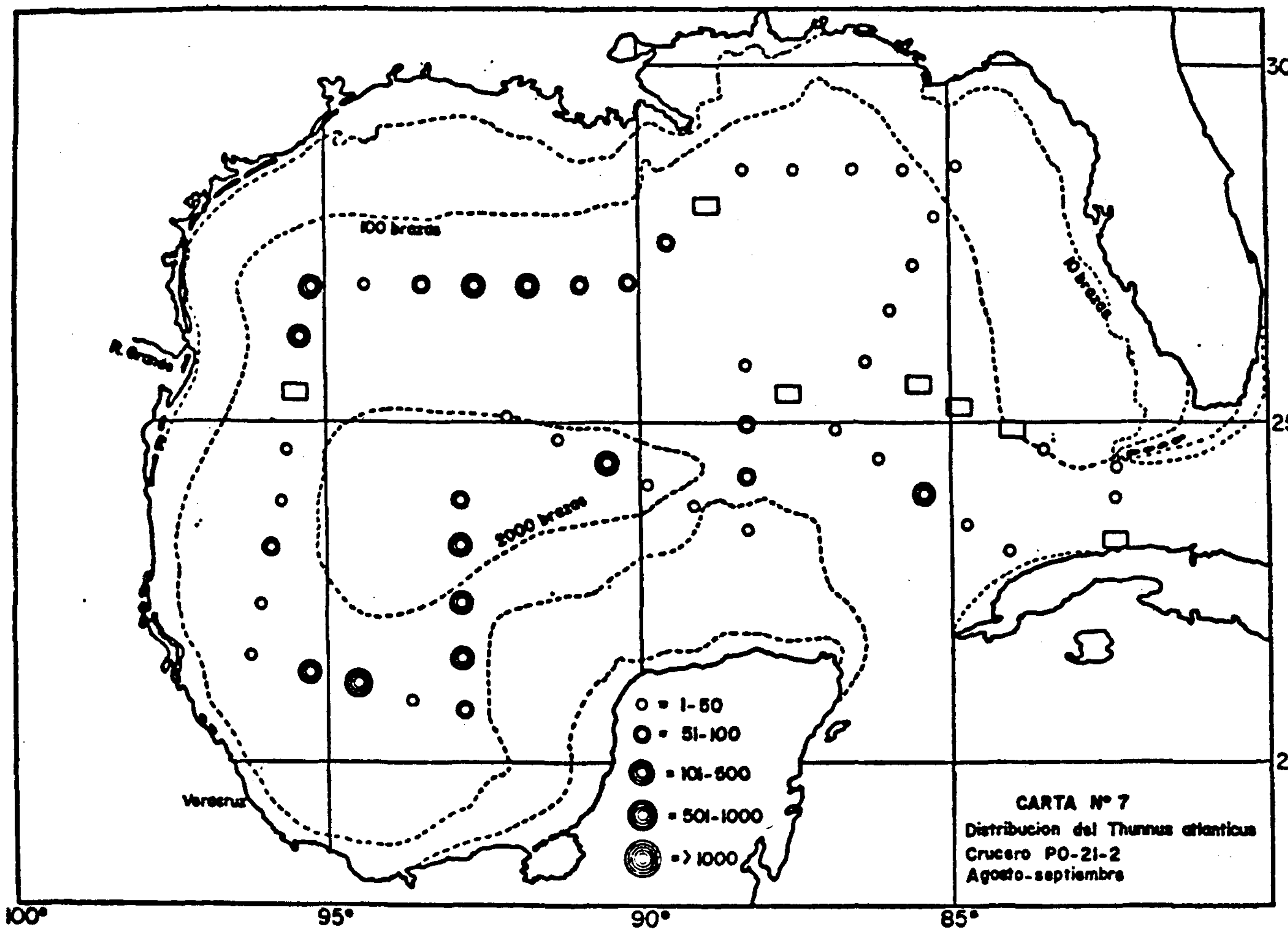


Figure 13. Distribution of blackfin tuna larvae in the Gulf of Mexico in October-November. Abundances are in number under 1 m^2 of sea surface (from Juárez, M.S.).

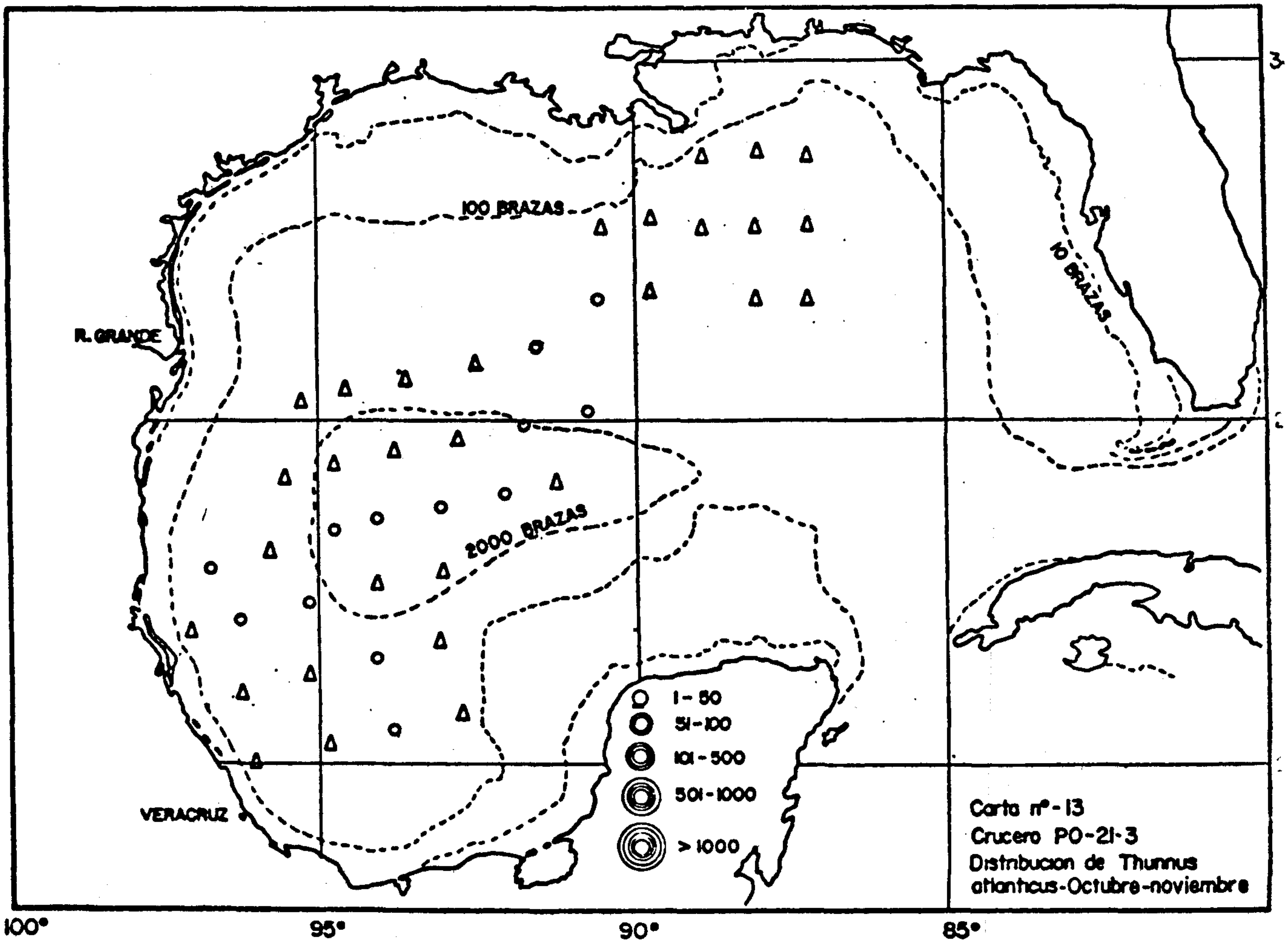


Figure 14. Larval distribution of Thunnus atlanticus in waters adjacent to the Bahamas, August, 1976. Numbers are larvae/m^2 (Juárez, 1978).

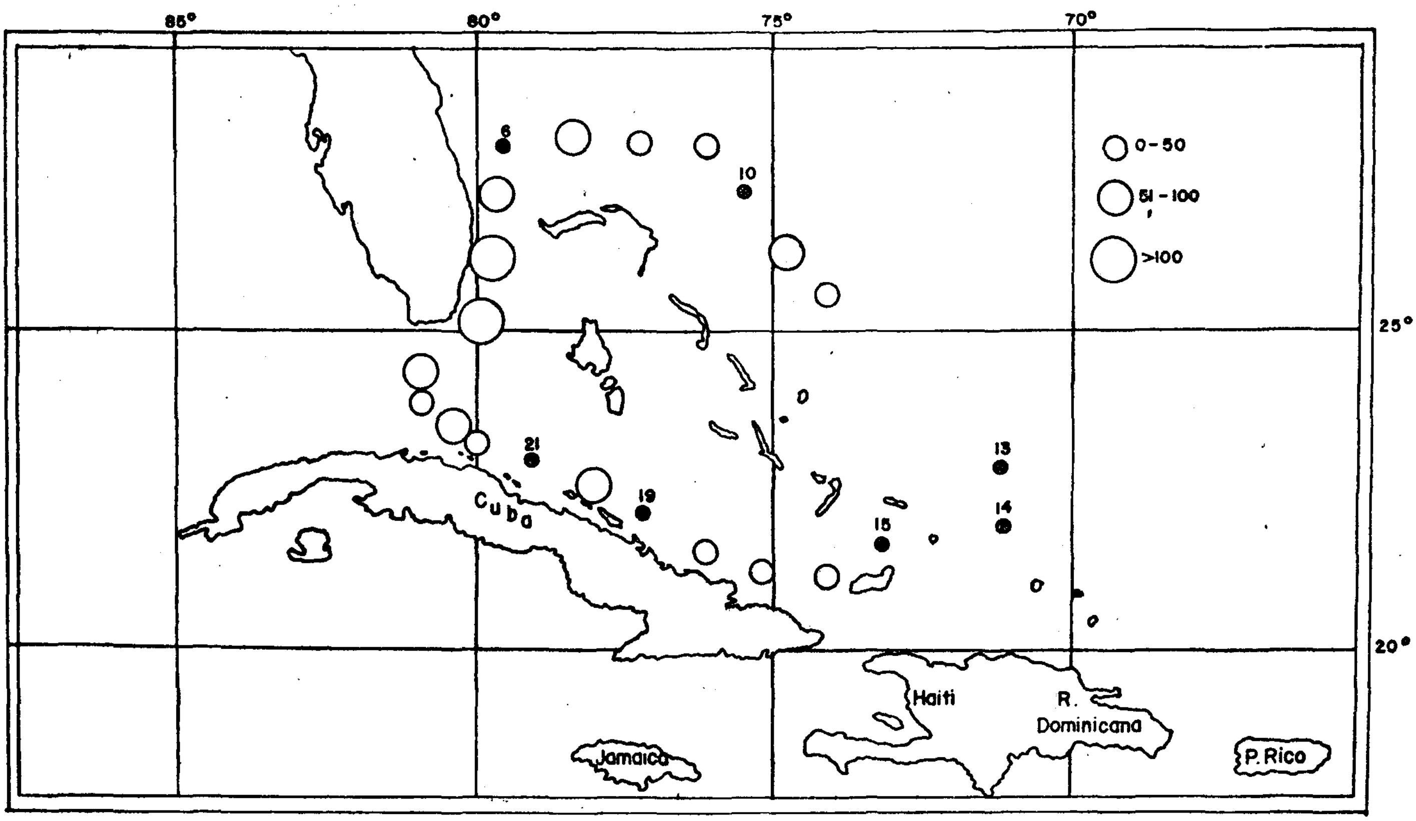


Figure 15. Distribution of blackfin tuna larvae collected during MARMAP OTP I, July-August 1982 by the FRV OREGON II. Small circles depict stations, large circles depict larvae.

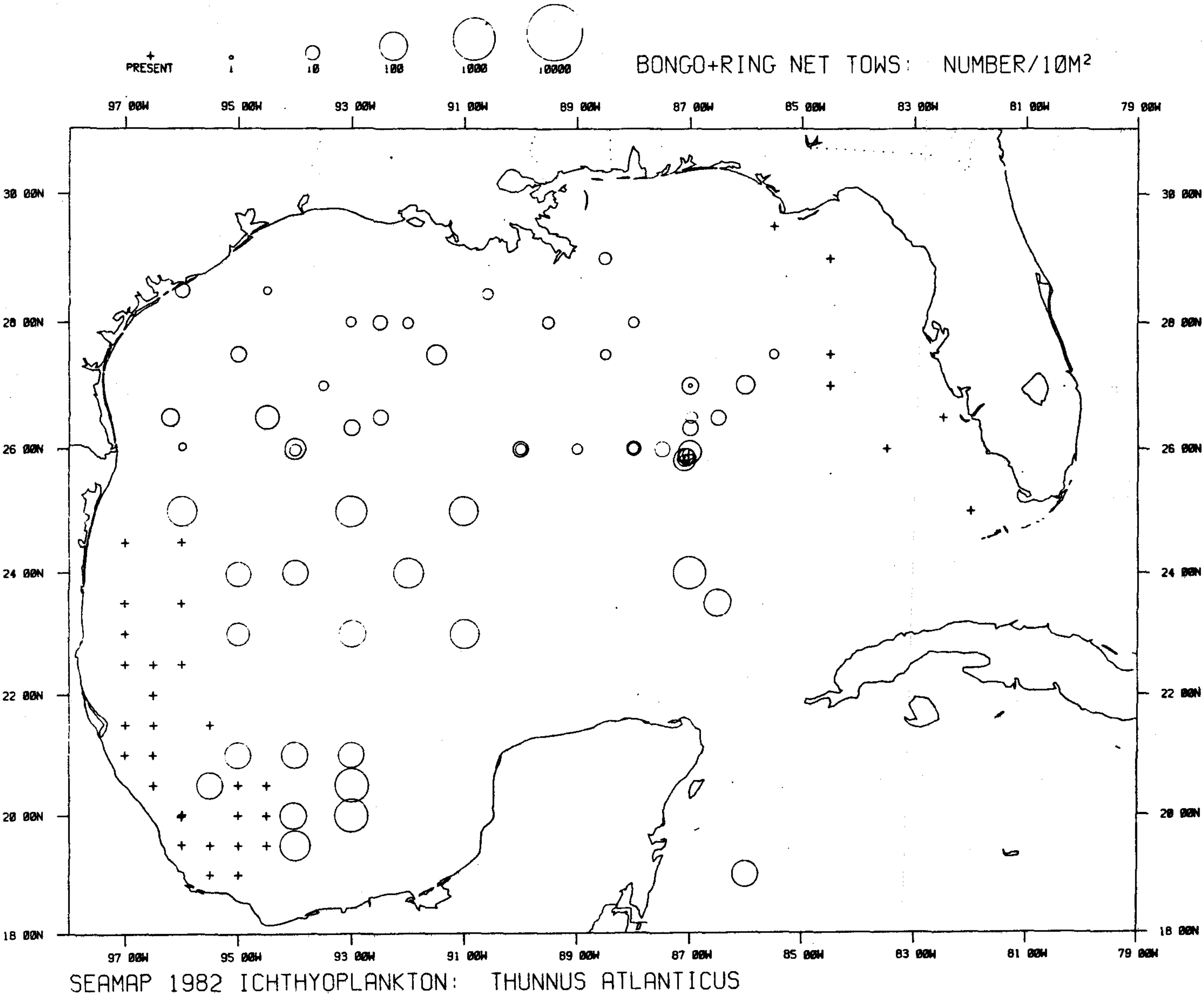
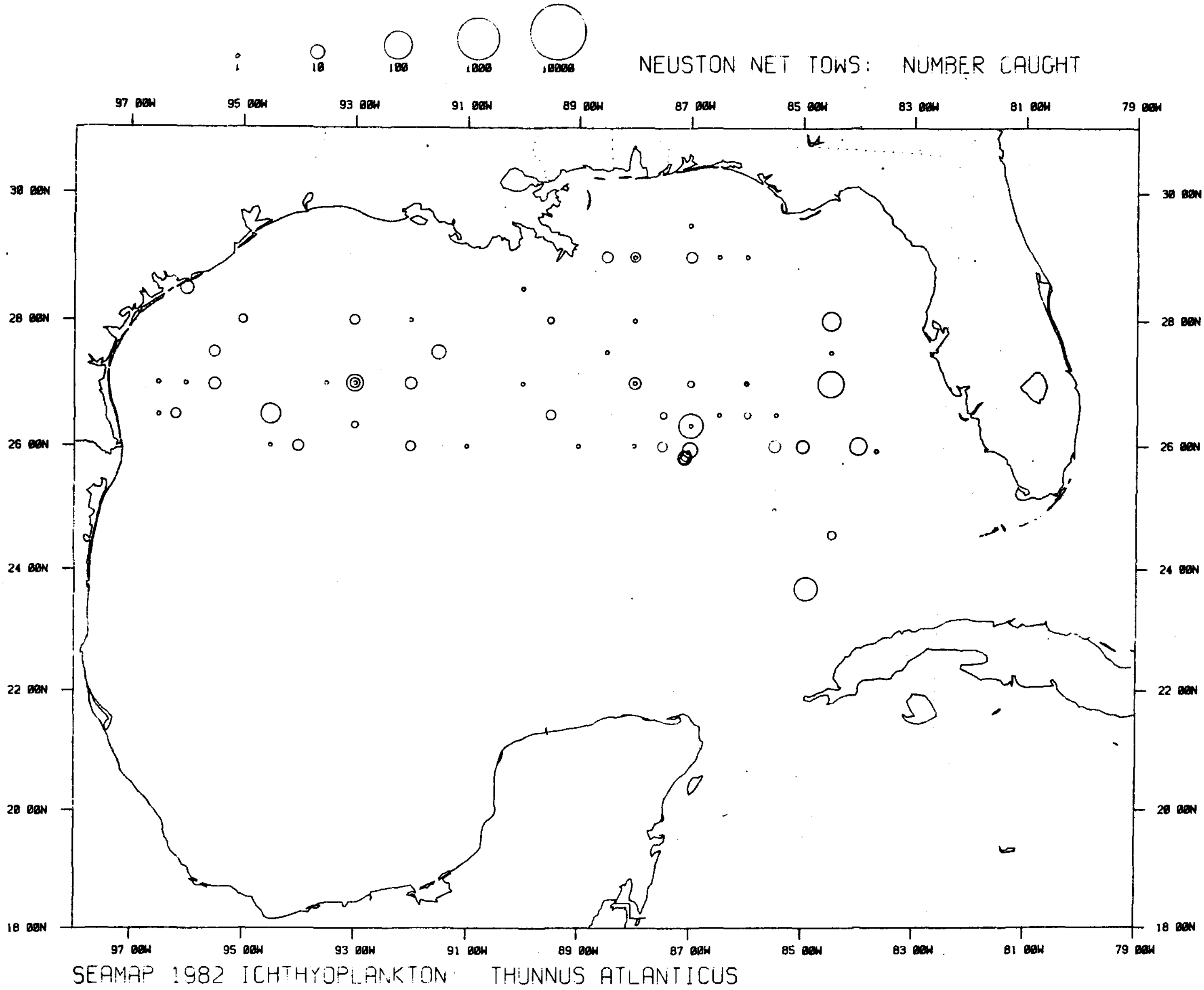


Figure 16. Distribution of blackfin tuna larvae collected during MARMAP OTP II, January-March 1983 by the FRV OREGON II. Small circles depict stations, large circles depict larvae.



Data on larval distribution from additional cruises by the National Marine Fisheries Service MARMAP [1]cruises (Richards et al., 1984) are given in Figures 16 and 16.

e) Early life history

(i) Eggs

Development: Ovarian development is described by Monté (1964) for blackfin tuna from Brazil. Nothing is known about planktonic eggs because they have not been described. In intensive collections and rearing of scombrid eggs from the southern Straits of Florida, Mayo (1973) did not rear any eggs which were attributable to blackfin tuna.

(ii) Larvae

The smallest identifiable larvae are about 2.5 mm (Richards and Bullis, 1978). Larger (6.0 mm) larvae are identified on the basis of erythrophore pigmentation, vertebral count, and distribution of larvae (Richards and Potthoff, 1974). Pigment characteristics are given in Table 5. Larvae of the blackfin tuna most closely resemble those of the bigeye tuna, T. obesus. Further, some larval blackfin tuna lack certain characteristic pigment and could be confused with yellowfin tuna or albacore.

[1]MARMAP VII

Table 5. Summary of pigment types of T. atlanticus larvae based on specimens authenticated by osteological methods. The number of specimens and size range for each body pigment type are given, and the number of specimens are given for presence or absence of jaw and caudal pigment. Damaged specimens account for those where no data were given (from Richards and Potthoff, 1974).

Body pigment type	No.	Size range (mm SL)	Upper jaw pigment Present	Upper jaw pigment Absent	Upper jaw pigment No data	Lower jaw pigment Present	Lower jaw pigment Absent	Lower jaw pigment No data	Caudal pigment Present	Caudal pigment Absent	Caudal pigment No data
Ventral pigment only:											
melanophore number unknown	4	6.0-11.0	-	-	4	-	-	4	-	-	4
1 melanophore present	29	5.9-11.8	8	-	21	19	3	7	6	2	21
2 melanophores present	15	6.4-12.1	3	1	11	8	1	6	3	1	11
3 melanophores present	9	5.9- 7.9	-	-	9	6	3	-	-	-	9
4 melanophores present	2	7.5- 8.5	-	-	2	1	-	1	-	-	2
5 melanophores present	1	6.0	-	-	1	-	-	1	-	-	1
No ventral pigment	20	5.8-12.3	6	-	14	9	2	9	2	2	16
Ventral and dorsal pigment	2	9.6-10.1	2	-	-	2	-	-	2	-	-
Ventral and lateral pigment	1	8.7	1	-	-	1	-	-	-	-	1

Juárez and Montolio (1975) reported on larval blackfin captures during a cruise in May and June, 1974, in the Gulf of Mexico in relationship to temperature and salinity values of 26 and 28°C, and within a range of about 35.7 to 36.5% (see Figure 17).

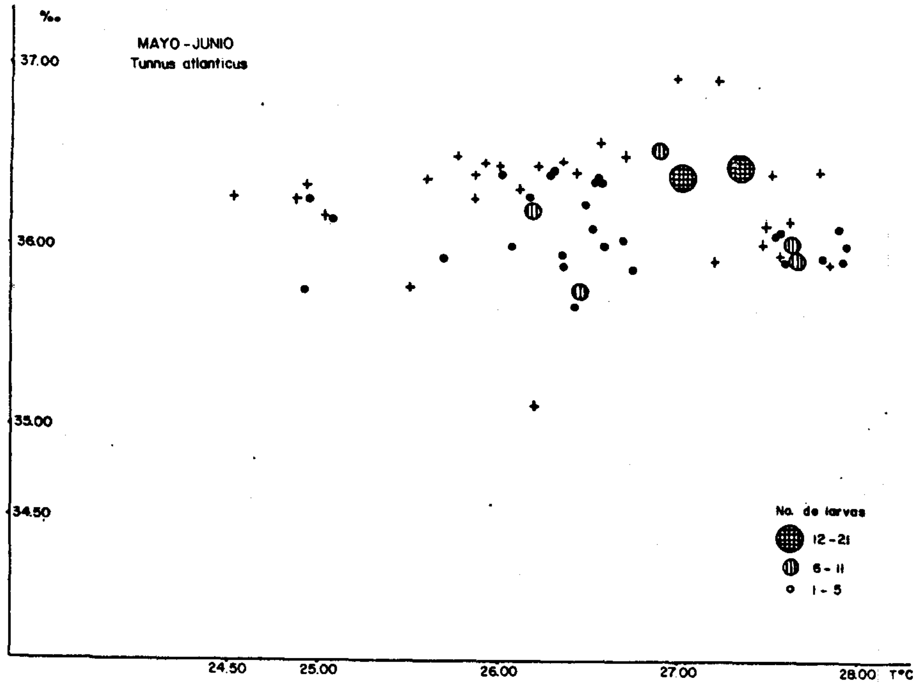


Figure 17. Relationship between larval distribution of blackfin tuna, temperature (°C), and salinity (°/oo) in the Gulf of Mexico.

Monté (1964) showed that gonads mature in the last quarter of the year in the southern Hemisphere.

In Cuba, Suárez-Caabro and Duarte-Bello (1961) reported ripening blackfin tuna in February and spent tuna in June. The spawning season, from this data, is not well defined. Morice and Cadenat (1952) suggest that spawning may occur in the Lesser Antilles.

6) Spawning and recruitment

This is directly related in part to the section on "spawning areas and seasons (see section 5), d) and also to the section on "environmental relationships" (see section 12, to follow). Larval data suggest that this is the most abundant tuna in the Gulf of Mexico and Bahamas, but the commercial fishery for adults in this area is very limited, so that the relationship between spawning and recruitment is not known. In the only area where there is an intensive fishery (Cuba), no studies have been carried out on the relationship between spawning and recruitment.

7) Behavior

a) Habitat preference

Blackfin tuna are epipelagic oceanic species found in clear tropical waters of at least 20°C. In some parts of the western Atlantic, they seem to be associated with islands and banks, while in others, blackfin tuna occur in large schools far from land. The biotic-abiotic relationships of this tuna with its environment are far less clear than has been demonstrated for other species of the genus Thunnus, mainly because of the present lack of directed fisheries for this resource and thus the lack of a need to know something about its ecological requirments.

Maghan and Rivas (1971) stated that it occurred near the surface where the water depths are between 6 and 4600 fathoms (ca 12 and 9200 m), thus attesting to a wide range of habitat preferenda. However, its distribution undoubtedly is more liklely related to factors such as water color and clarity, steepness of the continental shelf, water temperature, water color, plankton concentrations caused by upwelling and current rips, and runoff from land. Compared to the little tunny, the blackfin tuna is a blue-water fish, being found only in the very clear waters of the western Atlantic. It also is found in warmer water than the bluefin tuna (T. thynnus) or the albacore (T. alalunga). It moves to higher latitudes with the warming of the water in summer, but does so to a lesser degree than do other tunas.

Nothing is known about its swimming-depth preferences, although it appears to be capable of diving to considerable depths quite rapidly. As is discussed in the sections on food habits, it eats many small planktonic food organisms, which could indicate either that it is utilizing upwelled food at the surface, or is feeding at the thermocline (or pycnocline) in the deeper strata. Blackfin tuna are known to dive rapidly as a ship approaches, but whether this is an escape response or is to search for food is not known.

b) Schooling relationships

Blackfin tuna are caught by anglers in the Straits of Florida on a regular basis (see under Recreational fisheries, Sect. F.2). However, the catches of any charter boat or private sport-fishing boat seldom exceed 3-4 per day. In the Straits of Florida, large schools are not often seen, and it is believed by anglers that the schools of blackfin are swimming at subsurface depths. When blackfin tuna do take a trolled lure, there is certainly no indication that an entire school--if one indeed exists at subsurface levels--has ever risen toward the surface in response to anglers' teasers (artificial hookless attractants) or lures. However, Mowbray (1956) noted that in Bermuda "most of the small schools of blackfin tuna and false albacore [=little tunny] which struck at surface-trolled lures...were travelling at depths between 13 and 15 fathoms from the surface. On many instances I have noted a school on the sounder graph, told the crew to stand by for strikes, and have been almost instantly rewarded with success." He further observed that "during some summer periods blackfin tuna and false albacore...will not hit a lure that is not all red or, at least, contain red. By examining stomach contents, I have learned that during these periods these fish are feeding on a red squid and a small red shrimp."

In Cuba and Puerto Rico, large schools of blackfin are seen around the coastline where they are fished for commercially.

During cruises of the OREGON, large schools of blackfin tuna were observed in the Gulf of Mexico (Springer, 1957). On one occasion in the Atlantic the ship ran from Abaco to Barbuda over several days, and during the entire trip schools of blackfin tuna were seen continuously (Harvey Bullis, pers. comm.).

c) Association with other species

In Cuba, the blackfin tuna frequently forms large mixed schools with skipjack (Katsuwonus pelamis). For this reason, many catch statistics reports do not separate the two species, and hence catches of one or the other species may be underreported. In Puerto Rico, a few little tunny may school with schools of blackfin tuna close to shore. No other fishes have been reported to associate with blackfin tuna on a regular basis.

d) Seasonal or diurnal patterns

Seasonal changes in area distribution are discussed above under Section a.3) (Distribution: movement/migration pattern).

Diurnal patterns of movement are unknown. Most tunas of the genus Thunnus are daylight feeders, or at least are active early in the morning and late in the afternoon at dawn and dusk, which appears to be associated with feeding activity. There are no specific reports of anglers catching blackfin tuna at night, although admittedly only a few anglers fish at night, and the target fish are usually swordfish, which would be sought using baits too large for blackfin. There are no indications that blackfin regularly feed at night. However, their relatively large eye size suggests that they might be attracted to light to feed at night.

e) Environmental responses

No research has been carried out to measure the response of blackfin tuna to environmental factors, such as temperature, turbidity, or odors, such has been done on small tunas in the Pacific (see Sharp and Dizon, 1978). What little is known about such responses is covered below in Section 12)a, Environmental relationships.

8) FOOD HABITS

a. Larvae: nothing has been published on the food habits of larval blackfin tuna.

b. Juveniles: nothing has been published on the food habits of juvenile blackfin tuna.

c. Adults:

There is some confusion in the literature about the food habits of adult blackfin tuna. The first publication on its food (Beebe, 1936) stated that because reef fishes were found in the stomachs of blackfin, this must imply that they feed on the bottom (see also Bane, 1965, da Cruz, 1971, and Dragovich, 1967 for similar conclusions). However, it appears that most of these fishes in stomach contents were metamorphosing from a larval, epipelagic stage and gradually assuming a more epibenthic habit when they were eaten by the tunas (see for example Beebe, 1936, pp. 198-200). This phenomenon would be expected to occur around steep-sided islands such as Bermuda (Beebe, 1936) and Puerto Rico (Bane, 1965), where the distance from the blackfin's epipelagic habitat to the nearly vertical "wall" of the coral-reef habitat may be quite small.

Dragovich (1967) summarized the food of Atlantic tunas, presented in Appendix tables, which included the foods of seven species and which included about 500 different forms of fishes and invertebrates, primarily, as well as a few "miscellaneous" items such as salps. The blackfin eats a wide variety of fishes and invertebrates, but it cannot be ascertained from the limited data if this species shows specific patterns in its feeding habits with regard to feeding depth, to size of the fish eating or eaten, or to seasonal or diurnal variations in tuna food and feeding. Similarly, it is difficult to ascertain if the blackfin tuna descends to depth during the day to feed at, perhaps, the thermocline or pycnocline, rising toward the surface at dusk and dawn to feed upon zooplankton and larval fish assemblages which rise toward the surface at dusk and sink to depth at twilight. Insufficient data on the vertical and diel distribution of their foods is available at this time, but they could give a clue as to why only a few blackfin tuna can be caught by hook and line at any given time.

Studies on the food habits of blackfin tuna have been carried out in Bermuda (Beebe, 1936), Cuba (Suárez-Caabro and Duarte-Bello, 1961), Puerto Rico (Bane, 1965), Brazil (da Cruz, 1965; Zavala-Camín, 1982), and the south Atlantic and Gulf of Mexico (Manooch and Mason, 1983 and 1984; Manooch et al., 1985). These results do not add substantially to the list of taxa prepared by Dragovich (1967). Manooch and Mason (1983) found invertebrates in 82% of the blackfin stomachs, largely from North Carolina, with food and fishes were found in 67% of the stomachs. The most frequently found invertebrates are crustaceans (67%) and cephalopods (36%). The most important fishes were Balistidae (triggerfish), Trichiuridae (snake mackerels), and Carangidae (jacks).

9) Feeding behavior

Blackfin tuna have often been observed to leap from the water during feeding frenzies at the surface (Morice and Cadenat, 1952), and at that time these feeding schools are accompanied by birds which are also feeding on the tunas' prey. Coblentz (ms), in a letter to W.F. Rathjen dated 24 June 1986, reported on his observations on the food and feeding habits of blackfin tuna on the south side of St. John., U.S. Virgin Islands. He stated that the blackfin fed on the silverside Jenkinsia (Atherinidae), and inshore, schooling fish which were taken over depths of only 6 to 25 meters depth, and a distance of 10 km from the dropoff (blue-water environment). He believed that the predictable inshore occurrence of an abundant prey brought them well inshore to a ready supply of food. He reported that Jenkinsia regularly moved out of the bays each evening, then back into the bays at dawn, and were fed on by blackfin tuna during both periods.

Zavala-Camín (1982) analyzed stomach contents of numerous epipelagic fishes taken on longlines off southeastern Brazil (Fig. 18). The blackfin tuna is shown as occupying a depth range of 0-220 m, but with a concentration at 130-170 m, and therefore it is assumed that this may represent the potential range of feeding. Its position in the ecosystem relative to other large pelagics is intermediate between the epipelagic and continental shelf, i.e., it occurs over the continental slope, but well off the bottom (Fig. 19).

10) Predators on blackfin tuna

a. Larvae

Their larval stages are eaten by the little tunny (see Dragovich, 1967).

b. Juveniles

Ten juvenile blackfin tuna of 110 to 280 mm (SL) were collected from white marlin (Tetrapturus albidus) and yellowfin tuna by Japanese longline vessels in the western North Atlantic Ocean from March 1980 to March 1982 (Nishikawa and Kikawa, 1982). Nine tuna were from Area 3 about 200 miles east of New Jersey, and one was from Area 2 (Middle Atlantic to South Atlantic Bight). Specific dates and position of capture are given in Table 8. Potthoff and Richards (1970) found blackfin tuna juveniles in the nests of terns and gulls at Dry Tortugas, Florida.

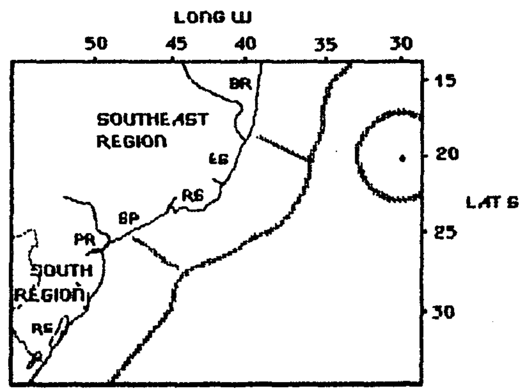


Fig. 18. Areas of the territorial sea of the southeast and south of Brazil.

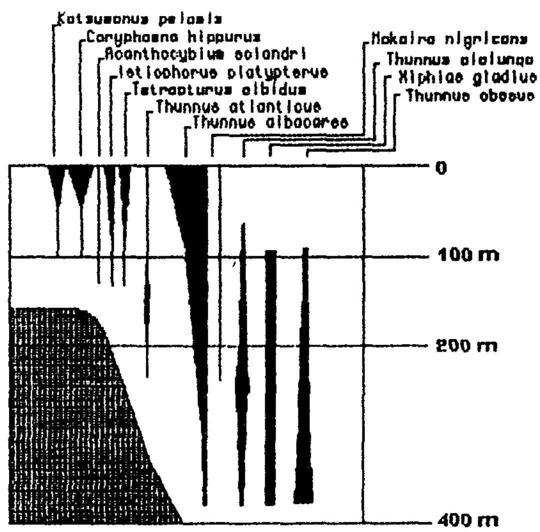


Fig. 19. Vertical distribution of the principal pelagic predators (teleosts) of the regions adjacent to the slope of the continental platform in the southeast and south of Brazil (modified from Zavala-Camín, 1982).

Table 7. Occurrence of <u>Thunnus</u> <u>atlanticus</u> from stomach contents from the western North Atlantic (from Nishikawa and Kikawa, 1983).

				Predator		
Date	Position	t°C	SL(mm)	Sp.	Sex	BL(cm)
7/07/80	39°25'N 63°09'W	26.2	146	White marlin	f	140
7/30/80	38°00'N 62°30'W	-	110	White marlin	-	-
8/05/80	38°40'N 63°01'W	28.7	180	Yellowfin	m	135
"	" " " "	"	172	"	"	"
"	" " " "	"	165	"	"	"
7/04/81	38°57'N 63°28'W	-	140	White marlin	-	148
7/07/81	39°37'N 62°56'W	-	190	White marlin	-	150
7/08/81	39°54'N 63°31'W	-	204	White marlin	-	154
7/12/81	38°13'N 65°20'W	-	230	White marlin	-	140
9/06/81	36°41'N 74°21'W	24.2	280	Yellowfin	-	105

Juveniles (65-260 mm) were found in the stomachs of tunas and tuna-like fishes caught on longline in Brazilian waters (Zavala-Camín and Von Seckendorff, 1979).

c. Adults

Blackfin tuna are regularly eaten by blue marlin, Makaira nigricans (Krumholz and de Sylva, 1958; Erdman, 1962), dolphin, Coryphaena hippurus (Collette and Nauen, 1978), and whale sharks, Rhinodon typus (Gudger, 1941; Bigelow and Schroeder, 1948). Studies by de Sylva (unpublish results) in the western North Atlantic show that blackfin tuna, frigate mackerel (Auxis spp.), and larger cephalopods are popular foods of blue marlin.

11) Competitors with blackfin tuna

Competitors (those feeding upon the same food) among other tunas are skipjack, principally, and yellowfin and albacore tuna (Dragovich, 1967). Probably dolphin and wahoo also are competitors.

12) Environmental relationships

a. Ecological requirements

No studies on specific ecological requirements of the blackfin tuna have been undertaken similar to the extensive research performed by the National Marine Fisheries Service on tunas in Hawaii (see Sharp and Dizon, 1978), and in fact it is believed that blackfin have never been held in captivity. The only publication dealing with environmental relationships is by Maghan and Rivas (1971), who presented information on the relation between surface temperature and catches of blackfin tuna (Table 8). We presume that they used data from U.S. Bureau of Commercial Fisheries (now National Marine Fisheries Service) exploratory vessels, but nowhere is this stated, nor is there any explanation on how the identity of the schools sighted was determined.

They stated that 92% of the sightings and catches of blackfin tuna occurred at temperatures from 24° to 30°C, and 67% occurred between 27° and 28°C. Using the same data, they studied the relation of 330 surface observations (school sightings and trolling and jackpole captures) to water depth. Highest concentrations of blackfin at the surface (86% of the observations), were over depths of 40 and 1,500 fathoms (80 to 3,000 m) with a peak at 80 to 90 fathoms (160 to 180 m).

Table 8. Monthly sightings and catches of blackfin tuna associated with surface temperatures (Maghan and Rivas, 1971).

Monthly sightings and catches of blackfin tuna associated with surface temperatures

Month	Northern Gulf			Southern Gulf			Caribbean and adjacent areas		
	Sightings & catches	Temperature		Sightings & catches	Temperature		Sightings & catches	Temperature	
		Range	Mean		Range	Mean		Range	Mean
January	1	75	75				1	78	78
February							2	78–83	80.5
March							4	79–80	79.8
April				3	80	80	5	80–82	80.4
May	1	82	82	4	81–82	81.8	57	78–84	81
June	6	72–87	81.3				37	80–84	81.5
July	11	83–88	85.7				2	83	83
August	13	83–87	85.1						
September	8	82–86	84.4				2	84–85	84.5
October	1	79	79				8	83–85	84.1
November	1	76	76				3	82	82
December	5	75–76	75.8						

Zavala-Camín (1981) presented depth distribution information for tunas and billfish in the southeast and south of Brazil (Figs. 18 and 19). He shows the depth range to be 0-250 m, and the typical depth to bottom as about 300 m.

b. Fisheries oceanography

Little is known about tuna oceanography in the Atlantic Ocean in comparison with extensive studies carried out in the Pacific (Sund, 1981), and even less is known about the applications of oceanography to finding blackfin tuna. A major review of tuna oceanography in the western Atlantic--and perhaps the only review--is by Roffer (1986). Some ideas on how surface-schooling tunas such as blackfin tunas might be related to seabird activity in relation to oceanographic fronts may be gleaned from Haney and McGillivray (1985).

E. Species profile for the little tunny, *Euthynnus alletteratus*.

I. Taxonomy

a. Scientific name: *Euthynnus alletteratus* Rafinesque, 1810.

Synonyms:

Scomber alletteratus Rafinesque, 1810

Scomber quadripunctatus E. Geoffrey St. Hilaire, 1817

Thynnus leachianus Risso, 1826

Thynnus thunina Cuvier, 1829

Thynnus thunnina Cuvier *in* Cuvier & Valenciennes, 1831

Thynnus brasiliensis Cuvier *in* Cuvier & Valenciennes, 1831

Thynnus brevipinnis Cuvier *in* Cuvier & Valenciennes, 1831

Orcynus thunnina Poey, 1875

Thynnichthys thunnina Giglioli, 1880

Thynnichthys brevipinnis Giglioli, 1880

Euthynnus allitteratus Jordan & Gilbert, 1882

Gymnosarda alletterata Dresslar & Fesler, 1889

Euthynnus thunnina Carus, 1893

Pelamys alleterata Fowler, 1905

Euthynnus alliteratus Ehrenbaum, 1924

Euthynnus alleteratus Chabanaud, 1925

Gymnosarda alleterata Chabanaud & Monod, 1927

Euthynnus alletteratus De Buen, 1930

Euthynnus alletteratus alletteratus Fraser-Brunner, 1949

Euthynnus alletteratus aurolitoralis Fraser-Brunner, 1949

Euthynnus quadripunctatus Postel, 1973.

b. FOA Names: En - little tunny; Fr - thonine commune; Sp - bacoreta.

c. Common names: The following common names are given by Rosa (1950) and by Collette and Nauen (1983):

COMMON NAMES BY COUNTRY: (The names capitalized are in more general use).

Angola	MERMA
Argentina	BONITO, Atún
Brazil	BONITO
British West Indies	SPOTTED BONITO, spotted tuna, little tunny, Mediterranean tunny, longbelly bonito, bonito, white bonito
Cuba	ATÚN, comevíveres
Denmark	TUNNIN
Dominican Republic	BONITO, atún
Egypt	THUNNA
France	THONINE, thonnine, thounnia, tounino, tonna, thounina, tounine, touna

Germany	THONINE
Ghana	EL'LA (Apollonian), poponkou (keta), little tunny
Greece	TONINA, tonnina, karvouni
Guinea	MAKRENI
Guyana	SPOTTED BONITO, spotted tuna, little tunny, Mediterranean tunny
Haiti	THON - BONITE
Israel	TUNNIT ATLANTIT
Italy	ALLITTERATO, tunna, tunnella, turina, alletterato, carcana, tonnina, litteratu, tonnella, covaritu, alliteratu, tonnetto
Ivory Coast	BOKOU-BOKOU (Alladian), bonita, klewe (Kru)
Malta Is.	CUBRIT, kubrita
Martinique	BONITE QUEUE RAIDE, thonine
Mauritania	CORRINELO (Vermuelen), bacorete, thonnine, thon
Mexico	ATÚN, bonito
Morocco	BACORETE
Norway	TUNNIN, tonnine
Portugal	PEIXE JUDEU, judeu, alvacoira, cachorra, alvacora
Puerto Rico	VAĊA, bonito
Romania	PĂLĂMIDĂ, pălămidă lacherda
Senegal	THONINE (French), walas (Lebou), dolo-dolo
Spain	BACORETA, bacora, atunito, tonyina, tunina, tonina, albecora, tunyina, arbecora
South Africa	Atlantic little tunny, atlantiese kleintuna, merma
St. Helena Is.	BONITO

Sweden	TUNNINA
Tunisia	R'ZEM, toun-sghir
Turkey	YAZILIORINOS
United Kingdom	THUNNINE
United States	LITTLE TUNNY, false albacore, little tunny, Atlantic little tunny, bonito, ocean bonito, boohoo, blood tube, watermelon tuna, spotted bonito, Mediterranean tunny
USSR	Atlanticheskii maliy tunets, maliy tunets, tsyatnystiy atlanticheskiy tunets
Venezuela	ATUNCITO, bonito, cabaña pintada, carachana
Yugoslavia	TRUP CRNOPJEG, tunj crnopjeg, trup rudan, voj, luc

d. Diagnostic features

Diagnostic Features: Gillrakers 37 to 45 on first arch; gill teeth 31 or 32; vomerine teeth absent. Anal fin rays 11 to 15. Vertebrae 39; incipient protuberances on 33rd and 34th vertebrae; bony caudal keels on 33rd and 34th vertebrae (Collette and Nauen, 1983). Coloration is metallic overall, being steel-bluish above and silver below. Dorsal markings composed of wavy stripes along the posterior portion of the back, and scattered dark spots below the pectoral fin (Manooch, 1984).

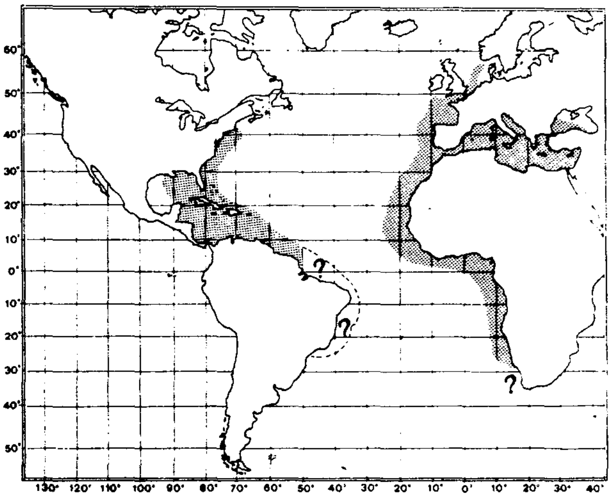


Figure 20. Distribution of little tunny in the Atlantic Ocean.

2. Biology

a. Distribution

1) Range: Found from Long Island, N.Y., southward to Vitoria Island, Brazil, and in the eastern Atlantic from the Oslo Fjord (Wheeler, 1969) to South Africa (Smith, 1953) and the Indian Ocean (Fourmanoir, 1954). It also occurs throughout the Mediterranean and, presently, the southwestern part of the Black Sea (Demir, 1961; 1963; Marchal, 1963).

Rosa (1950) gave the following geographic distribution for the little tunny:

"North Atlantic Ocean - individuals [are] occasionally found on the coast of Norway as far north as Sund, Skagerrak Strait, southern coast of the United Kingdom and Ireland, coast of France and Spain; coast of Portugal, Azores, Madeira, Canary and Cape Verde Is., French Morocco, Spanish Sahara, French West Africa, Gambia, Portuguese Guinea, Sierra Leone, Liberia, Gold Coast, coast of the United States from Cape Cod on the coast of Massachusetts to the coast of Florida, occasionally found north of the Cape Cod, Bermuda Is., Bahama Is. - Caribbean Sea and Gulf of Mexico, Leeward, Windward, Trinidad and Tobago Is., Puerto Rico, Dominician Republic, Haiti, Cuba, Gulf coast of Mexico and the United States - British Guiana.

Mediterranean Sea - Coast of Spain, Balearic Isl., France, Italy, Sicily Is., Malta Is., Yugoslavia, Syria, Lebanon, Israel, Egypt, Libya (Tripolitania), Tunisia, Algeria, Spanish Morocco.

South Atlantic Ocean - Coast of French Equatorial Africa, Belgian Congo, Angola, St. Helena Is., Brazil, Argentina."

It is largely coastal in its habits, seldom venturing far from land, although Mowbray (1956) noted that little tunny occurred in Bermuda every month of the year. However, this species is typically a coastal pelagic (neritic) fish of the continental shelf, and cannot be considered as being a fish of the "high seas" (Marchal, 1963).

2) Seasonal changes

The best observations on migration of little tunny are by Carlson (1951); a summary paper is provided by Carlson (1952). This reconnaissance pointed to a wide and seasonal distribution of surface schools along the Atlantic and Gulf coasts. Schools are normally seen over and outside the Dry Tortugas shrimp grounds, with a degree of frequency from April through November; throughout the remainder of the year little tunny occasionally come to the surface for the waste discarded by shrimp trawlers. Analysis of observations by fishermen (Carlson, 1951) indicated that surface schools show up progressively farther northward along both the Gulf and Atlantic coasts as the spring and summer advance. This is followed by a southward regression as the fall and winter develop, and considerable variation in the size of schools can be expected. Thus, we can say that, in the U.S., little tunny migrate seasonally, moving south and offshore during fall and winter, then returning northward in the spring (de Sylva and Rathjen, 1961). In summer, the little tunny is abundant in the Gulf of Mexico and Atlantic at least as far north as Cape Hatteras. In winter, large numbers of little tunny are found off south Florida, primarily in the Gulf, south and west of Naples (Gulf of Mexico Fishery Management Council, 1982), and in the Torgugas (de Sylva and Rathjen, 1961). At the same time, some are found offshore in more northern regions such as off Georgia (Carlson, 1952). Some fraction of the stock(s) may invade the Caribbean in winter; however, there are no available data to document such an extension (Davis, 1979).

3) Movement/migration patterns

Our analysis of charterboat sport fishery records, based upon data presented by Williams et al. (1985), reflects their seasonal migration in terms of catch per unit of trolling effort (see Appendix, I.b.). They virtually disappear from the northern Gulf of Mexico and South Atlantic Bight with the advent of cooler weather in the late fall, returning northward in the spring.

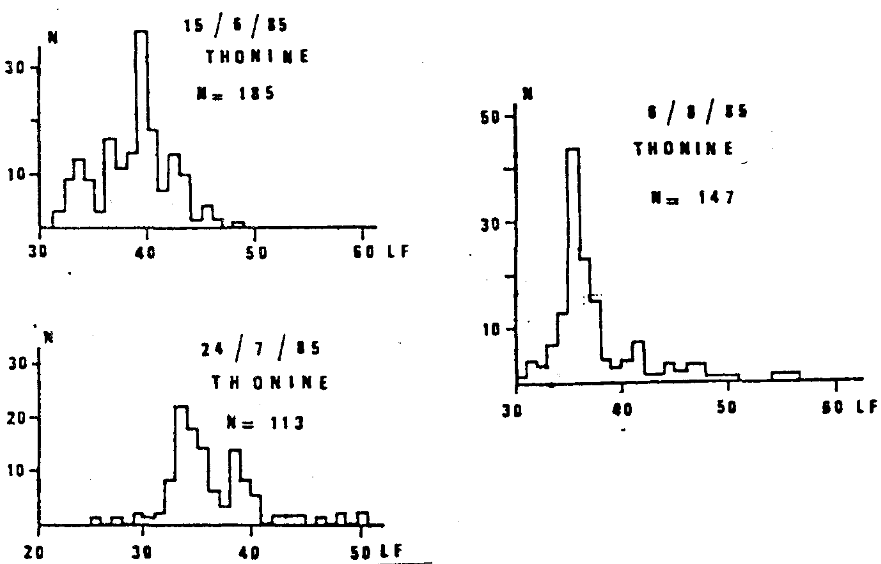
In the western Atlantic Ocean, between 1973 and 1985, there were 502 little tunny tagged between New England and Cozumel (Mexico), mostly between the Middle Atlantic Bight and southeast Florida; however, there have been no tag returns (Mr. Ed Scott, Southeast Fishery Center, NMFS, Miami, personal communication).

The only other tagging studies are in the eastern Atlantic, reported by Rey and Cort (1980), and by Diouf (1983, 1985). From October, 1978 to June 1980, little tunny taken from almadabra traps in the Mediterranean coast of Spain were tagged. Of the 244 little tunny tagged, seven were recovered, two of which entered the Atlantic Ocean (Gulf of Cadiz). The rest were all recaptured within the area of marking with the exception of a single fish which was taken 390 miles away on the coast of Blida (Argelia) after having been at large for 45 days.

Diouf (1985) tagged 730 little tunny, using dart tags, taken by artisanal trolling methods off Dakar, Senegal, from May to August between 14°45N and 17°33°N. Because little tunny, together with the Atlantic bonito (Sarda sarda), and frigate mackerel (Auxis thazard) were not differentiated during tagging and recapture, it is not clear as to the results. However, it is stated that 2.5%, or 19, little tunny were recaptured mostly within the area of marking, indicating that, even after more than 60 days at large, migrations are not extensive (see Table 9).

Table 9. Number of little tunny (thonine) by lapse of time at large and rate of recapture indicated by species on 10 October 1985 (Diouf, 1985).

Nombre de jours en liberté	ESPECES		TOTAL
	Thonine	Bonite à dos rayé	
> 15	1		1
15 - 30	7	1	8
30 - 45	4	1	5
45 - 60	5		5
> 60	2		2
Total recapturés	19	2	21
Total marqués	730	394	1124
Taux de recapture	2.5 %	0.5 %	1.8 %



Distribution of frequency in the same artisanal zones.

b. Age and Growth

1) Age and size/weight relationship

Major papers on age and growth of little tunny include those by Postel (1955), de Sylva and Rathjen (1961), Landau (1965), Rodríguez-Roda (1979), Menezes and Aragão (1980), Cayré and Diouf (1983), and Johnson (1983). Estimates of age were made from counts of growth bands on dorsal spine and vertebral sections of 491 little tunny captured off Senegal in 1979 (Cayré and Diouf, 1983). These bands appear to be formed during the cold season (November-May). Mean size at estimated age was determined for the first eight years of life. Size-frequencies, the estimated age-length relationship, and the estimated age-length relationship are presented in Appendix 1a. They showed that vertebral rings reveal more rings than in spine sections, suggesting that vertebrae are better indicators of actual age than are fin spines. Maximum age of fish in their sample was 8 years old, corresponding to a mean fork length of 80.2 cm.

Johnson (1983) compared dorsal spine rings and vertebral rings of little tunny in the northeast Gulf of Mexico. The largest fish in these samples (67.5 cm mean fork length) was six years old (Appendix Ia).

Mean sizes at estimated ages calculated from spines and vertebrae were similar to those from Senegal or for those calculated by Cayré and Diouf (1983) but were less than sizes-at-age for little tunny from other areas. Based upon length-frequencies of little tunny caught by anglers in South Florida, they estimated that the catch is composed esentially of fish of three to four years old.

2) Length and weight relationships

Length-weight relationships are given for West Africa (Postel, 1955) and South Florida (de Sylva and Rathjen, 1961) (Appendix 1a). The largest fish reported by Postel (1955) appears to be about 9.5 kg, and a length of 90 cm, and by de Sylva and Rathjen (1961) to be about 6.4 kg and a length of about 75 cm. The largest little tunny reported is a 27-pound (12.24 kg) fish taken on rod and reel off Key Largo, Florida in 1976 (IGFA, 1986). It would appear that the 12.24 kg little tunny would be considerably older than eight years.

Age-weight and age-length relationships for little tunny from the Mediterranean (Landau, 1965) are presented in Appendix Ia.

For South Florida little tunny (N = 343), Beardsley and Richards (1970), based upon the length-weight relation $W - \underline{a} L^{\underline{b}}$, calculated that for a length (FL) range of 23.1 - 85.8 cm and a weight (kg) range of 0.23-8.39, $\underline{a} = 4.956 \times 10^{-6}$ and $\underline{b} = 3.26314$.

Length-weight data are presented by Diouf (1980) for little tunny from Senegal.

c. Reproduction

1) Age at sexual maturity

Criteria for determining stages of sexual maturity in the little tunny (de Sylva and Rathjen, 1961) are presented in Table 10. The authors determined that in South Florida waters, ripe males were present from February through November and ripe females occurred every month except December. A peak in the percentage of ripe fish is seen in June, when the water temperature is 74 to 79°F (23 to 26°C). The occurrence of several groups of very small juvenile little tunny from the Gulf of Mexico throughout the summer (Klawe and Shimada, 1959) suggest a protracted spawning over this period (de Sylva and Rathjen, 1961), Manooch (1984) noted that females as young as one year are capable of spawning.

2) Sex ratio

Postel (1950) and Frade and Postel (1955) stated that young little tunny (387-562 mm) from West Africa remained ripe most of the year. This would indicate that they are mature at least at age II, probably at age I+ (see Appendix Ia for age-length relationship). In West Africa, Postel (1955), based on studies of the gonosomatic ratio, indicated the length at first maturity to be 60 cm fork length, which would correspond to an age of nearly IV. It is not clear to us why the authors' results differ.

Chur (1972) reported that for the areas of Cap Blanc, Senegal, Sierra Leone, and Monrovia (West Africa), a minimum length at maturity was 428 mm (total length) for females and 440 mm for males. This would correspond to an age about III years (see Appendix Ia for age-length relationship).

TABLE 10

CRITERIA FOR STAGES OF SEXUAL MATURITY IN THE LITTLE TUNA

Males	
Stage 1	White but slender. Blood vessels on surface not developed. Firm to the touch.
Stage 2	Thicker than stage 1. Blood vessels developed on surface, but milt does not flow out when spermatic canals are pressed.
Stage 3	Thicker than stage 2. Blood vessels further developed. Milt flows when spermatic ducts are pressed.
Females	
Stage 1	The ovaries are thin and the blood vessels are not yet developed on the surface which is smooth. Ova do not show as distinct grains. Sometimes difficult to distinguish from testes.
Stage 2	Thicker than 1. Development of blood vessels perceptible on surface which shows transverse folds.
Stage 3	Thicker than 2. Folds further developed on the surface. Purplish stripes appear along the folds. Ova showing as distinct grains, at least under magnification.
Stage 4	Thickness further increased. Surface distended. More numerous purplish stripes. Eggs distinctly visible.
Stage 5	Ovary spent. Most large eggs extended from ovary, a few adhering to walls. Slimy consistency to ovary walls.

(from de Sylva and Rathjen, 1961).

Diouf (1980) reported that the size at first maturity for little tunny from Senegal was 435 mm (FL?) for males and 430 mm for females. All fish less than 250 mm were immature. It was considered that the size of first maturity corresponds to the length at which 50% of the individuals are ripe.

Size at first maturity is given by Diouf (1980) as Figures 21 and 22 for males and females, respectively, for little tunny from Senegal.

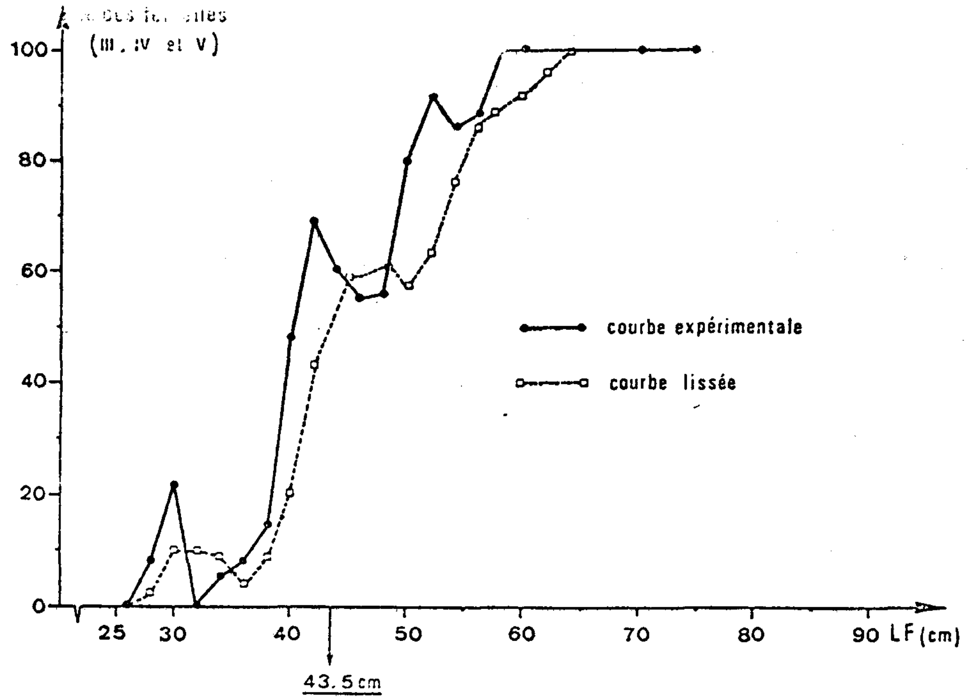


Figure 21 Size at first maturity in males (Diouf, 1980).

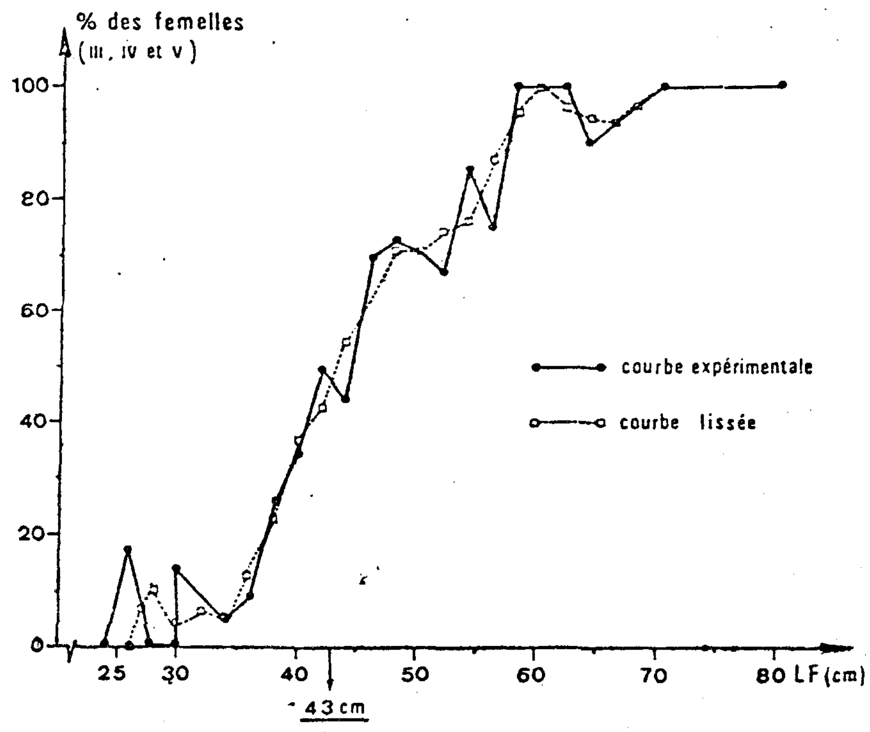


Figure 22. Size at first maturity in females (Diouf, 1980).

3) <u>Fecundity</u>

The number of eggs per gram of body weight in West African little tunny is 20%, and close to 6000 (Postel, 1955). This means that a little tunny of 75 cm fork length, having an ovary of 290 g, would produce 1,750,000 eggs.

Diouf (1980) presented data on fecundity for little tunny from Senegal. In the size interval sampled (30.0 - 78.5 cm FL), partial (ripe) fecundity varied between 71,000 and 2,200,000 eggs. The relation between partial fecundity, length (FL), weight (W) of individuals, and weight (PO) of the gonads is calculated as:

-- fecundity-size relation of females:

$$\log F = 2.9413 \log L + 1.1750,$$

$$\text{where } F = 3.2381^{2.9413}$$

with $n = 28$; $r = 0.870$.

-- fecundity-weight relation of females:

$$F = 182.00\ W - 4725.42$$

with $L = 0.746$; $n = 28$

-- fecundity-weight relation of ovaries:

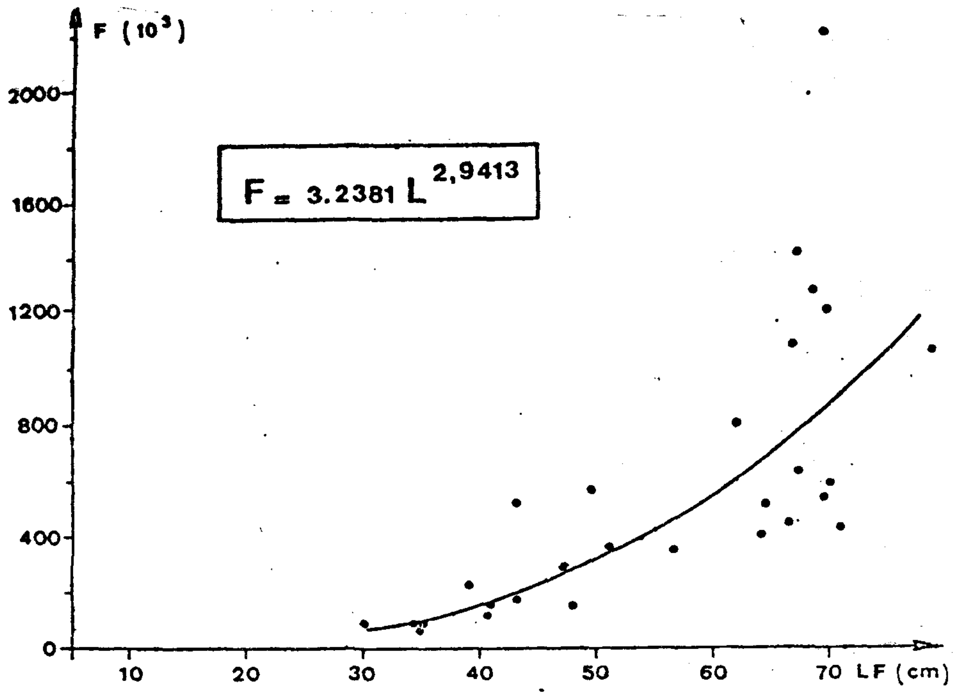
$$F = 6073.74 \quad PO - 82871.28$$

with $r = 0.923$ and $n = 28$.

These relations are shown graphically in Figures 23-25.

No fecundity data are available for little tunny from the western North Atlantic.

Figure 23. Length-fecundity relation in females from Senegal (Diouf, 1980).



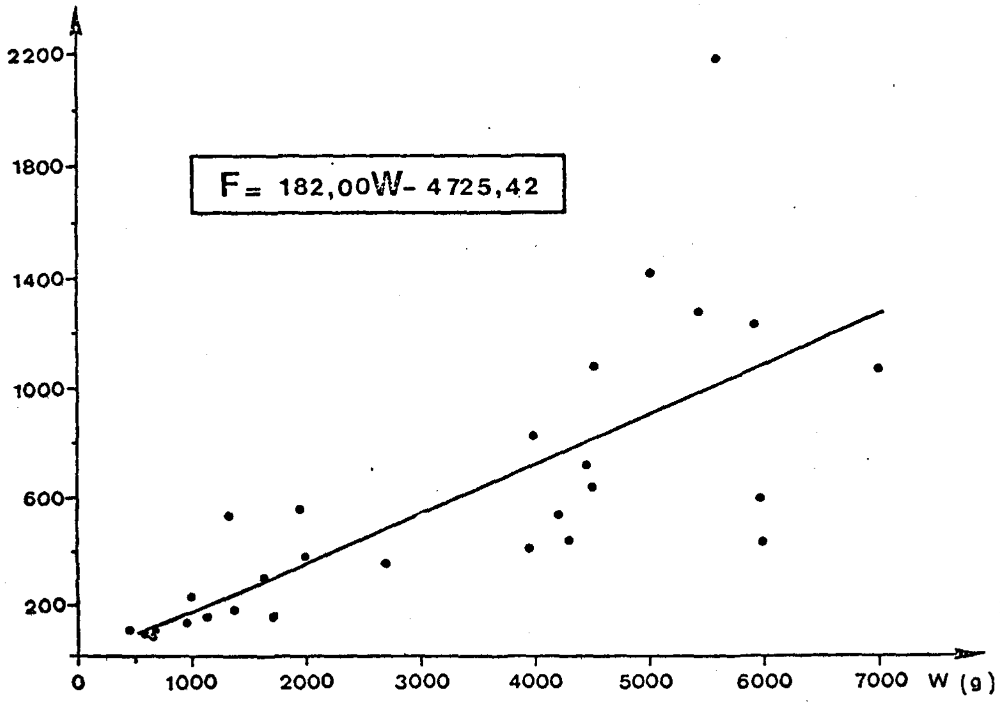


Figure 24 Weight-fecundity relation in females (Diouf, 1980).

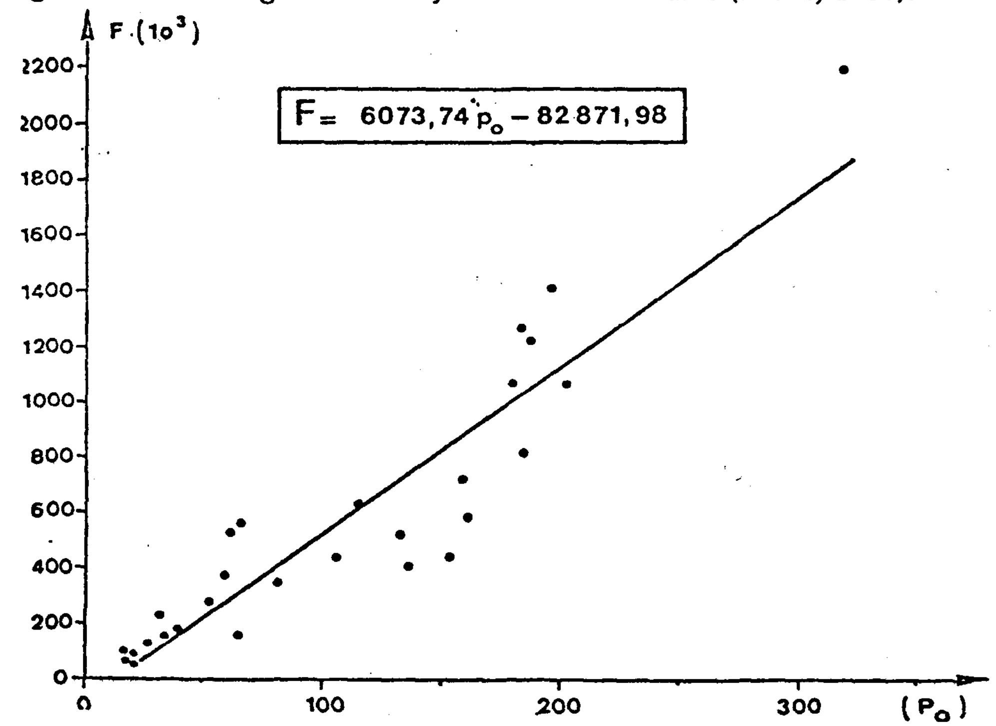


Figure 25 Weight-fecundity relation of ovaries (Diouf, 1980).

4) Spawning areas and seasons

The spawning areas of the little tunny have been summarized by Yoshida (1979) for the northwestern Gulf of Guinea and the Atlantic and Mediterranean Sea, and are depicted in Appendix Ia. Major spawning areas in the western Atlantic are south Florida-Cuba-Bahamas, the northern Gulf of Mexico and west of Campeche, the Carolinas, southeast of Hispaniola, and the Brazilian coast. In the eastern Atlantic, spawning occurs from Senegal to Nigeria. The occurrence of larvae well offshore between West Africa and Brazil would suggest that the eastern and western Atlantic stocks of little tunny are probably the same.

Spawning also occurs in the offshore Gulf of Mexico (Figs. 27 and 28), based on 1982 collections prepared by Kelley et al. (1985), and a high concentration of larvae is seen in the center of the Gulf. Richards et al. (1984) showed high concentrations of larvae in 1983 in the northern Gulf of Mexico from bongo and ring net tows (Figs. 29 and 30).

The spawning season off South Florida (Fig. 31) is from January through November (de Sylva and Rathjen, 1961), with peaks in June and October. Manooch (1984) identified the major spawning areas as being in offshore waters of about 90 to 110 meters deep.

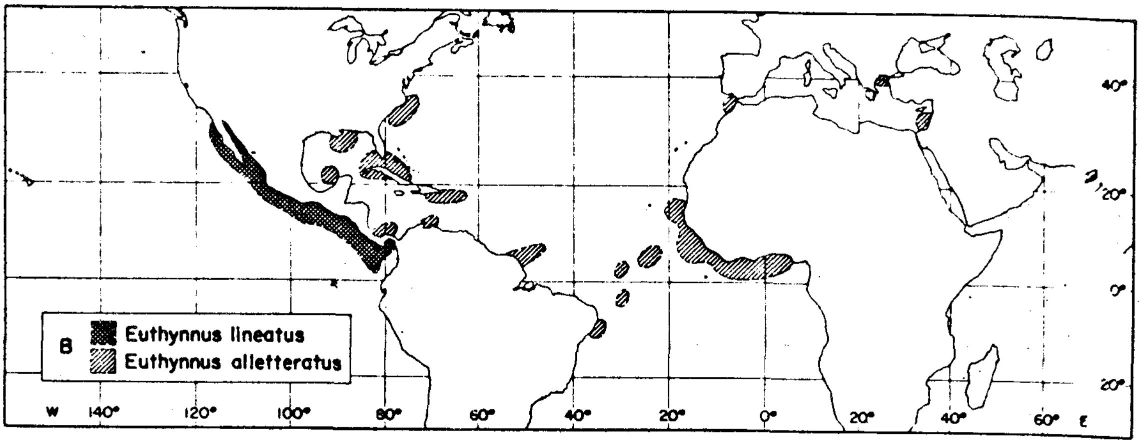


Figure 26. Distribution of larval and juvenile Euthynnus spp. (from Yoshida, 1979).

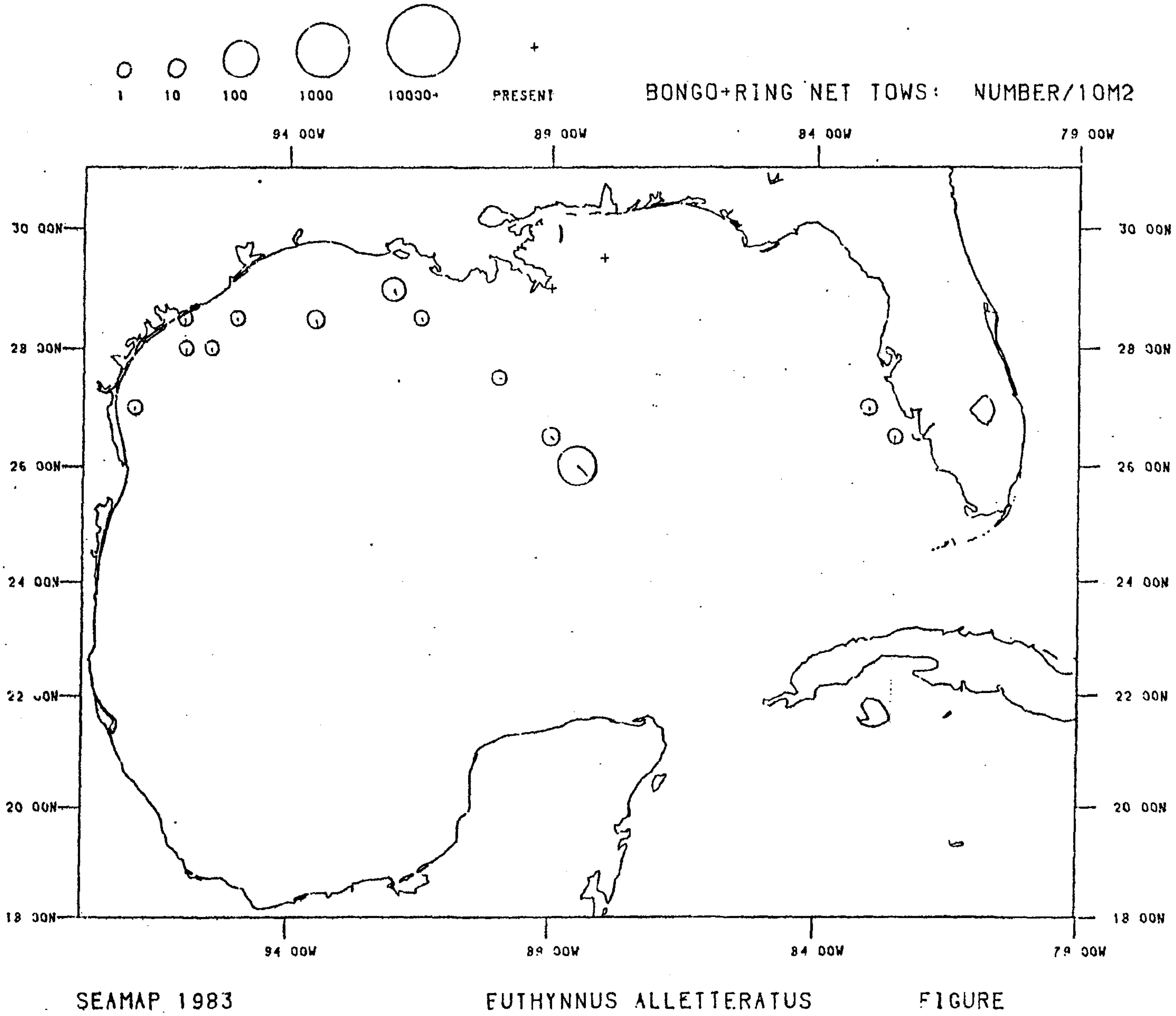


Figure 27. Distribution of larval stages of little tunny in the Gulf of Mexico based upon 1982 collections (Kelley et al., 1985) using bongo nets and ring nets.

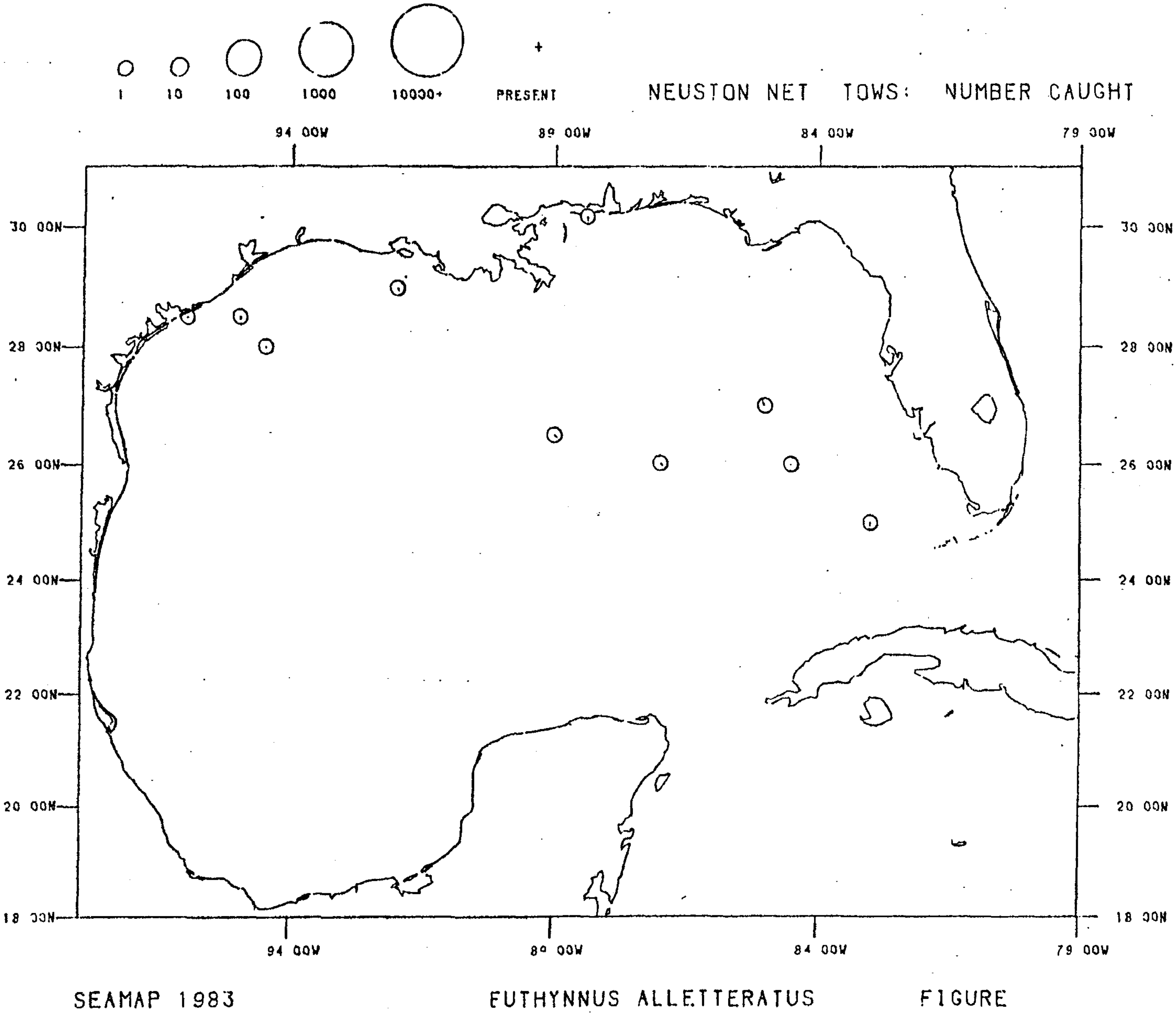


Figure 28. Distribution of larval stages of little tunny based upon 1982 collections (Kelley et al., 1985) using neuston nets.

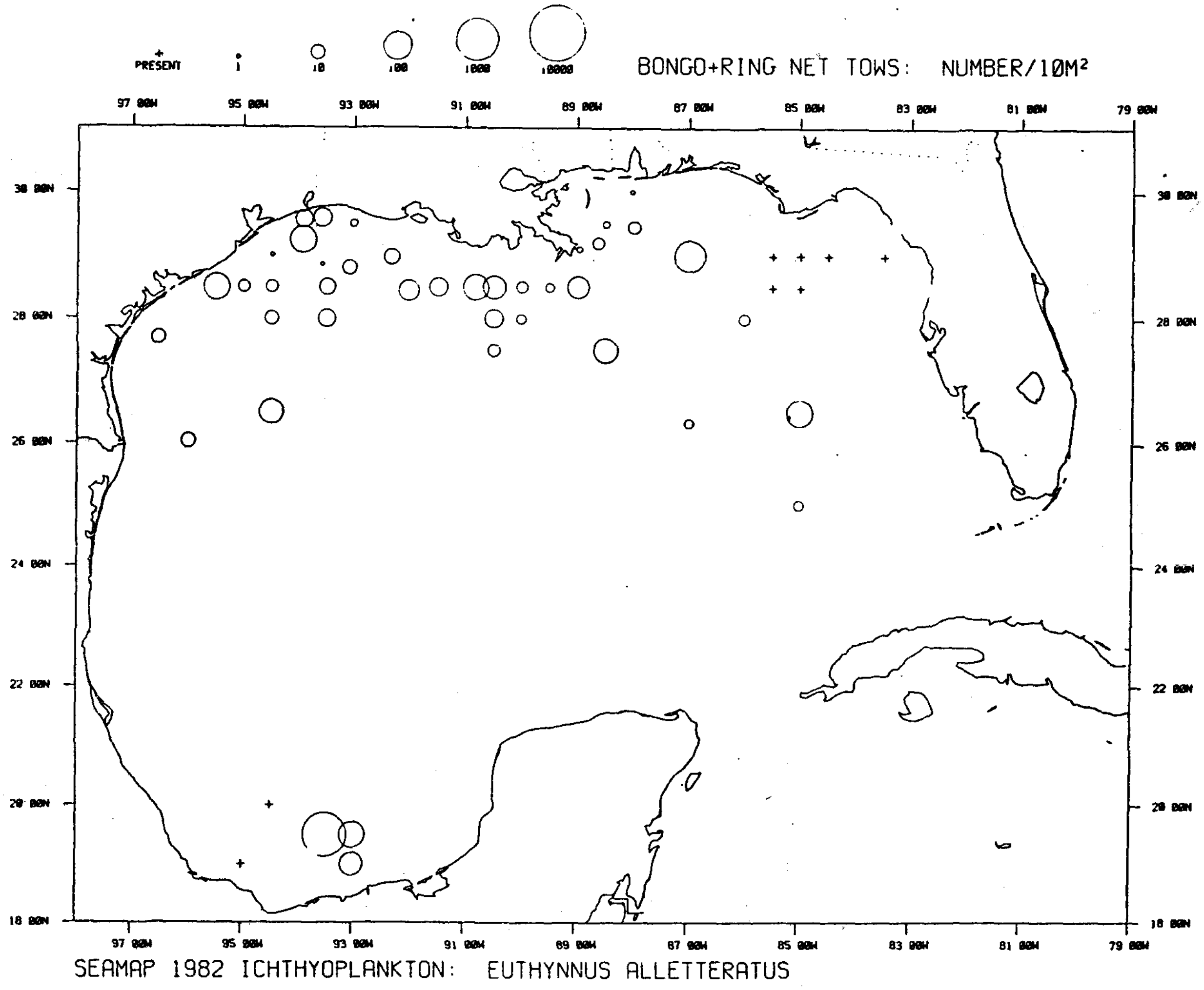


Figure 29. Distribution of larval stages of little tunny based upon 1983 collections (Richards et al., 1984) using bongo nets and ring nets.

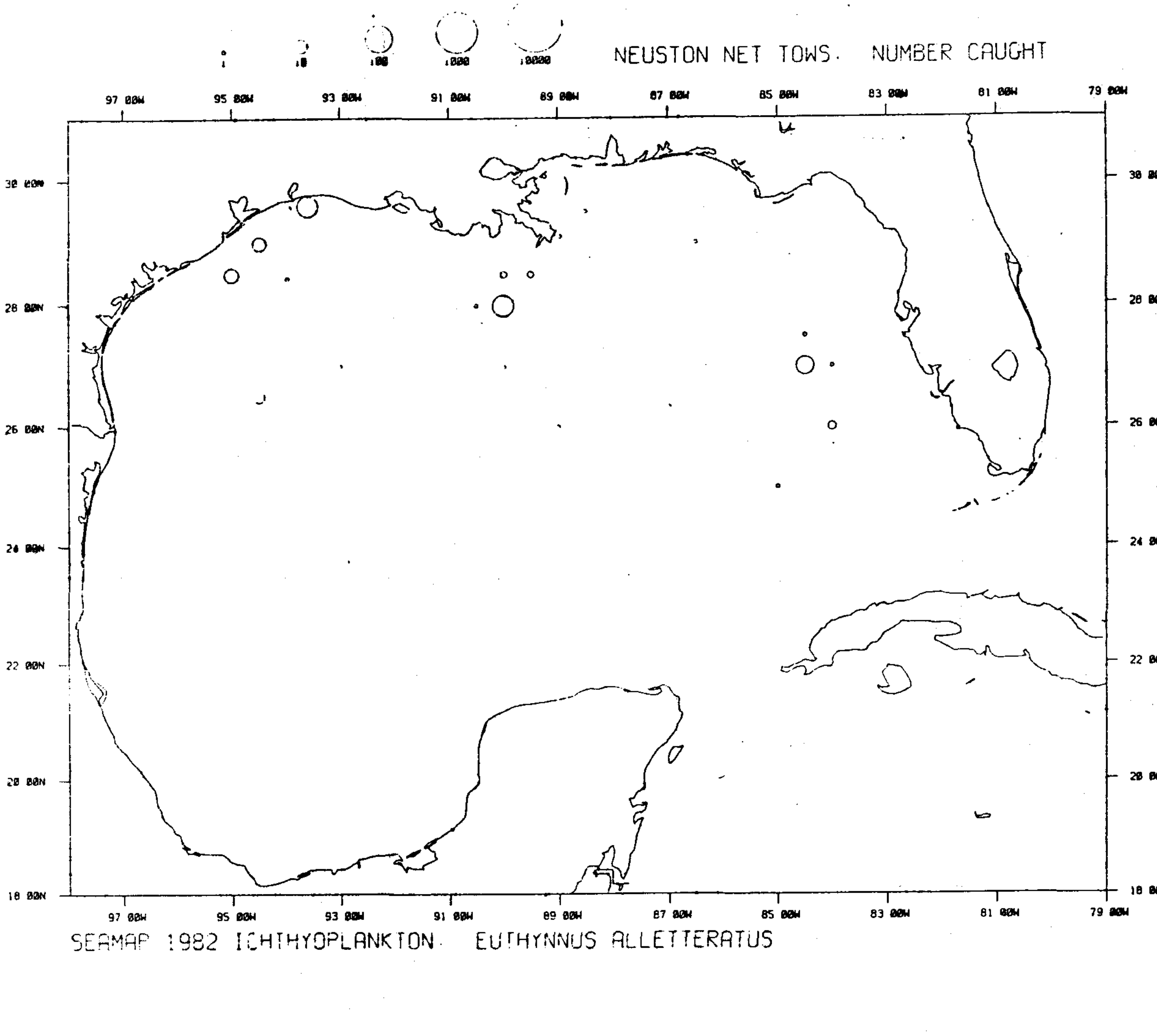


Figure 30. Distribution of larval stages of little tunny based upon 1983 collections (Richards et al., 1984) using neuston nets.

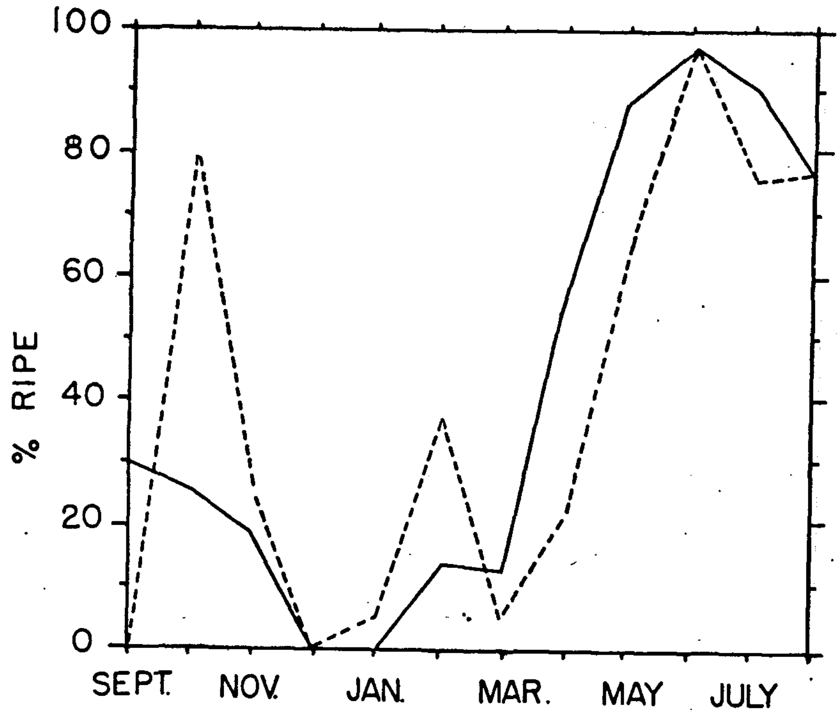


Figure 31. Spawning season of little tunny off Miami, Florida, as indicated by percentage of ripe fish. Solid line represents males (N=285); dashed line represents females (N=238) (de Sylva and Rathjen, 1961).

In the western South Atlantic, Menezes and Aragão (1980) reported that gonads in all stages of sexual development occurred throughout the year, with no evidence for a definite spawning period of Brazil (Table 11).

Table 11 Distribution of the trimestral frequency of the gonadal states of bonito, Euthynnus alletteratus, in the State of Ceará (Brazil), during the period February 1974 to June 1977 (Menezes and Aragão).

	Absolute frequency				
Gonadal state	1.º	2.º	3.º	4.º	Ano
I	-	-	1	-	1
II	7	4	5	11	27
III	7	13	14	11	45
IV	3	1	2	4	10
V	8	5	4	11	28

Postel (1950, et seq.) and Frade and Postel (1955) stated that young little tunny (387-562 mm) remain ripe most of the year off West Africa, while adults (712-937 mm) are ripe from June to August, with development beginning in April and decreasing in activity toward the end of summer. Chur (1972) reported that spawning of little tunny occurred in June-July off Cape Blanc, from January to March-April off Senegal, and February-March off Monrovia. Larvae of little tunny occurred in greatest numbers (up to 60 specimens per net haul) in April-June (Kazanova, 1962; Rudomiotkina, 1985). In the Gulf of Guinea, massive spawning was observed in October (Marchal, 1963).

No common opinion exists regarding the spawning grounds of the little tunny (Rudomiotkina, 1985). Distribution of the adult fish is limited by continental shelf waters in West Africa (Marchal, 1983) and the western North Atlantic (de Sylva and Rathjen, 1961) (see Figure 32). The areas of larval occurrence are mainly in the coastal waters, and it is believed that spawning occurs near the coasts (Gorbunova, 1965; Calkins and Klawe, 1963; Marchal, 1963), although the larvae do occur in the open ocean (Nishikawa et al., 1978; Rudomiotkina, 1985; see our Figure 26). In summary, judging by the periods of larval occurrence and from the data on distribution of the fish with mature gonads, a seasonal pattern in reproduction of the little tunny is noticeable. Massive spawning in each area near the West African coast (between 15°N and 10°S) is confined to the warmest season of the year: from April-May to August-September in the Senegal area; in February-June in the Sierra-Leonean-area; from September-October to March-April in the Gulf of Guinea; and in the Congo-Angola area from January to June. Spawning usually takes place in the warm (temperature above 25°C) and saline (above 34.6°/oo) waters, although it is sometimes recorded at low temperature (20.0-22.7°C) (Rudomiotkina, 1985).

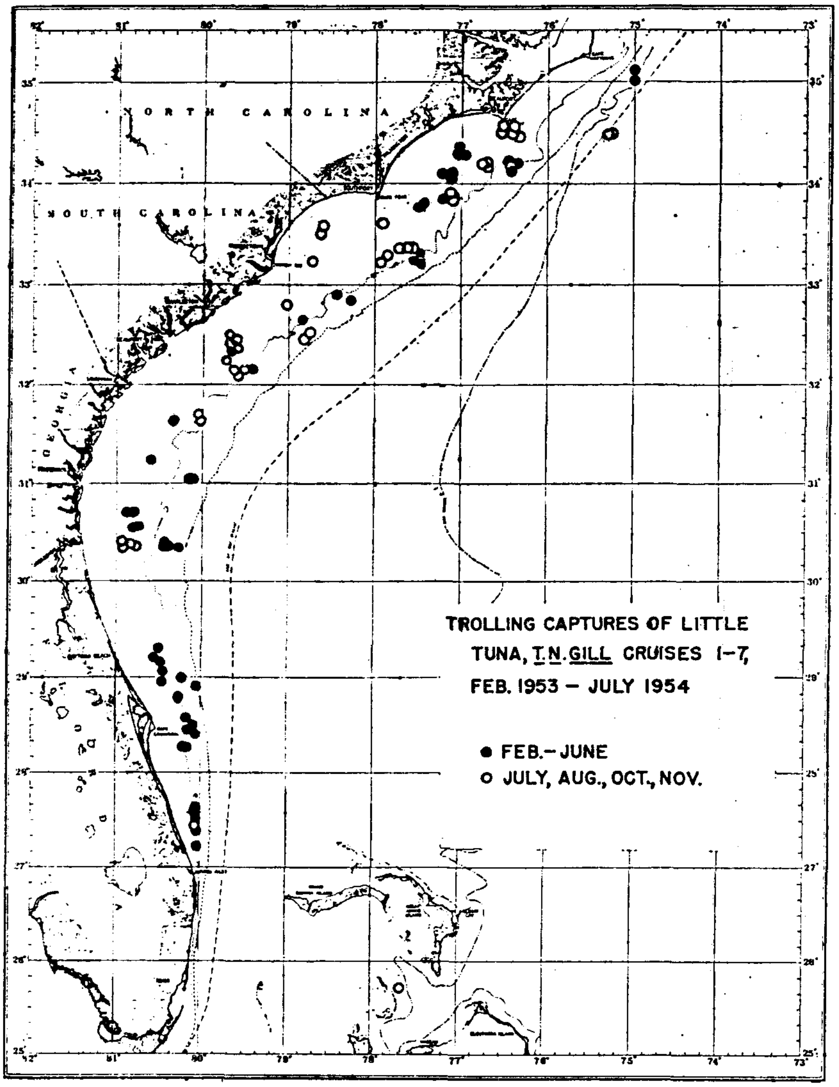


Figure 32. Seasonal distribution of little tunny off the southeastern United States. Data compiled from cruise reports of the U.S. Fish and Wildlife Service vessel T.N. GILL (from de Sylva and Rathjen, 1961).

Gonosomatic ratios of little tunny in West Africa were studied by Postel (1955) to disclose spawning seasons, the peaks in the relative gonad-to-body weight indicating a spawning peak from June to September. Ovarian development closely parallels the increase in the gonosomatic ratio (Appendix I a).

d. Early life history

1) Eggs

Mayo (1973) carried out extensive plankton tows using a 1-m plankton net (mesh size = 500 m) off Miami, Florida, at the edge of the Straits of Florida and coastal waters. The eggs of Euthynnus alletteratus are common in the western Straits of Florida during the summer months.

The eggs and prolarvae of this species are distinguished from other species by the lack of melanophores on the oil globule, by the presence of yellow pigment on the oil globule behind the developing eyes, in the anterior, dorsal finfold, and by an egg diameter of 0.89 mm (see Appendix I a). Early postlarvae of E. alletteratus have numerous, evenly spaced melanophores on the ventral margin of the trunk, a melanophore on the pectoral symphysis, an unpigmented hindbrain, and a melanophore on the pre-anal finfold (Figs. 33-34). Pigmentation of the spinous dorsal fin and gular region of the lower jaw occurs early in the development of this species (Mayo, 1975). They were collected in the morning through early afternoon from 1 June through 15 September in the Straits of Florida from the western current edge (usually over a depth of 30 or more meters) to approximately 25 km east of the edge. Hatching of the eggs of E. alletteratus occurred in the laboratory from 1800 to 0200 hours at 27°C.

The egg averages 0.89 mm (a range of 0.84 - 0.94 mm; n=8) in diameter, located posteriorly in late-stage embryos. The light yellow chromatophores form a distinct pattern in the late-stage egg of this species: (1) one to three on the dorsal surface of the oil globule; (2) two granules in the tissues between the oil globule

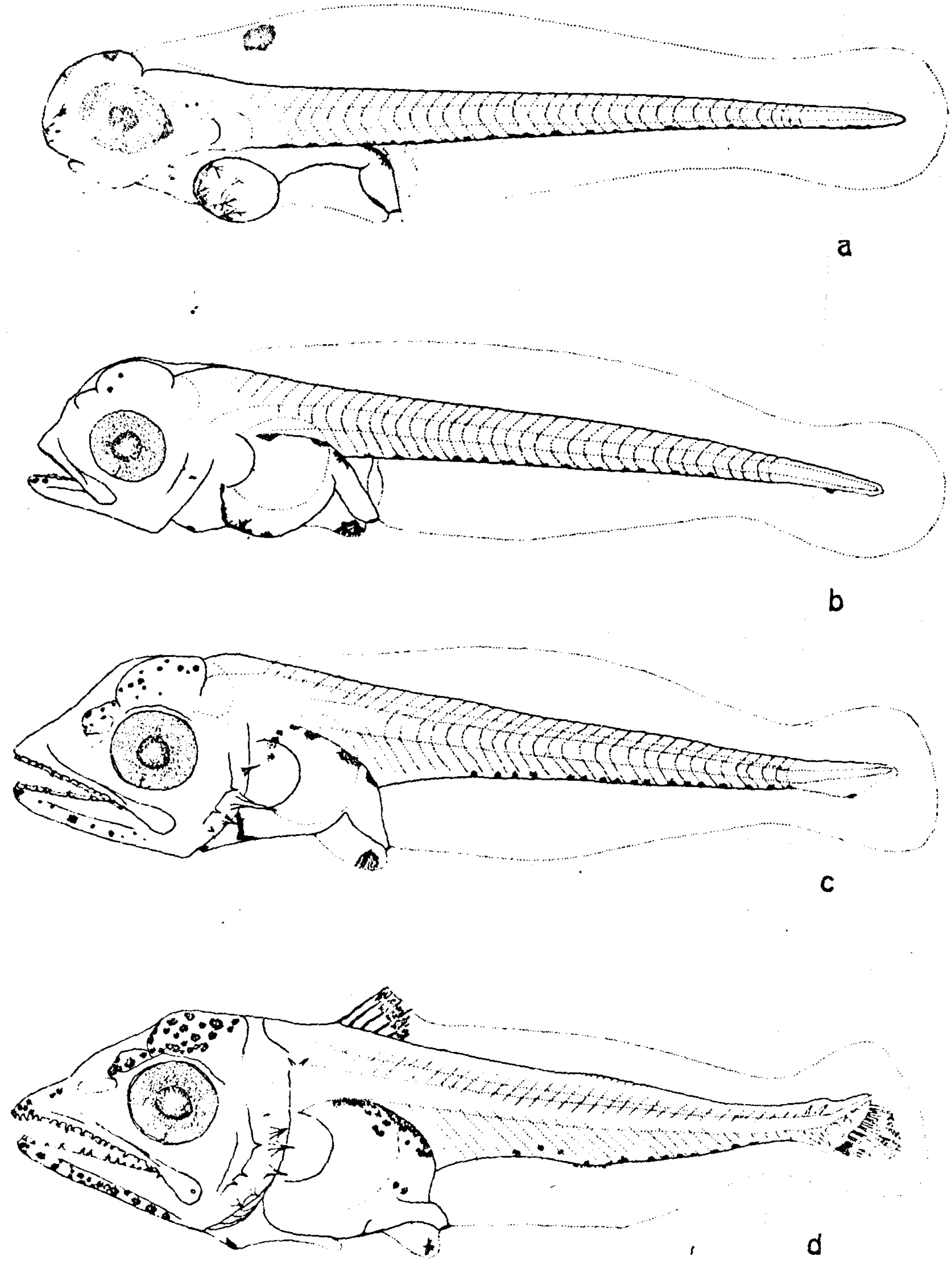


Figure 33. Larvae of the little tunny, Euthynnus alletteratus. (a) 2.85 mm, (b) 3.74 mm, (c) 4.64 mm, (d) 6.20 mm. The gray patches represent the yellow pigment described in the text (from Mayo, 1973).

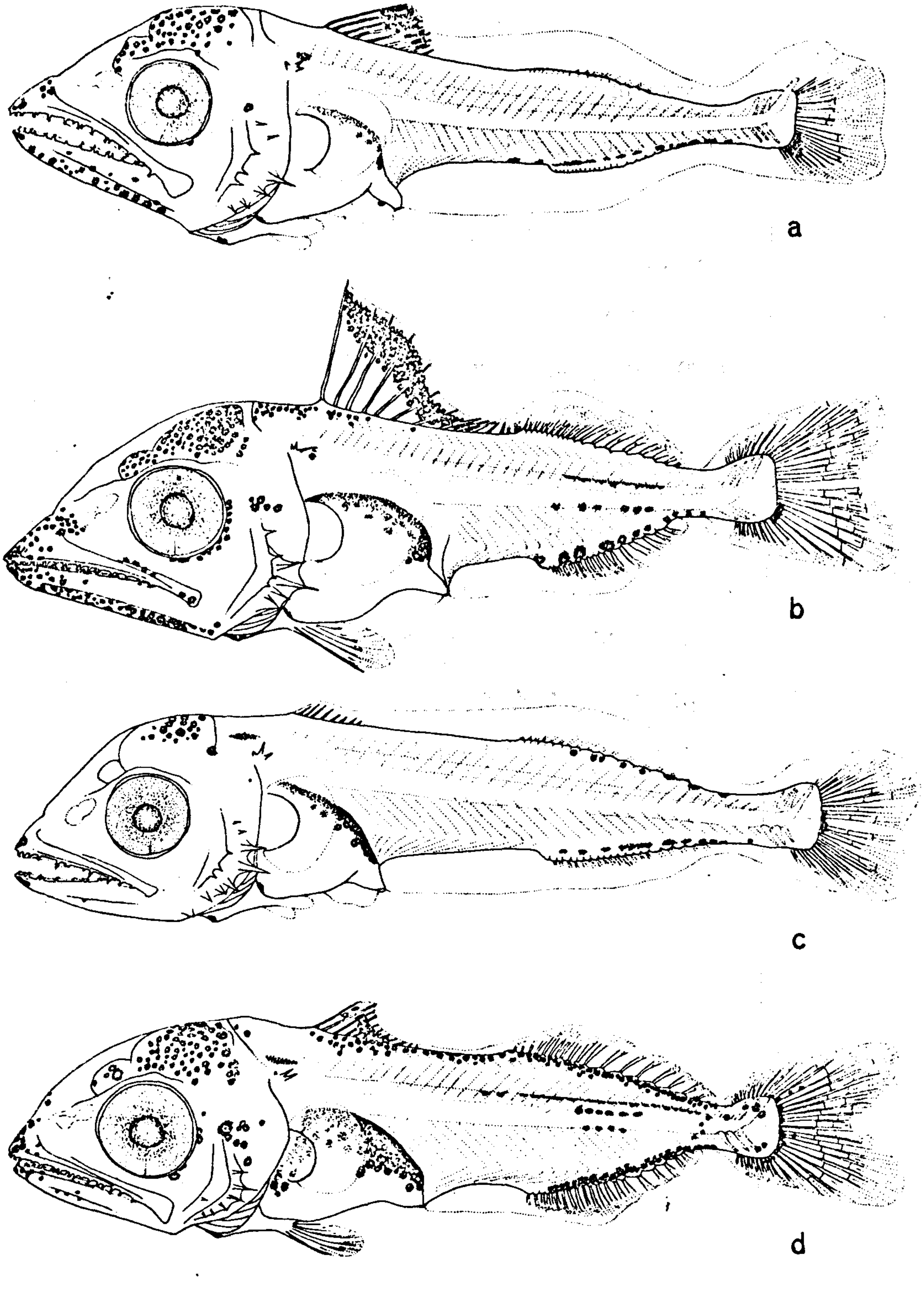


Figure 34. Larvae. (a) Euthynnus alletteratus, 6.60 mm, (b) Euthynnus alletteratus, 9.37 mm, (c) Auxis sp. a, 6.75 mm, (d) Auxis sp. a, 8.90 mm (from Mayo, 1973).

globule and the ventral surface of the notochord; (3) one granule posterior to each optic cup; and (4) two lateral, block-like patches at the anterior end of the notochord.

2). Larvae

The larval stages of the little tunny were described by Mayo (1973) from specimens reared from eggs captured off South Florida (Figs. 33 and 34), and ranged from 2.85 mm to 9.37 mm. They can be distinguished from other tuna larvae largely on the basis of melanophore patterns, according to Kazanova (1962). Data on growth of larvae up to 20 mm are presented by Mayo (1973) (see Figure 35). The distribution of larval little tunny collected in the Atlantic Ocean by Japanese scientists is shown in Figure 36.

e. Spawning and recruitment

Nothing is known about the relationship among fecundity, spawning, and recruitment.

Figure 35. Growth of the little tuna, Euthynnus alletteratus (o) and skipjack tuna, Katsuwonus pelamis (▲). Lengths and regression lines are plotted against time after hatching (from Mayo, 1973).

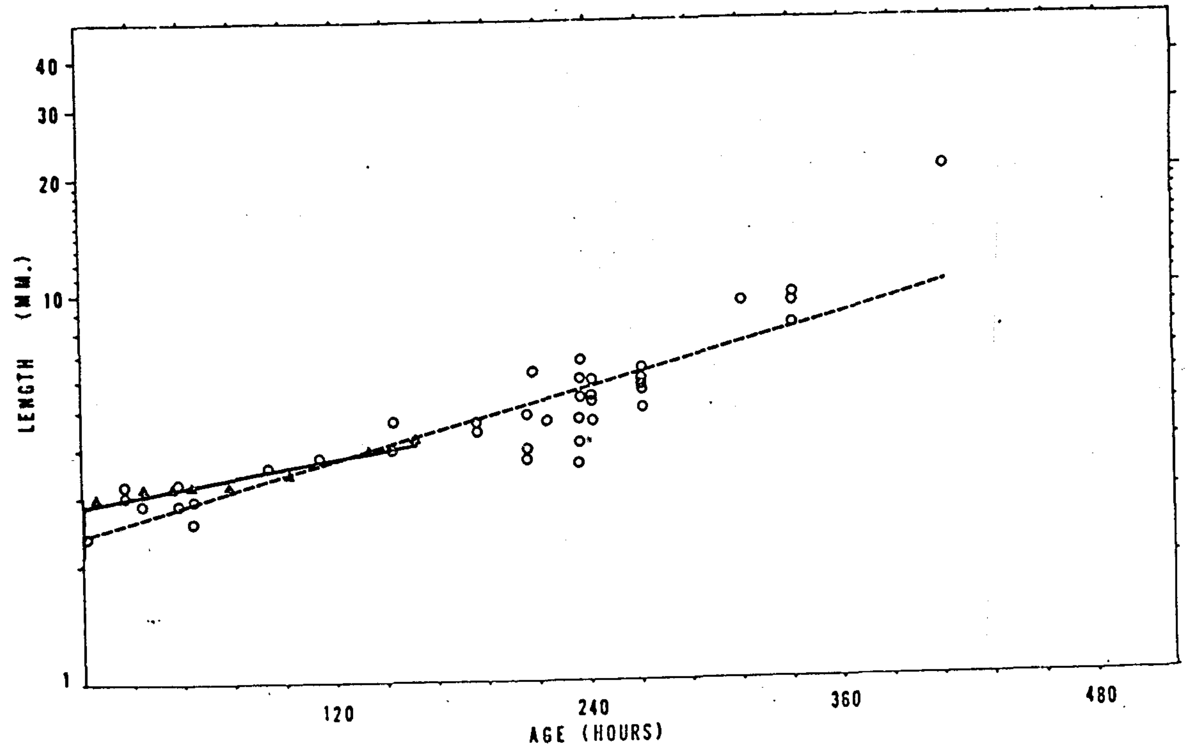
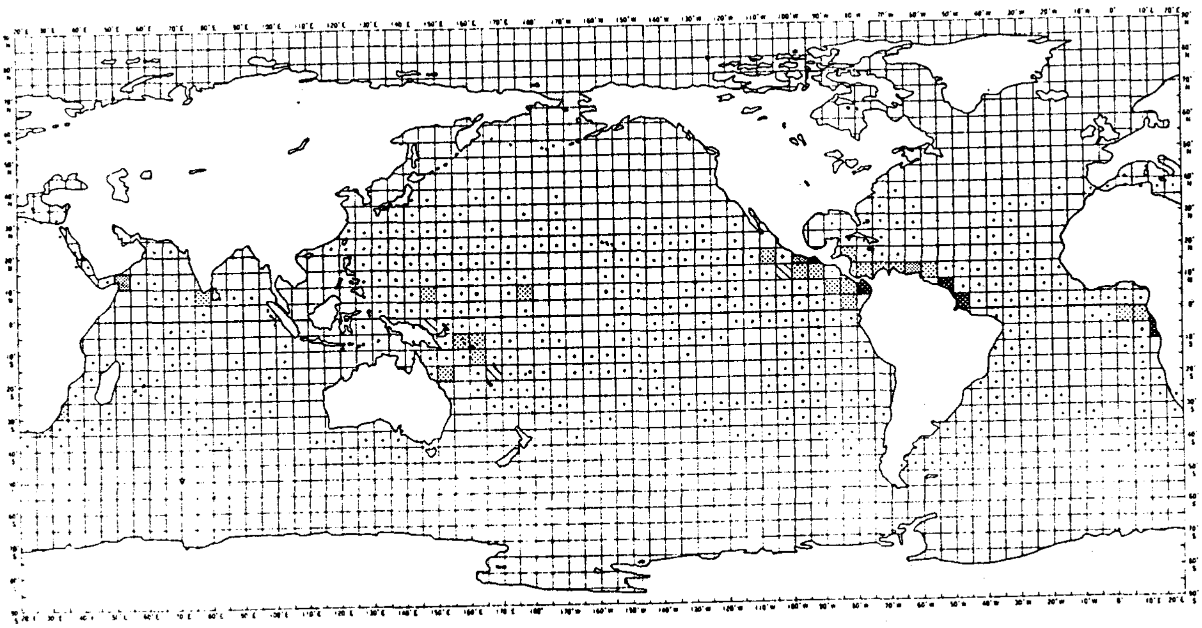


Figure 36. Distribution of larvae of little tunny (Euthynnus spp.). Atlantic larvae are E. alletteratus (Nishikawa et al., 1978).



e. Behavior

1) Habitat preference

As seen in Figure 39, the little tunny is a coastal species in the neritic province in the southeastern U.S. Collette (1978) considers it to be less migratory than the skipjack and other tunas, and reported that it is usually found in coastal areas with swift currents, near shoals and offshore islands.

In south Florida, there is evidence of a general drift of little tunny out of the Miami region toward the south during the winter. Large aggregations of this species are noted by shrimp fishermen in the vicinity of Tortugas during the winter months, which do not seem to be present the remainder of the year. Conversely, the little tunny occurs farther northward along the Atlantic coast during the summer months. These data, based on material collected by the U.S. Fish and Wildlife research vessel T.N. GILL, also suggest that there may be a slight inshore drift during the warmer months. Serventy (1941) noted a summer, coastwise migration of little tunny in Australia toward the south.

The apparently large day-to-day fluctuations of the little tunny are well known to the charterboatmen. Thus, large schools which were taken by anglers in the middle of June shortly disappeared and hence reappeared, to a lesser extent, in July. It is at this time that the peak of the spawning season occurs, and it is possible that these peaks in the catch represent spawning aggregations.

Along the Atlantic coast, most little tunny are caught in "green water," that is, they seldom are taken in the "blue water," or slope water of the Florida Current. The inshore, more turbid waters are thus more typical habitat for the species. Morice and Cadenat (1952) noted that little tunny were found in turbid, inshore waters of Guadalupe. Little tunny seldom enter very shallow waters, but in some West African rivers they are occasionally taken in seines in large numbers. Postel (1950) believed that this was part of a seasonal migratory pattern.

Although Springer and Bullis (1956) collected both young and adults of the little tunny over deep waters in the Gulf of Mexico, the adult is generally confined to shoal waters, and it is more of an inshore species than other "small" tunas such as the blackfin tuna and the oceanic bonito. Whiteleather and Brown (1945) observed that the little tunny seemed to be definitely a continental fish in the region of Trinidad, Tobago, and British Guiana. Springer and Bullis (1956) listed 22 catch localities for the little tunny in the Gulf of Mexico made by the M/V OREGON using various gears. Of these, six are young specimens caught by trolling, handlines, pole and lift nets, or shrimp trawls. The adults occurred over water ranging from 50 to 600 fathoms (100 to 1200 m), with a mean depth of about 80 fathoms (120 m). However, the median depth value is only 18.5 fathoms (37 m), thus indicating that for these data, while the little tunny does venture far out over deep water, it is more likely to be taken in shoal water. Anderson (1954) stated that along the coast of the southeastern United States, with few exceptions, little tunny were taken by trolling within the 20-fathom line. Mather and Day (1954), in a series of extensive observations over deep water in the tropical Atlantic, reported only two little tunny taken, both of which occurred in relatively shallow water. In the eastern Atlantic, Postel (1950) reported that little tunny occurred to the 100-m isobath. Godsil (1954) discussed the apparent restriction of E. yaito to within the 20- to 30-fathom (40- to 60-m) contour around the Hawaiian Islands, and Williams (1956 noted that schools of E. affinis seemed to be restricted to within the 100-fathom (200-m) curve off British East Africa (de Sylva and Rathjen, 1961).

2) Schooling relationships

This species has strong schooling tendencies for individuals of about the same size, which have been reported as being large and elliptical, sometimes covering up to two miles on the long axis (Manooch, 1984). Large schools of little tunny were reported by Carlson (1951, 1952) in his exploratory surveys along the Atlantic and

Gulf coasts. Feeding schools can be located by the presence of diving birds that are also feeding on the smaller fishes (Collette, 1978).

3) Association with other species

There is no clear pattern if little tunny regularly school with other species. Collette and Nauen (1983) stated that this species schools by size with other scombrid species, but did not specify which species. Yoshida (1979) noted that little tunny often school with other species, including Auxis sp., Sarda sarda, and Selar crumenophthalmus. All the individuals in these mixed schools tend to be of the same size (Marchal, 1963). They probably school with king mackerel (Scomberomorus cavalla), and Whiteleather and Brown (1945) reported that they occurred with Spanish mackerel (S. maculatus).

4) Seasonal and diurnal patterns

This section is discussed earlier under Section a, Distribution, 3), Movement/migration patterns. An extensive discussion is also included in Carlson (1951, 1952). A report by Chilton (1949) is presented below.

"The Fish and Wildlife Service has attempted to accumulate available information on the identity, abundance, season, and location of these fish in the waters of the Atlantic Coast from commercial fishermen, sport fishermen, fish dealers, fish processors, and other observers.

"The meagre evidence collected indicates that these fish may maintain a seasonal migration along the Atlantic Coast. In the winter months they have been seen in large schools off the coasts of South Carolina, Georgia, and Florida. In May and June they have been reported as migrating north off the coast of North and South Carolina. In August and September, they have been caught with ocean pound nets in fair abundance off the coast of New Jersey and New York. In November and December, these fish have been observed migrating south again off the coast of North Carolina. Like the menhaden though, some of these fish seem to remain in southern waters the year around.

"Since the field of study, so far, has been largely restricted to the Atlantic coast, no data have been collected on the movement in the Gulf of Mexico. However, there are reports that they have been found off the coast of Mississippi in fair abundance in June.

"Whiteleather and Brown (1945) stated 'The survey in August and September found a fair number of schools of spotted bonito, some of which are mixed with Spanish mackerel....The spotted bonito, although taken occasionally in oceanic waters, seems to be definitely a continental fish....It is too shy to be taken in the tuck seine, but with a purse seine quiet schools can be surrounded and caught. The spotted bonito referred to is the little tuna.

"Fiedler et al. (1947) say of the Cuban fisheries: 'The offshore species such as tuna are now little used. There are definite indications that enormous numbers of the various migratory species pass Cuba at certain times of year. A large and productive fishery could be established using these species as a basis. However, until commercial exploration is carried on, there remains only fragmentary evidence of the actual size of migrations.

"Carl Carlson, fishery engineer of the Fish and Wildlilfe Service, in conducting experiments with fishing gear in the South Atlantic in 1944 reported: 'Numerous schools of the little tuna were observed during the month of June off the coast of Florida. These fish appeared in compact schools, exhibiting a lesser degree of activity than the schools of tuna which are captured with pure seines in the Pacific. Several of these schools were circled by our fishing vessel, and the distance traveled indicated that a purse seine of less that 300 fathoms in length would have been adequate to surround them.

"A concern on the east coast of Florida reports catching little tuna in June, July, and August, by trolling with spoons and artificial squid as lures. This firm reports that sometimes with two men trolling from a mackerel boat, from 1,000 to 5,000 pounds per day are caught.

"Captain H.H. Von Harten of Beaufort, South Carolina, says that he has seen enormous schools of these fish in January and February, approximately 50 miles out in the ocean off his home port, and near the Gulf Stream. He said that ordinarily they were very easily taken with spoons and feather lures.

"E.W. Copeland of Morehead City, North Carolina, reports that several years ago an ordinary menhaden boat, using the usual deep menhaden purse seines, caught about 50,000 pounds of these fish the first day the boat went out after them. It was Mr. Copeland's recollection that this catch was made either in December or in January. He attempted to make fish meal from these fish, but found them too large to handle in his menhaden processing plant. Since there was no market demand for this species he could find no use for them.

"Another interesting report on these little tuna comes from fishermen on the lower Chesapeake Bay. They said that in 1946 several fairly large schools of these fish were seen 'jumping all over the place' near Old Point Comfort. A few of the little tuna were caught by sportsmen trolling, but interest in the sport soon die down as no acceptable method of cooking them was found.

"W. Emmett Andrews, formerly a fishery educational specialist in the Fish and Wildlife Service, reports that in early August 1940, while trolling with stag tail lures on the edge of the Gulf Stream about twenty miles off Ocean City, Maryland, his party caught ninety of these fish in less than an hour's time. The average weight was about eight pounds, and the range from four to 10 pounds. These fish were not seen from the surface and were encountered while trolling for other fish. The party trolled back and forth across the school until they caught all they wanted.

Most of this catch was eaten by his friends and neighbors of Cambridge, Maryland. They split the fish, put them in heavy brine for about an hour to draw out the blood, drained them, sprinkled them with salt, and let them stand overnight. They found that by broiling the fish well and basting with hot bacon fat they made a tasty dish.

"For a number of years these fish have been taken in fair amounts in ocean pound nets in August, September, and October off the coasts of New York and New Jersey. The determination of their abundance has been very difficult because this particular species of fish has had so many names, and had frequently been included with other species when reported by fishermen and dealers.

"In statistical reports of the Fish and Wildlife Service, covering New Jersey and New York, for several years past, an annual take of approximately 500,000 pounds of frigate mackerel and bonito has been indicated. It is now believed, in the light of recent developments, that a fairly large percentage of this catch were little tuna.

"On August 27, 1948, a sports fishing party boatman, operating out of Forked River, New Jersey, said the ocean in this vicinity was alive with little tuna at that time, but he tried to avoid them because in this area nobody seemed to want them."

5. Environmental responses

No experimental studies have been carried out on the behavioral responses of little tunny to any artificial or natural stimuli. It is attracted to FADs (fish aggregating devices) (see Wickham et al., 1973 ; our Figure 37). A closely related species (*Euthynnus affinis*) has been found to possess a high auditory threshold at 1000 HZ (Iversen, 1963; Foote, 1980). Postel (1955) presented detailed information on the relationship between little tunny distribution off West Africa in relation to temperature and salinity fluctuations.

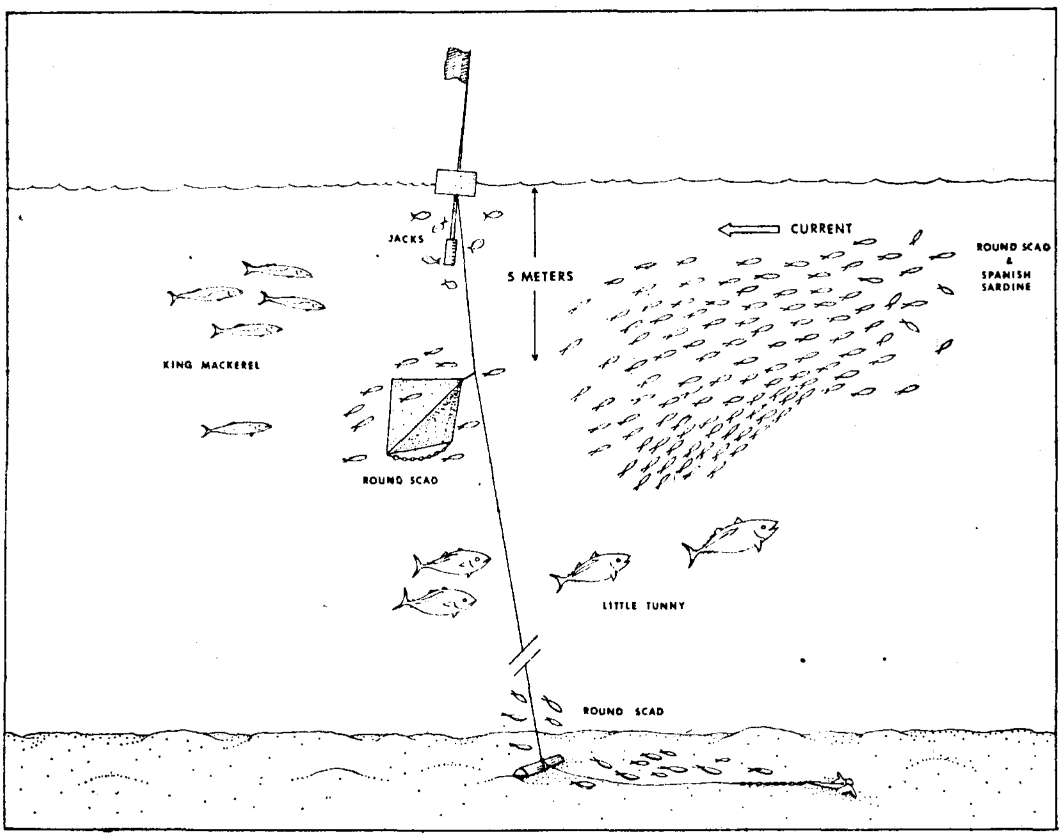


Figure 37. An illustration of the mooring arrangement used for deploying single structures [of FADs]. The characteristic positions of fish around the structure are shown schematically (Wickham et al., 1973).

f. Food habits of:

1) Larvae

No studies have been carried out to determine the natural food of the larvae of little tunny. Mayo (1973) used predominantly copepod nauplii to rear the larvae in the laboratory, which grew up to 20 mm, and stated that these and other scombrid larvae "required a large quantity of food." Houde and Richards (1969) also reared little tunny eggs through hatching, using copepod nauplii and copepodites. They stated that 12 days after hatching, some larvae did accept brine shrimp (Artemia salina) nauplii, but that the larvae would not eat zooplankton or other larval fish.

2) Juveniles

Nothing is known about the food habits of juvenile little tunny.

3) Adults

The food habits of little tunny carried out through the mid-sixties was summarized by Dragovich (1967), and is listed in Appendix I a. The round herring (Etrumeus teres) was the most important food species of Euthynnus alletteratus in specimens collected from the southern Atlantic coasts of the U.S., making up 39 o/o of stomach contents items (Carlson, 1952). Squid also was important, accounting for 28 o/o of food items, and the Spanish sardine (Sardinella anchovia) made up 12 o/o of food items. Other components of the stomach contents were the round scad (Decapterus punctatus), Spanish mackerel, and mud parrotfish (Sparisoma flavescens). Unidentified fish made up 11 o/o of total food items (Carlson, 1952). In another study, both little tunnies collected contained Spanish mackerel, and one little tunny contained larval little tunny, indicating cannibalism (Klawe, 1961). Carangidae (jacks) and Exocoetidae (flyingfish) are some other groups fed upon by little tunny (Dragovich, 1969).

More recent studies along the southeastern and Gulf coasts of the U.S. by Manooch _et al_ (1985) confirmed that they feed primarily on clupeids, carangids, and squids, in addition to small crustaceans. Information is presented in Appendix Ia on the frequency of occurrence of selected foods of little tunny by predator size, and for season of collection. Frequency of occurrence percentages for selected foods is also given by area of collection.

Food habits of little tunny off Brazil were reported by Menezes and Aragoa (1980). The most important foods were fishes and crustaceans, with herrings, jacks, halfbeaks, flyingfish, and triggerfish being most important (Appendix Ia). Squids and octopuses were also eaten. They concluded that the only differences in the food habits of the little tunny between the eastern and western waters of the Atlantic Ocean was the occurrence of algae in the diet of the western Atlantic population.

In the eastern Atlantic, extensive studies on the food habits of the little tunny have been carried out by Postel (1950 _et seq_.). Clupeid, fishes, anchovies, jacks, mollusks, and crustaceans are all important foods. Chur (1972) noted that the little tunny showed changes in the diet with growth as follows:

Group 1: small tunas of 30-40 cm, feeding heavily on crustaceans, shrimps, squids, and on the fry of some Sparidae and groundfish.

Group 2 tunas of mean length of 40-60 cm feeding mainly on fry of some species which inhabit the water over the shelf edge (_Upeneus prayensis_, _Priacanthus_ sp., and on larvae of crustaceans.

Group 3: tunas of 60-85 cm, feeding on typically pelagic species (_Sardinella_ sp., _Trachurus trachurus_, _Scomber_ sp.), and also on groundfish and their fry _Pagellus_ sp., _Mullus_ sp.,).

g. _Predators on:_

1) _Larvae_

Nothing was found in the literature concerning predators having eaten larval little tunny.

2) Juveniles

Klawe (1961) reported juvenile little tunny in the stomachs of adult little tunny and skipjack between Cape Hatteras and the Bahamas. Juveniles (20-180 mm) were found in stomachs of tunas and tuna-like fishes caught by longline in Brazilian waters (Zavala-Camín and von Seckendorff, 1979).

3) Adults

Adult little tunny are eaten by sailfish (Voss, 1953), being found in 7.6 o/o of all food found in an analysis of 241 adults taken off south Florida. Little tunny have been found in the stomachs of bull sharks, *Carcharhinus leucas*, from the eastern Gulf of Mexico (Clark and von Schmidt, 1965). Other sharks such as the tiger shark (*Galeocerdo*), large yellowfin tuna, and sailfish have also been reported to eat them (Marchal, 1963).

h. Competitors

Marchal (1963) listed as competitors for the same foods the scombrids (*Auxis thazard* and *Sarda sarda*. Dolphins (*Delphinus*) and other cetaceans (*Grampus*, *Globicephalus*) seek anchovies as food in the same manner as the lilttle tuna. Manooch *et al*. (1985) showed that the diet of little tunny was more similar to that of king mackerel (*Scomberomorus cavalla*) than that of Spanish mackerel (*S. maculatus*).

i. Environmental relationships

1) Ecological requirements

This has already been discussed in Section e, Behavior, 1), Habitat preferences. There are no experimental studies profiling the conditions under which little tunny respond to stimuli. Some information is available on the temperature-salinity conditions in which little tunny occur in the eastern Atlantic

(Postel et seq., 1950; Marchal, 1963). The following section is from Yoshida's (1979) synthesis of three species of Euthynnus and their responses to environmental factors:

"Tester (1959) summarized the various experiments on the response of E. affinis and other tunas to stimuli (Hsiao 1952; Miyake 1952; Tester 1952a, 1952b; Van Weel 1952; Tester et al. 1954; Hsiao and Tester 1955; Tester et al. 1955; Miyake and Steiger 1957). It was found that E. affinis were attracted to continuous white light over a range of moderate intensity (about 70 to 450 fc). Euthynnus affinis were attracted to a light of weaker intensity, and were repelled by a light of stronger intensity (Hsiao 1952). In experiments testing the reaction of E. affinis to moving objects of various colors, it was found that white lures were slightly more attractive than red, black, or silver (Hsiao and Tester 1955). Hsiao and Tester (1955) noted, however, that this may have been associated with greater visibility than color preference. Experiments on the chemoreception of E. affinis indicated that this species had a well-developed sense of smell or taste in that they were strongly attracted to clear colorless extracts of tuna flesh. It was further found that the attractant was contained in the protein rather than the fat fraction of the clear extract (Van Weel 1952; Tester et al. 1955). It was also determined that E. affinis became conditioned to the smell of juices exuded from the food which presumably contained common or similar substances which stimulated the feeding response (Tester et al. 1954).

"Nakamura (1968) determined the visual acuity of E. affinis. Visual acuity was defined as the ability to see clearly the fine details of objects, especially as the objects become smaller and closer together. To determine the visual acuity, E. affinis were trained to discriminate between vertical and horizontally striped images that were projected on an opal glass plate in an experimental tank. The visual acuity of two E. affinis, 36.4 cm (0.9 kg) and 43.4 cm (1.6 kg), were determined at various levels of luminance. Nakamura (1969) also conducted these experiments on K. pelamis and noted that at lower luminances the visual acuity of the two species were similar. At higher luminances, however, K. pelamis had a greater visual acuity than E. affinis.

"Experiments have also been conducted to describe the hearing thresholds and frequencies audible to E. affinis (Iversen 1969). Based on experiments with two specimens, Iversen determined a threshold curve for acoustic sound pressure for E. affinis which showed that the fish perceived sounds from 100 to 1,100 Hz. The lowest mean threshold was 7dB/mbar at 500 Hz. At 100 Hz the threshold was 30 dB/mbar higher than at 500 Hz, and at 1,100 Hz it aws 23 dB/mar higher. The mean thresholds for E. affinis were consistently higher than those for T. albacares (Iversen 1967). Iversen (1969) noted that this difference could have resulted in part from the lack of a gas bladder in E. affinis.

"Steffel et al. (1976) conducted experiments on captive E. affinis to determine their ability to discriminate temperature gradients. Tests on two fish yielded a discrimination threshold of 0.10° to 0.15°C. Their experiments indicated that the thermal sensitivity of E. affinis is no more acute than that of inshore fishes and appeared inadequate for direct sensing of weak horizontal temperature gradients at sea.

"Walter (1966) determined the swimming speed of E. affinis by high-speed motion pictures. He observed that E. affinis traveled an average of 5.9 body lengths/s while feeding and a maximum of 10.0 body lengths/s. The nonfeeding swimming speed, with food present, averaged 4.5 body lengths/s and ranged from 2.9 to 12.5 body lengths/s.

"Magnuson (1969) investigated the swimming activity of captive E. affinis as related to their search for food in outdoor tanks. He determined that the average swimming speed of E. affinis, averaging about 35 cm long, was 80 cm/s during the day and 83 cm/s at night in tanks containing no food. These fish had been in captivity for less than a month. Swimming speed measurements made after the fish had been in captivity for 5 to 6 and 8 months showed that the speed was lower than that of fish held less than a month, but no marked difference was observed between the mean speed during the day (74 cm/s) and the mean speed during the night (72 cm/s). Magnuson (1969) also measured the swimming speed of E. affinis in tanks containing several thousand live prey fish. They appeared to swim faster than those without food, averaging 108 cm/s during the day and 92/cm/s at night. He noted that the higher day speeds were caused from intermittent high-speed pursuit of the prey. Euthynnus affinis did not prey on the baitfish at night.

"Magnuson (1969) found that swimming speed was highest after a meal and decreased when the fish were deprived of food. He argued that if the level of swimming activity is regulated by search for food, swimming speed decreased during deprivation. He concluded that swimming activity must be regulated in response to some biological need other than food search. He further concluded that swimming activity appeared to be more closely related to the requirements for maintaining hydrostatic equilibrium and gill ventilation than for food search.

"Inoue et al. (1970) also made observations on the swimming speed of E. affinis. They found that E. affinis swam at a speed of 0.30-1.27 m/s during the day and 0.33-0.75 m/s under artificial lights in their experimental tanks 4 m in diameter and 0.6 m deep.

"Nakamura and Magnuson (1965) gave a detailed description of the coloration of living E. affinis which exhibited three transient color patterns or markings that were related to feeding. These patterns or markings were black spots ventral to the pectoral fins, faint vertical bars on the flanks, and a yellowish middorsal stripe. These three color patterns were observed when E. affinis were feeding. Nakamura and Magnuson (1965) suggested that these transient color patterns may act as 'social releasers' to signal the presence of food to other members of the school.

"Wickham *et al.* (1973) investigated the efficacy of midwater artificial structures for attracting pelagic sport fishes in the Gulf of Mexico near Panama City, Fla. With equal experimental fishing effort they obtained significantly greater catches of *E. alletteratus* around the artificial structures than in adjacent control areas. However, they noted that *E. alletteratus* were seldom observed or captured at the structures unless baitfish were present. They concluded that *E. alletteratus* apparently were not attracted by the structures *per se*, but rather by the presence of the baitfishes that were attracted to the structures."

2) Fisheries oceanography

There is no information on the use of physical oceanographic factors to predict where little tunny may be concentrated. They appear to be found in a wide range of temperature and salinity, but they clearly move north with the increasing temperature in the late spring, moving southward in the fall with decreasing water temperatures (see Appendix Ib). The fact that the little tunny is a "green-water" fish rather than a "blue-water" species (de Sylva and Rathjen, 1961) suggests that water color and/or turbidity may play an important role in its distribution, and that the use of satellite oceanography to determine water color and water-color boundaries may be an important tool in exploratory fishing (see also Section G, at the end of this report).

F. Fisheries activities for blackfin tuna and little tunny

--History

Due to nomenclatorial problems, good historical information on commercial fisheries for the subject species is sparse and sometimes erroneous. Highly organized, directed fisheries for the species are lacking. Exceptions are in Cuba, Venezuela, eastern Brazil, and the eastern Atlantic effort for little tunny, where regular effort is in place. As a consequence, much of the available literature on fisheries aspects is scattered or only from anecdotal sources. The researcher should refer to ICCAT "Collective Volume of Scientific Papers," 1973-1984 (1985), for an impression of what is available.

--History of fisheries in the United States

1) Little tunny

An early discussion of interest in little tunny is provided by Chilton (1949) which cites intermittent fishery activity "from Cape Cod to the Florida coast, and also in the Gulf. The little tunny has been reported in abundance at certain seasons of the year. It has also been reported in fair abundance in various parts of the Caribbean Sea." This report goes on to review information on the species for the east coast at that time. It also provides background on early interest in commercial fishing for the species. For the Caribbean, Whiteleather and Brown (1945) speculate on the potential for a fishery for this species off Trinidad, Tobago, and British Guiana (now Guyana). Fiedler et al. (1947) recorded the species as being of fishery interest in the "Caribbean area" and made specific mention of live bait fishing for "tuna and bonito" in Cuban waters. Carlson (1951) recorded limited but positive knowledge of the species from New Jersey to Mississippi and contiguous waters and the same author (1952) reported on experimental and exploratory fishing off the southeastern United States directed to the species. Rivas (1951) commented that "....the flesh is good and of commercial importance through the West Indies...." Marcille (1985) summarized fisheries interest in the Lesser Antilles and off Venezuela. Postel (1950 *et seq.*) reviewed fishery aspects for the eastern Atlantic, and Miyake (1981) provided a summary of Atlantic fisheries activity. For the Indo-Pacific area, fishery activity on the species has been documented by Serventy (1941).

2) **Blackfin tuna**

There is no directed commercial fishery for blackfin tuna or little tunny in the U.S. Commercial fisheries in the Caribbean are covered in subsequent sections.

4. Description of the commercial fisheries for "small" tunas

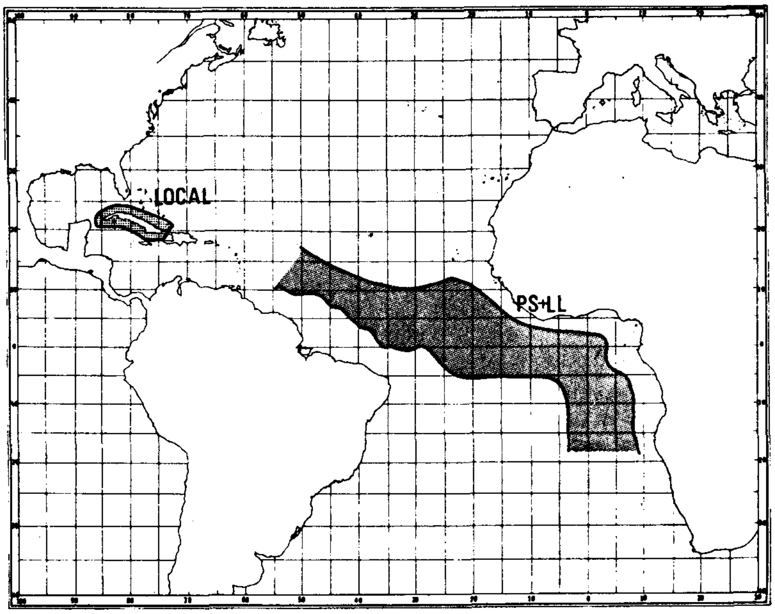
a. **Cuba**

Cuban fishermen have fished for tunas since 1932. Among the species caught are skipjack tuna (*Katsuwonus pelamis*), known as *bonito*; Atlantic blackfin tuna (*Thunnus atlanticus*), called *albacora*; little tunny (*Euthynnus alletteratus*), called *comevíveres*; frigate mackerel (*Auxis thazard*), also called *comevíveres*; and yellowfin tuna (*Thunnus albacares*), known as *atún de aleta amarilla*. Unfortunately most statistical information lists these species under the collective name of tuna (*atunes*). Nevertheless, in a few papers we found data on blackfin tuna separated from both little tunny and frigate mackerel.

1) **Fishing Areas**

In 1984-1985 Cuban tuna vessels operated in the Atlantic in an area (Fig. 38) similar to that of previous years (García Moreno and Rodríguez Rodríguez, 1985). Locally small and medium vessels carried out their activities using pole and line for skipjack and blackfin tuna in waters immediately adjacent to Cuba.

Fig. 38. Fishing areas of cuban tuna vessels. (The local fishery includes small scale LL(longlines), troll and BB (baitboats)(from García Moreno and Rodríguez, 1985).



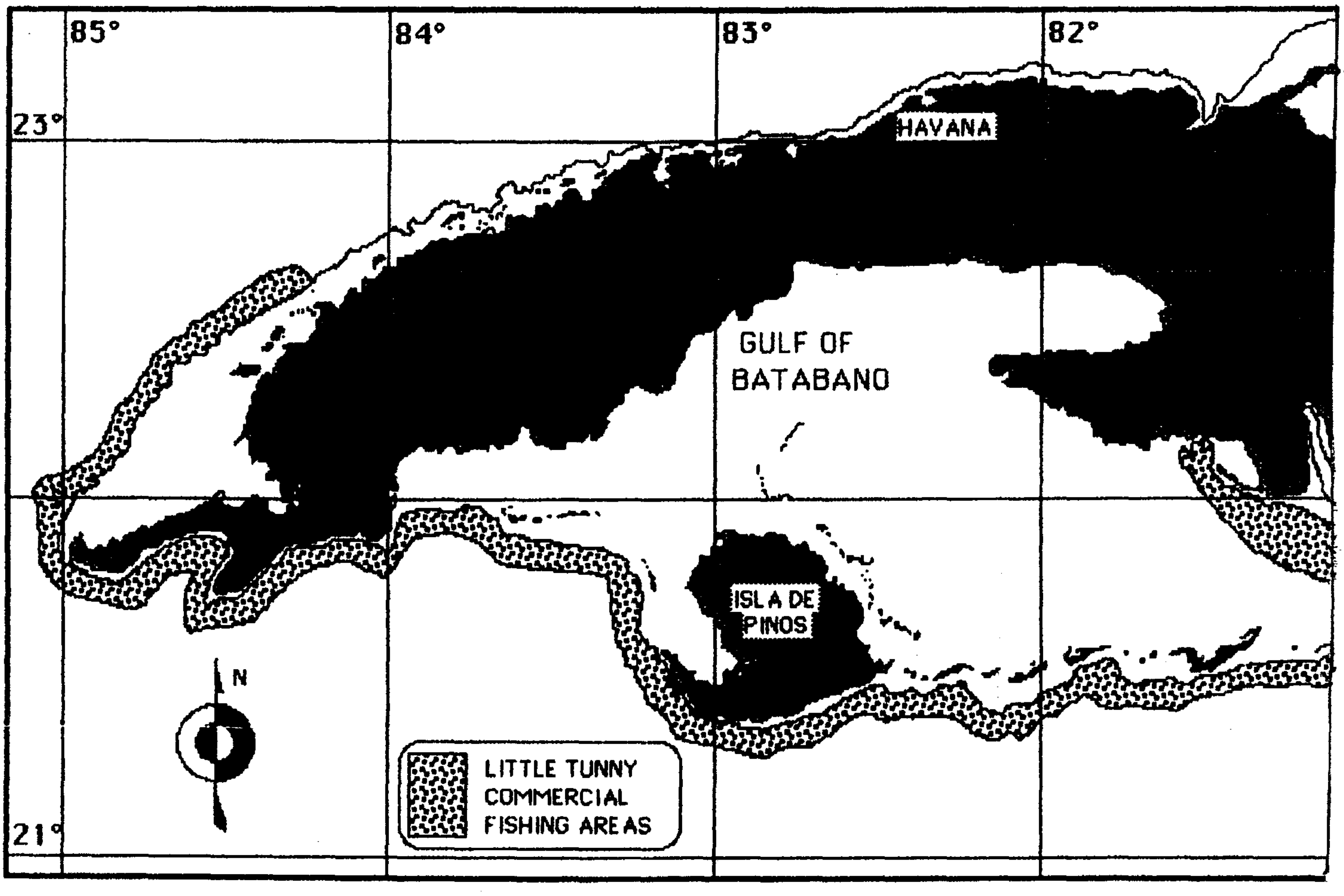


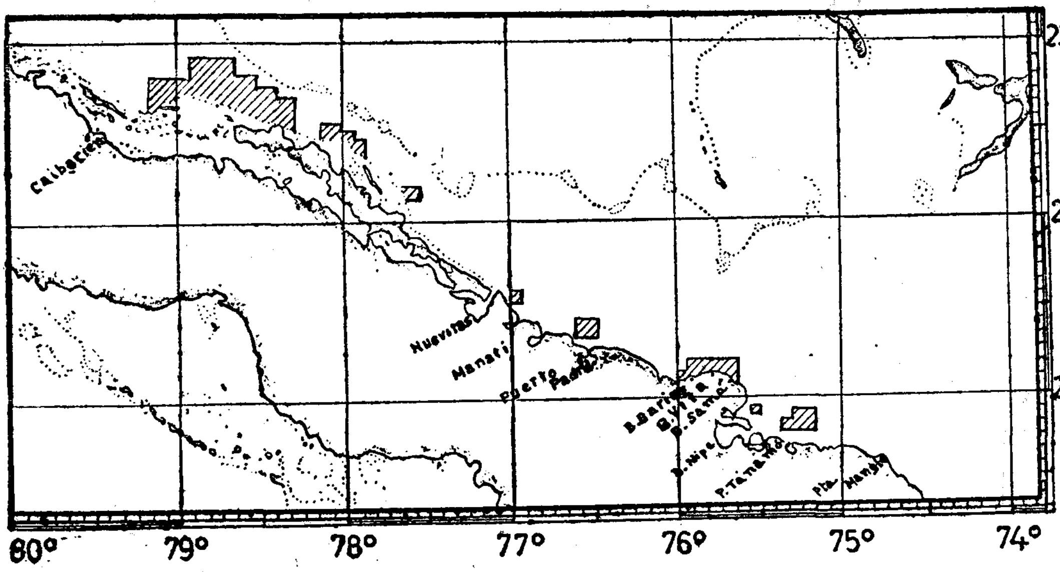
Figure 39. Map of the commercial fishing area of little tunny in Cuba.

There are two areas around Cuba where the species of tuna mentioned above are caught. The main, traditional area is 414 nautical miles long and 3 to 5 miles wide (Fig. 39). It is located along the southwestern part of the island, between Bahia de Cochinos and Cayo Guano south of Matanzas province, continuing toward the west to Cape San Antonio, in the western tip of the Island, and then to the northeast to Punta Tabaco north of Pinar del Río province (Suárez-Caabro and Duarte-Bello, 1961, fig. 1, page 20).

A second area, the Cubans call the "New Fishing Zone," for tuna fisheries are located off the north coast of the island from Caibarién Port, north of Villa Clara province, through Point of Tánamo at Holguín province in the eastern part of the island (Carlés, 1971; our Fig. 40). This new zone for tuna fisheries is 300 miles long by 5 miles wide. According to Carlés (1971), the best area of this zone is situated between 77^{o} 30' W and 79^{o} 15' W and is protected by the Bahamas Channel. Along this new zone they have found important concentrations of blackfin tuna and skipjack, and there are ample areas of live bait. The key sardine or manjúa (Jenkinsia lamprotaenia) is available to attract tunas fished with pole and line, the same as in the traditional area of fishing in the southwestern part of Cuba.

The Cubans have conducted exploratory fishing for tunas in the new zone during 1961-1963 and in 1967 (Carlés, 1971) when they found suitable concentracions in that area. Suprisingly, we have not found any information that they have established a commercial fishery for tunas there.

Figure 40. Principal areas of capture, New Zone (D) (from Carlés, 1971)



b) Vessels

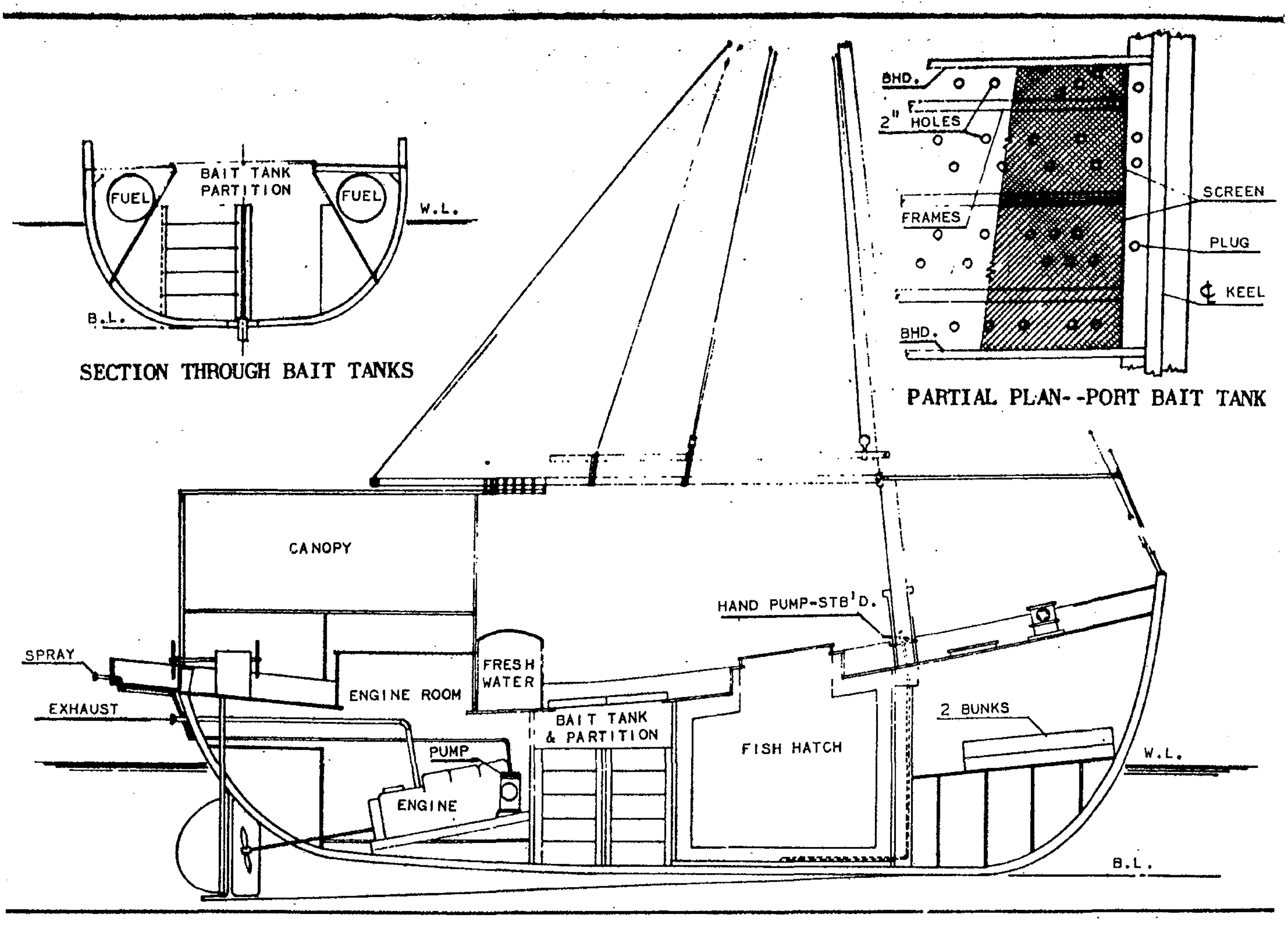
According to García Moreno and Rodríguez Rodríguez (1985), the Cuban tuna fleet basically comprises 18 long-range longliners, 9 mediumrange longliners, and about 59 baitboats. The fleet also includes one purse seiner and approximately 50 small boats using and gill nets or trolling lines; thus 43 percent of the fleet is baitboats.

The typical Cuban tuna-bait boat is a modified sloop (balandro) with a gaff-rigged mainsail, usually with a flying jib (Fig. 41). The sails are not used regularly, but are carried in case of emergency. The boat has a shallow draft (1.1 - 1.4 m) which is important in working over the shoal areas during daily bait-catching operations (Rawlings, 1953). The usual characteristics of these boats are 9 - 17 m length, 3-5 m wide, with one 30-165 hp inboard motor, and a speed of about 9 knots (Suárez-Caabro and Duarte-Bello, 1961). Located from stern to bow are: the engine, the bait tank, the ice box, and the berth for the crew (Rawlings, 1953). Seven to nine men crew these boats and consist of a captain, one engineer, a cook, a chummer, and three to five fishermen. These boats carry a radiotelephone and compass but most captains rely only on coastal and practical navigation.

Key sardines are oxygenated in the bait tank only when the boat is sailing because there is no water pump. The tank bottom is full of holes that permit the seawater to be flushed into the tank by the vessel's forward motion. All Cuban tuna fishing boats carry a flat bottom skiff (chalana) of 4.5 m length and an outboard motor of 3-5 hp. It is used to locate and catch the bait in shallow waters along mangrove shores of the coast.

In Cuba in some tuna-fishing areas they use a large transport boat called an enviada. This "mother ship" is only used to transport the tunas from the boats on the fishing grounds to the canneries, thus giving the fishing boats more time to fish.

Figure 41. Inboard profile of Cuban tuna-fishing boat showing typical arrangement (from Rawlings, 1953).



Baisre and Paez (1981) point out recent technological improvements that have been introduced into the Cuban fishing fleets. These include an increase in the length of the boats, more powerful engines, better bait tanks, and water systems. They have improved the crew facilities and the fishing methods. There is also a water-spray system on the stern to help to catch the tunas.

During 1963 and 1964, Cuba bought eight longline vessels from Japan and Spain (Sokolov and Ramis, 1964) and they started to fish for tunas in the central Atlantic and eastern Pacific oceans. Probably these boats catch only large tunas and billfishes. Small tunas are taken only as incidental catches.

c) Scouting

In Cuba the fishermen locate the blackin tuna and the little tunas by watching for sea gulls (gaviotas and gallegos) (*Sterna* spp. and *Larus* spp.) flying over the fish schools, by the swirl of the sea water produced by the fish at the surface, and by their jumping in the sea. They catch various species of tuna on the trolled lines because they are always trolling during the fishing trips. But as far as we know the Cuban fishermen do not use electronic instruments such as Loran, Sonar, or Asdic to locate small tunas.

d) Gear and Methods

The most important gear used locally to catch small tunas by the Cuban fishermen is pole and line. The pole is a 4-m length of bamboo (*Bambusa* spp.), called caña brava. At the tip of the pole they fix a line which is equivalent in diameter to 30-36 thread hard-laid seine twine. The preferred material is four strands of nylon of about 6-thread diameter twisted together and tightly served with a hard-finished cotton thread (Rawlings, 1953). The No. 6 leader (0.04-cm diameter wire) (76 cm from snap-on to squid) is 58-pound breaking strength, with a special dull finish.

The feathered squids used are made from a small halibut-type hook (1.6 cm from tip to shank) which is shortened, the barb removed (the point is flattened on the inside toward the shank), and weighted. The hollow quills from man-o-war birds and vultures are trimmed, split, and pulled over the squid and provide excellent protection for the feathers (Rawlings, 1953).

Very early in the morning, before fishing, the tuna boats go into the shallow-water areas of the key to detect and catch enough bait (manjúa) to fill the vessel's bait tank. This operation usually takes a long time, and sometimes they spend almost half a day scouting for and catching bait.

The equipment used to catch bait consists of the flat-bottom skiff, mentioned above in the section on vessels, and a 36.4-m to 63.7-m bait net and a floating bait receiver. The fishermen catch the bait using a net of the beach-seine type of 63 m length and 2.1 m high, fished in the shallow mangrove areas. They put the catch into the floating bait receiver which is then floated to the side of the vessel. With a 45-cm diameter scoop net, they carefully transfer the bait from the floating receiver to the vessel's bait tank. This is a delicate operation because if the small key sardine is damaged, the percentage of survival in the bait tank is very low.

As soon as the vessels approach the schools of tuna, the chummer (manjuero) throws handfuls of bait off the starboard side amidship to attract the school. If the fish breaks water in the wake, which is always watched for very closely at this time, the water-spray system is started on the stern and pole fishing begins.

The method of catching tuna by trolling lines when the boat is sailing is more to detect tuna concentrations than a way of fishing.

According to Cubillas (1966), exploratory fishing for tuna using purse seines has been done in cooperation with the Democratic Popular Republic of Korea and Cuban fishermen in the south of Cuba from Casilda (south of Sancti Spiritus province) to Cape San Antonio in the western tip of the island and then from there to the north to Caibarién and Nuevitas ports in the north coast of Cuba. Cubillas (1966) does not present sufficient scientific data to permit us to interpret the results of this exploratory fishing. He pointed out that the purse-seine fisheries were successful and insisted that the old statement that this type of gear could not be used with success because of the clarity of the Caribbean waters is untrue.

e) Landings

In Cuba the total 1983 catch (8,984 MT) of tuna and tuna-like species was slightly higher than that of the previous years (4 percent) but it was relatively low with respect to the levels since 1971 (García Moreno and Rodríguez Rodríguez, 1985). Catch by gear and the species composition of the total annual Cuban tuna catch are shown in García Moreno and Rodríguez Rodríguez (1985, figs. 2-3, page 243). In spite of the decline in the yellowfin catches, this species continues to be the most important, with 2,709 MT (30 percent); the blackfin represents only 558 MT (6.2 percent) and other tunas 80 MT (0.9 percent).

The following (Tables 12-14; Figs. 58-59) show Cuban tuna catches from 1949 through 1984 taken from Suárez-Caabro and Duarte Bello, 1961), ICCAT, CVSP, 17, Report A (1982) and García-Moreno (1986). Between 1949 to 1959, figures refer to skipjack, blackfin, and other tuna; from 1960 to 1967 catches were not reported; since 1968 to 1979 catches refer to blackfin only and between 1980 to 1984 blackfin tuna and little tunny are reported separately.

Table 12

Landing in Cuba of Skipjack, blackfin, and other tuna from 1949 to 1959 (MT) (from Suárez-Caabro and Duarte-Bello, 1961).

Year	Catch (MT)
1949	532.6
1950	711.3
1951	776.4
1952	1211.9
1953	1263.5
1954	1351.4
1955	1376.3
1956	1482.8
1957	1927.8
1959	908.7
1959	1669.6

	1968	*1969*	*1970*	*1971*	*1972*	*1973*	*1974*	*1975*	*1976*	*1977*	*1978*	*1979*
TOTAL	*1223*	*970*	*1322*	*1215*	*395*	*1471*	*1509*	*1710*	*2004*	*1901*	*1421*	*1421*
Brasil	83	53	52	75	295	296	194	129	94	273	190	525
R. Dom.	100	100	100	100	100	200	124	79	90	68	61	96
France							21	7				
Cuba*	1040	817	1170	1040		975	1170	1495	1820	1560	1170	1300

* "Bonito" (Skipjack) catches are assumed 65 °/o Blackfin 35 °/o Skipjack. /Les prises de "bonito" (listao) représenteraient 65 °/o de thon à nageoires noires et 35 °/o de listao. / Las capturas de "bonito" se supone son: 65 °/o atún aleta negra y 35 °/o listao.

Table 13. Atlantic blackfin tuna catches (MT) (from García-Moreno, 1986).

Table 14. **Cuban catches (MT) of tunas and tuna-like species during 1980-1984 (García-Moreno, 1986).**

	1980	1981	1982	1983	1984
Yellowfin	5,800	4,900	3,754	2,709	4,005
Albacore	100	100	111	74	136
Bigeye	1,400	700	521	421	447
Skipjack	2,500	1,300	1,323	1,835	1,558
Spotted Spanish mackerel	500	600	476	689	544
Billfish	800	600	589	1,068	678
Swordfish	600	400	686	1,228	1,367
Blue marlin	--	300	436	396	373
Atlantic little tuna	--	100	77	6	15
Blackfin	--	700	622	558	487
Others	100	--	--	--	--
Total	11,800	9,700	8,595	8,984	9,610

Figure 42. Catches, by gear, of Cuban tuna vessels; LL, longline, BB, baitboat; PS, purse seine; TROL, trolling (García-Moreno, 1986).

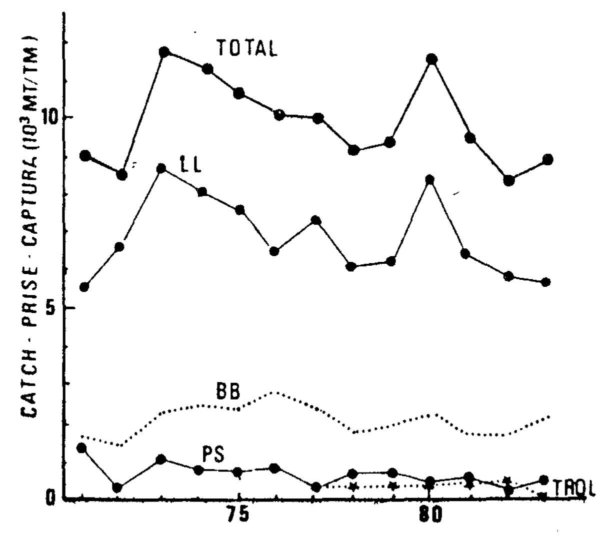
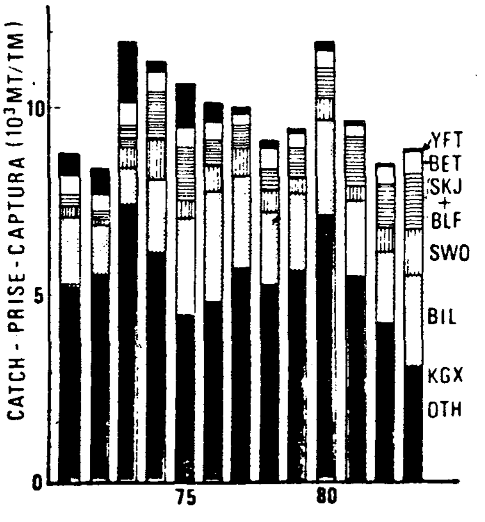


Figure 43. Species composition of Cuban catches of tunas and tuna-like fishes (García-Moreno, 1986). YFT = yellowfin tuna; BET = bigeye tuna, SKJ = skipjack; BLF = bluefin tuna; BIL = billfish; SWO = swordfish; KGX = (?); OTH = other



b. **PUERTO RICO**

1) Fishing Areas

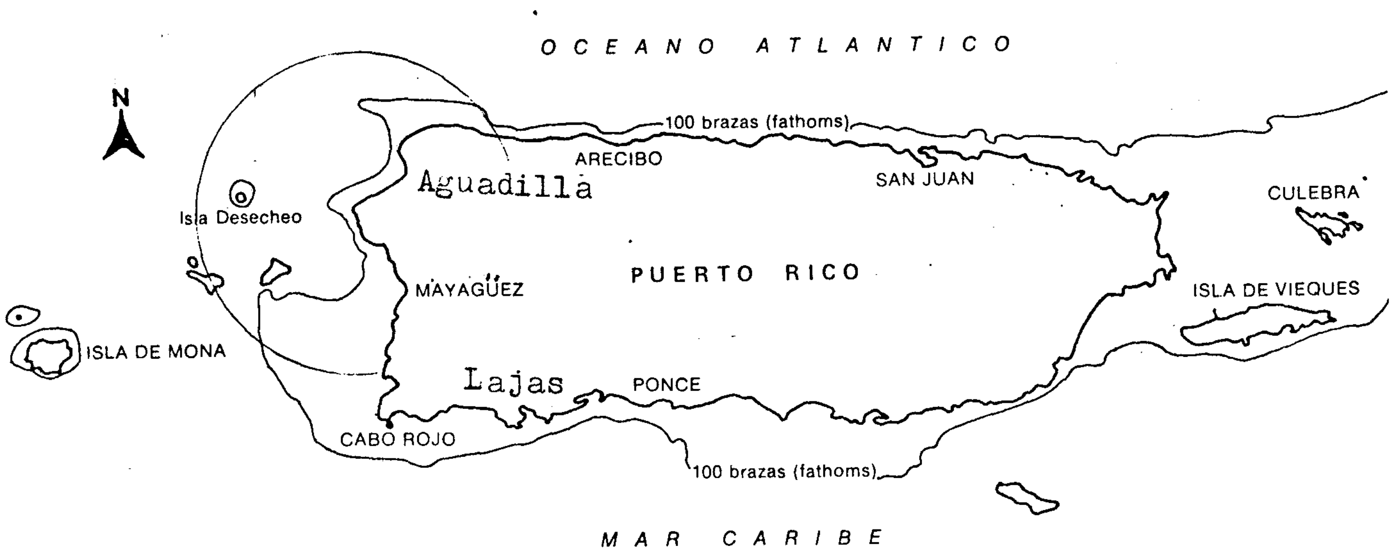
Juhl et al. (1970) during exploratory cruises in the western tropical Atlantic reported and identified blackfin tuna, little tunny, and skipjack tuna off the southern and northeastern part of the island. These species have been reported all around the island. According to Bane (1965) the blackfin tuna is one of the most abundant of the tunas around Puerto Rico. The largest concentrations have been noted off Rabos, Aguadilla, Desecheo Island, and La Parguera, Lajas.

In Puerto Rico tunas have several common names. Blackfin tuna is called albacora in San Juan, atuncito in La Parguera, Lajas, and bonito in Aguadilla; yellowfin tuna is called atún de aletas amarillas (*T. albacares*); albacore is also called albacora (*T. alalunga*); and frigate mackerel (*Auxis* spp.) is known as maduro, mauro, or vaquita (Erdman, 1983). Little tunny is known as vaca or bonito.

Blackfin tuna occur in mixed schools with skipjack and typically more from east to west along the edge of the dropoff during migrations in Puerto Rican waters. The little tunnny is caught throughout the year in the surface waters of the island shelf and it appears to follow the east to west migration pattern of the blackfin tuna (Centaur Associates, Inc., 1983).

Tuna fishing is highly localized in Puerto Rico. The main fishing area is located in Aguadilla, a fishing center on the northwestern coast of the island. From Playuela, the main fishing village of Aguadilla, the dropoff is less than one nautical mile from the shore (Fig. 44). To the west, 18 miles from Aguadilla in the deep waters of the Mona Passage is the tiny island of Desecheo where the fishermen always find plenty of schools of tuna (Weiler and Suárez-Caabro, 1980, map fig. 3, p.6). We estimate that during the season more than 70 % of the landings in Aguadilla are tunas (Suárez-Caabro, 1979).

Figure 44. Puerto Rico and insular shelf (from Weiler and Suárez-Caabro, 1980).



2) Landings

In Puerto Rico the commercial catch includes about 3% of several species of tuna. In 1967 Puerto Rico started to collect commercial fisheries statistics from the local fishermen and in 1969 for the first time tuna (atún) appeared in the statistical reports (Juhl and Suárez-Caabro, 1971). Under this heading they reported the following species: blackfin, yellowfin, bigeye, bluefin, albacore, skipjack, and little tunny. The following table shows the landings of tuna in Puerto Rico from 1969 to 1980 in metric tons by coasts:

LANDINGS OF TUNA (MT) IN PUERTO RICO

	Coasts				
Year	North	South	East	West	Total
1969	(2)	(2)	(2)	(2)	12.7
1970	8.8	(1)	11.3	44.6	64.7
1971	15.9	(1)	9.1	114.5	139.5
1972	7.9	2.3	6.8	75.4	92.4
1973	4.5	(1)	8.5	47.6	60.6
1974	2.8	2.8	1.1	45.4	52.1
1975	15.9	1.1	2.3	58.4	77.7
1976	9.8	1.1	2.8	70.3	84.0
1977	4.0	1.7	4.5	57.8	68.0
1978	30.0	2.5	4.5	44.9	81.9
1979	(2)	(2)	(2)	(2)	86.4
1980	(2)	(2)	(2)	(2)	74.4

(1) Figures enclosed by parentheses supply less than 1 MT

(2) Not reported by coasts

(3) Data from 1969, 1979, and 1980 were taken from Centaur Associates, Inc. (1983); for 1970 to 1976 from Status of the Fisheries in Puerto Rico, Department of Agriculture, Laboratory of Fisheries Research, Cabo Rojo, Puerto Rico; and from 1977 and 1978, from CODREMAR, LIP, Cabo Rojo, Puerto Rico.

3) Vessels

Puerto Rico does not have a tuna fleet specifically for domestic fisheries. Most boats fishing for tunas are located in Aguadilla. The most common of fishing vessel for this purpose is an outboard motor launch called a yola 5 - 5.5 m long. Motors most frequently used are of 16 - 25 hp. In 1978 there were about 60 boats (yolas) fishing for tuna in Aguadilla (Weiler and Suárez-Caabro, 1980). The number of fishermen was about the same because each fisherman is the owner of one boat.

4) Scouting

The fishermen of Puerto Rico detect the schools of tunas by practical methods such as birds flying over the fishes, by the swirl of the sea water, or by jumping tuna. No special electronics such as Loran, Asdic, or Sonar are used. In Puerto Rico and the Virgin Islands, "the least tern (*Sterna albifrons*)...is a coastal species and is seldom seen offshore beyond the 100-fathom curve. They are good indicators of little tuna schools ... in spring and summer" (Erdman, 1967).

5) Gear and Methods

Especially in the Aguadilla area of Puerto Rico, they fish for tuna using trolling lines (silga) only. Lines of cotton or nylon line and 18 - 36 inches of steel leader wire called verguilla are fished with a feather jig (Suárez-Caabro, 1979).

Some exploratory fishing for tuna using other gear has been planned in Puerto Rico. Bane (1965) carried out exploratory fishing with longlines in the Mona Passage and adjoining areas. He captured no tunas using longlines; nevertheless, trolling was satisfactory because several blackfin and little tunny were caught.

Occasionally a few small tunas are taken in beach seines but these are incidental catches.

c. **Lesser Antilles**

"Regarding little tunny and frigate mackerel (Auxis sp.), "these tunas are captured in the Lesser Antilles in the more coastal regions where they form small shoals swimming over the continental shelf. They are fished with beach seines from the Iles de Saintes and in the south of Martinique to the end of March-April; the shoals can be often most frequent and of a large size in the south of the Lesser Antilles (Sacchi et al., 1981). Little tunny are fished for by seine at Montserrat, from April to July and in August-September at Dominica (Morice and Cadenat, 1952). This species is frequently captured at Trinidad and Tobago; being very continental, the little tunny should also be particularly abundant on the South American continental shelf in the regions near estuaries. The catches of little tunny and the frigate mackerel approach 2400 tons per year in Venezuela. No figure is available for the region of the Lesser Antilles; the potential resources are not known but the stocks are considered to be very little exploited." (translation of Marcille, 1985).

d. DOMINICAN REPUBLIC AND HAITI (HISPANIOLA)

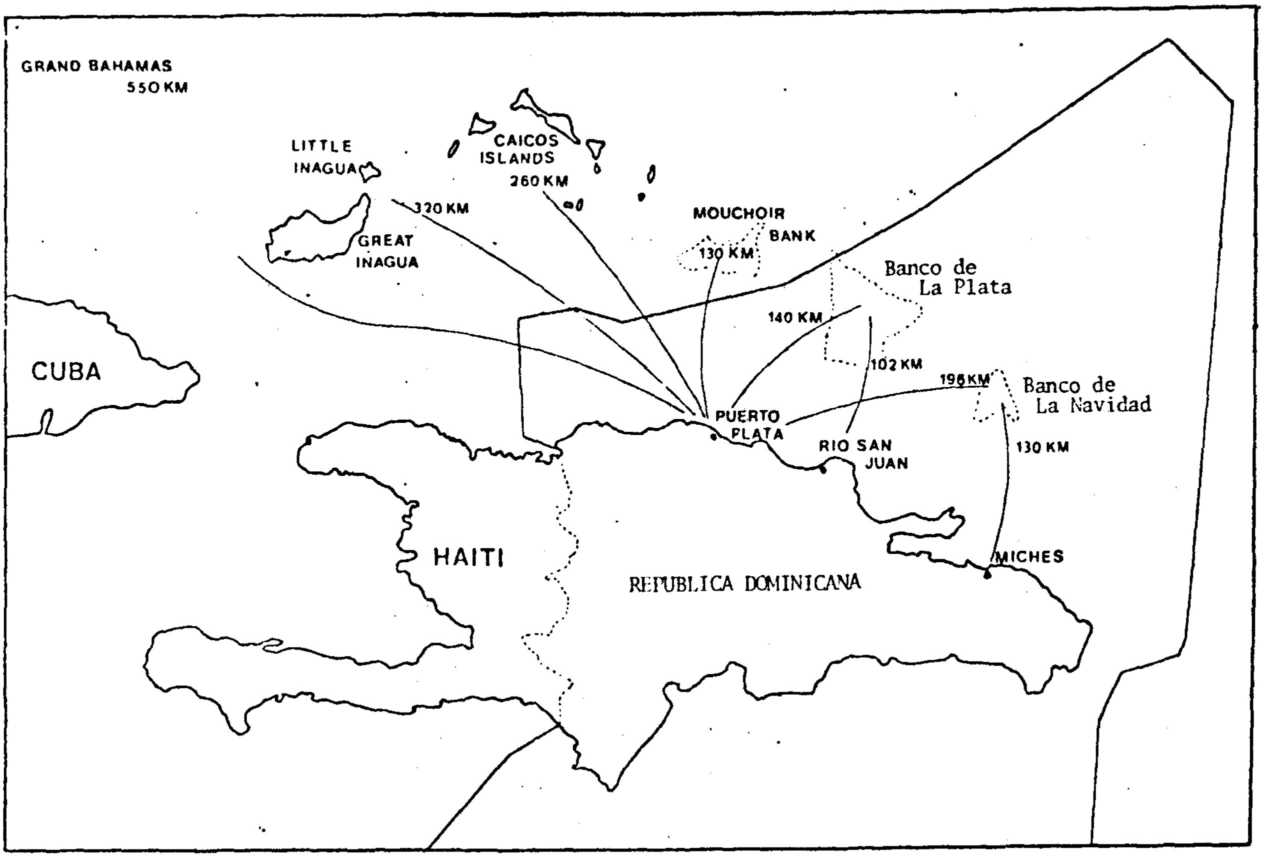
1) Dominican Republic

The Dominican Republic is located in the eastern half of Hispaniola in the northern Caribbean Sea (Fig. 45). The commercial fishery is only artisanal. There are many small fishing centers around the coast of the Dominican Republic, but all can be grouped to the following fishing zones (Fig. 46):

North coast:	Monte Cristi
	Puerto Plata
	Samaná
East Coast:	La Mona
South coast:	Saona
	Santo Domingo
	Ocoa
	Beata

According to Giudicelli (1979) the hand line (cordel) is the main fishing gear in the Dominican Republic. Little tunnies (bonitos) are caught using surface hand line and trolling line (curricán). The hand line is made of nylon monofilament of 60- to 150-pound strength or a cotton twisted line of 1 or 2 mm diameter. These lines carry 1 to 4 hooks at the end. The fishermen use live bait to catch little tunny close to the surface. The trolling line is used when they are sailing from one fishing ground to another. It is specially employed on the south coast of the Dominican Republic. Usually the fishermen use one line of 100- to 200-pound strength of nylon monofilament or twisted cotton of 2 to 3 mm diameter. Each carries one hook and artifical lure or live bait.

Figure 45. Dominican Republic and Haiti (Hispaniola) and adjacent waters (from Fisheries Development, Ltd., 1980).



Some fishermen use two trolling lines from each boat, and if they find a school of fish then they stop sailing and fish using hand line at the surface (Fisheries Development, Ltd., 1980).

Dominican Republic fishermen detect fish using the same practical methods we have described for other artisanal fisheries elsewhere in the western Atlantic. Nevertheless, according to Fisheries Development, Ltd. (1980), the fishermen of the south coast use trolling lines to detect little tunny schools, as we have mentioned above.

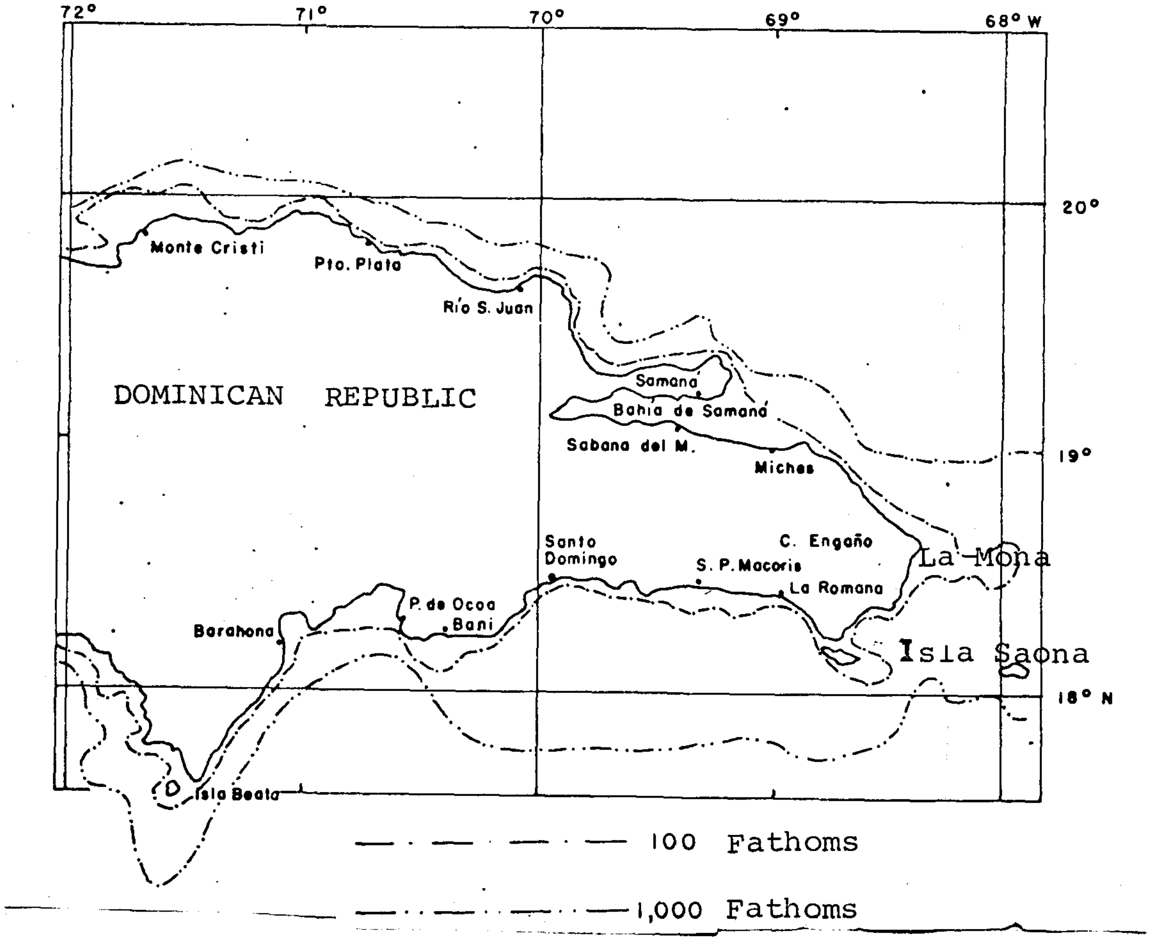


Figure 46. Fishing zones of the Dominican Republic (from Fisheries Development, Ltd., 1980).

The following table shows in MT Dominican Republic catches of <u>bonito</u> according to data from National Statistics Office (Oficina Nacional de Estadisticas):

Year	MT
1973	253.6
1972	112.5
1971	147.7
1970	153.2
1969	135.4
1968	122.8
1967	115.9
1966	150.6

The artisanal fleet of the Dominican Republic comprises boats (cayucos and yolas) which belong to each fishermen (Giudicelli, 1979). These boats are between 2.1 m and 6.1 m long. There is a certain type of craft they call botes (boats), of wood and fiberglass, which is between 4.6 m and 7.6 m long and has an outboard motor of about 15 hp. All other boats more than 7.6 m long, with inboard motor and sail, are called barcos (craft). In a survey carried out by Fisheries Development, Ltd. (1980) they found that yolas and cayucos represent 91% of the total, while botes and barcos are only 9%. The distribution of the artisanal fleet in the Dominican Republic is given in the Appendix I a.

There is very little information on fishery statistics for certain species in the Dominican Republic. Little tunny is reported as *Euthynnus alletteratus*, according to Bonnelly de Calventi (1975) but is referred to as *Auxis thazard* according to Fisheries Development, Ltd. (1980). However, we believe that under this common name (bonito) both species are caught around the Dominican Republic waters. Undoubtedly other small tunas occur around the Dominican Republic. The wide continental shelf on the south coast probably harbors large concentrations of little tunny, while the north coast is steep-sided and close to deep water, and schools of blackfin tuna and skipjack tuna undoubtedly occur there commonly. From 1973 to 1983, the Dominican Republic reported substantial catches of blackfin tuna (Table 14).

b) **HAITI**

Haiti, which occupies the western third of the island of Hispaniola, lying between Cuba and Puerto Rico, is bounded on the north by the Atlantic Ocean and on the south by the Caribbean (Fig. 45). To the west is the Windward Passage and to the east, its neighbor, the Dominican Republic. The Haitian coastline extends from the Bay of Manzanillo to Cape San Nicolas Môle on the north and from Pedernales to Cape Tiburon on the south. Practically the entire west coast is included in the Gonaive or Léogâne Gulf and Gonaive Channel. The total coastline measures about 1,100 miles. Off the coast are three large islands, Tortuga Island on the north coast, Gonaive Island on the west coast, and Vache Island on the south coast. There are also some smaller islands such as the Grande Cayemite and La Grosse Caye (Fig. 46).

According to United Nations (1949) only about 500 fishermen of a total of more or less 7,000 spend all their time at fishing. The rest are really part-time fishermen. In the fishery a great variety of gears is being or has been used. Fishing apparatus is of the simplest type. Handlines are used extensively, both for bottom fishing and for trolling. The materials are imported usually, but native ingenuity has devised substitutes in some cases for lines, floats, and leads. Some of the more progressive fishermen set up to 20 lines from the gunwale of their boats and others set flag lines carrying as many as 900 hooks (Fiedler et al., 1947). Furthermore, other types of gear are used such as fish pots, gill nets, and haul seines. However, much of this equipment is badly constructed and maintained. Equipment designed for one kind of fishing is made and used for a different, often unsuitable purpose. Some types of gear, for instance the trammel net, which could be put to extended and profitable use, are employed only in very confined localities. Preservation of the nets, when attempted at all, is performed in a very crude manner.

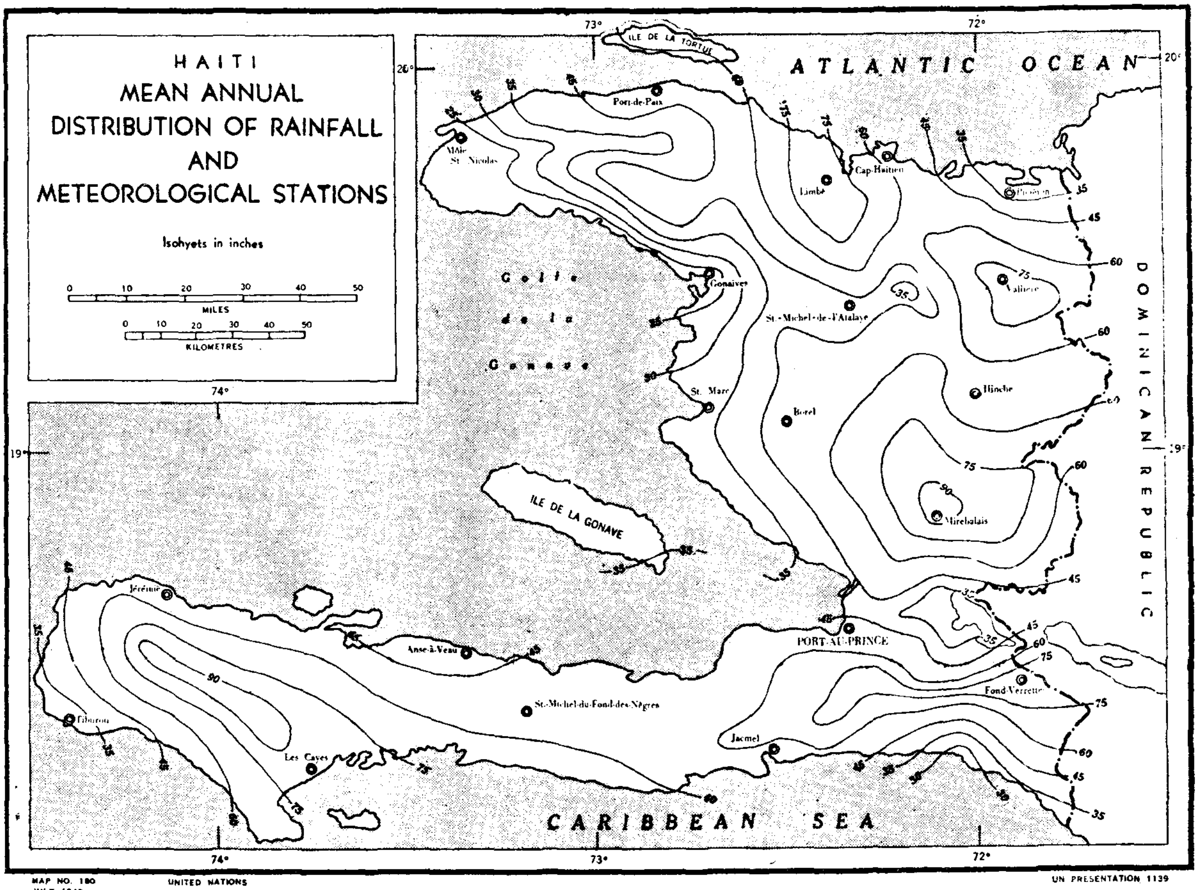


Figure 46. Map of Haiti (United Nations 1949)

All craft used in the Haitian fisheries are small and locally built of imported or domestic materials. The largest are sailboats up to 9 or 11 m (Fig. 47). These vessels are rather clumsy and cannot be regarded as very seaworthy of well built. They are not designed for the use to which they are put and, consequently, cannot operate very efficiently even though they are well handled by the fishermen. None is equipped with live wells or ice-boxes. These boats may at times be used for other purposes such as freighting agricultural products. When fishing, they may carry a crew of four to six men who operate pots, gill nets, hook and line, and small haul seines.

According to Fiedler et al., (1947), there are other types of fishing boats such as smaller sailboats and boats which are also crudely built and not very seaworthy. All those boats and sailboats we have mentioned have a fishing radius of between 2 to 20 miles. The smallest fishing boats are dugout canoes which are usually paddled; occasionally a small sail may be used on the larger ones. There are also a few rafts or floats which are built of native logs and the typical pri pri which is a simple wooden raft, sometimes made of bamboo lashed together, sometimes of more substantial logs, sometimes paddled, sometimes sailed with the aid of an old flour sack. It is almost certainly a direct descendant of the original Indians' rafts which were called pipirites, the word having now become corrupted into pri pri in the north and piri piri in the south (Routh, 1959).

The United Nations (1949) made a rough estimate of the catch in Haiti. They stated that the most probable catch figures at that time were between 1588 MT and 1814 MT. There were previous estimates of the catch with which these figures may be compared. M. Audant (Audant and Hulsizer, 1943) put the total catch at 914 MT, and Fiedler et al (1947) gave a figure of 937 MT, which they

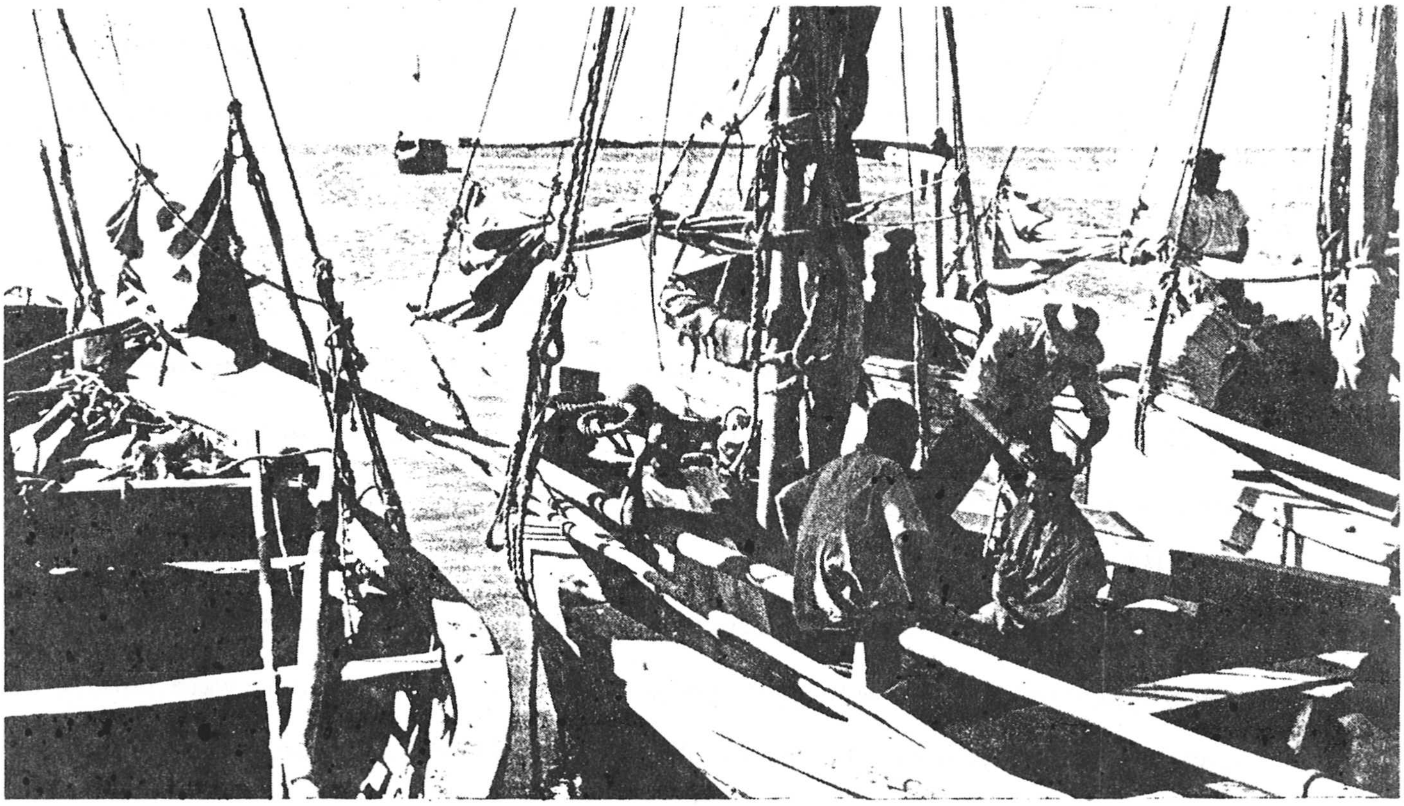


Fig. 47. Locally built boats used in fishing and transport are made of heavy rough-hewn timbers (United Nations, 1949).

stated was derived from M. Audant. In Audant's tabulation, which shows the estimated catch by ports, almost half the fishermen and equipment, however, are credited with no catch at all. As far as can be judged from this tabulation, it means that the total of approximately 907 MT represents that for only half the fishing effort. The total catch would then be of the order of 1814 MT.

The fish fauna and its distribution in Haitian waters is typically West Indian (Fiedler et al., 1947). Beebe and Tee-Van (1928) reported that a small colony of Greek fishermen was located at Port-au-Prince. This group was engaged in net and hook and line fishing. Their particular specialty was the capture of little tunny and frigate mackerel (Auxis sp.) in the outer parts of Port-au-Prince Bay (Fiedler et al., 1947).

Routh (1959) stated that during his initial survey in Haiti, on many occasions shoals of bonito or skipjack (Katsuwonus pelamis) and blackfin tuna were noticed feeding at the surface. This author also mentioned that during exploratory fishing for tunas, carried out by a chartered Cuban tuna boat and its crew in waters around Môle St. Nicolas at the northwest tip of Haiti, during the trials the blackfin tuna was by far the commonest species taken, with skipjack second, and yellowfin tuna, little tunny, and frigate mackerel also taken. Because of the statements mentioned above, we conclude that little tunnies occur in Haitian waters and that these fish could be caught using trolling lines and pole and lines as in others areas of the Caribbean Sea.

We were unable to obtain copies of two major reports on Haiti (Audant and Hulsizer, 1943, and Routh, 1958). Presumably these documents contain much more detailed data on fisheries of Haiti.

e. **Venezuela**

Venezuela's coast is about 2,800 km long. The continental shelf is about 200 m deep at its outer edge and falls rather rapidly to 2,000 m. It is about 100 km wide off the state of Sucre and about 10 km wide off La Guaira. There are approximately 90,000 km of shelf within the 200-m contour. The shelf is of uniform depth except for the Cariaco Trench which lies between Cumaná and Higuerote, about 60 km offshore. There are three important relatively shallow gulfs: Venezuela, Cariaco and, París (Figure 48).

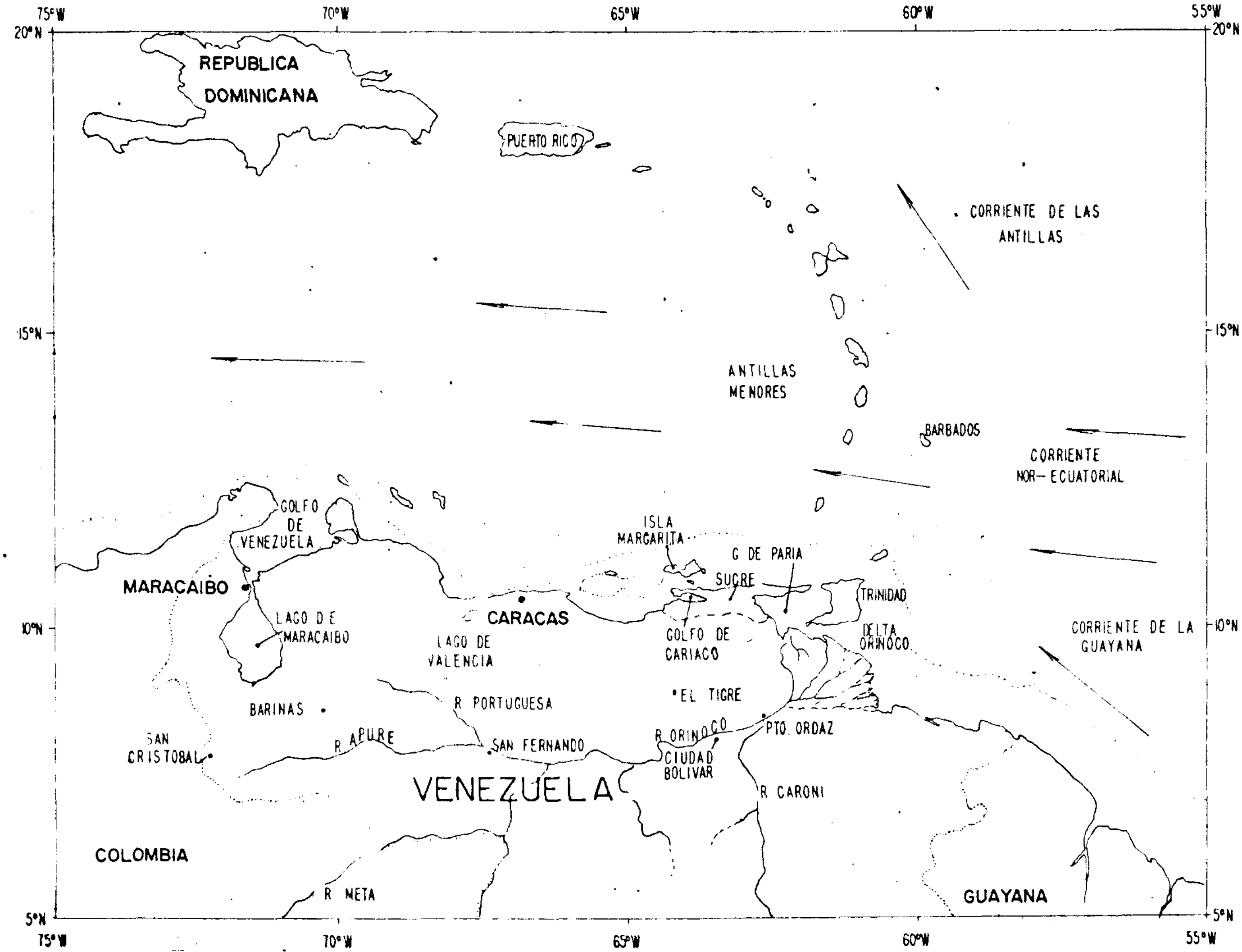


Figure 48. Northern Venezuela and parts of the Caribbean Sea and the western Central Atlantic (Simpson and Griffiths, 1967).

The principal ports used by fishing vessels are Cumaná, Porlamar, Pampatar, La Guaira, Morro Puerto Santo, Carirubana, Guarano, and Maracaibo (Fig. 49). As fishing ports, all are deficient. Morro Puerto Santo and Guaranao are used nearly exclusively by fishing vessels; the others are primarily for coastal shipping.

Most tunas caught by the Venezuelan commercial fleet are canned in fish-processing plants in or near Cumaná in eastern Venezuela. Three species of tuna are taken from the Caribbean Sea and the western North Atlantic Ocean by longliners operating out of Venezuelan ports. There are known locally as aleta amarilla (Thunnus albacares), albacora (T. alalunga), and ojo grande (T. obesus), of which relatively few are caught. According to Simpson and Griffiths (1967) a longline fleet supported a tuna fishery since 1959 in Venezuela. At the same time there is a small-boat fishery which catches little tunny (carachana pintada), frigate mackerel (cabaña negra), and Atlantic bonito, cabaña cariba or bonito, among others. Most of these fisheries are located in the northeastern Venezuelan waters. These species are sold fresh in the market or are used for subsistance.

It is not rare to catch little tunny by purse seine (probably cerco de playa, Fig. 50), but it is more common to catch this species by longline (palangre flotante, Fig. 51) (Cervigón, 1966). Furthermore, little tunny are also caught using trolling lines (curricanes) and sardines as bait (Fig. 52). The same species is found almost every year between Margarita Island and the continent (Fig. 49).

Figure 49. Northeastern Venezuela and adjacent waters (Simpson and Griffiths, 1967).

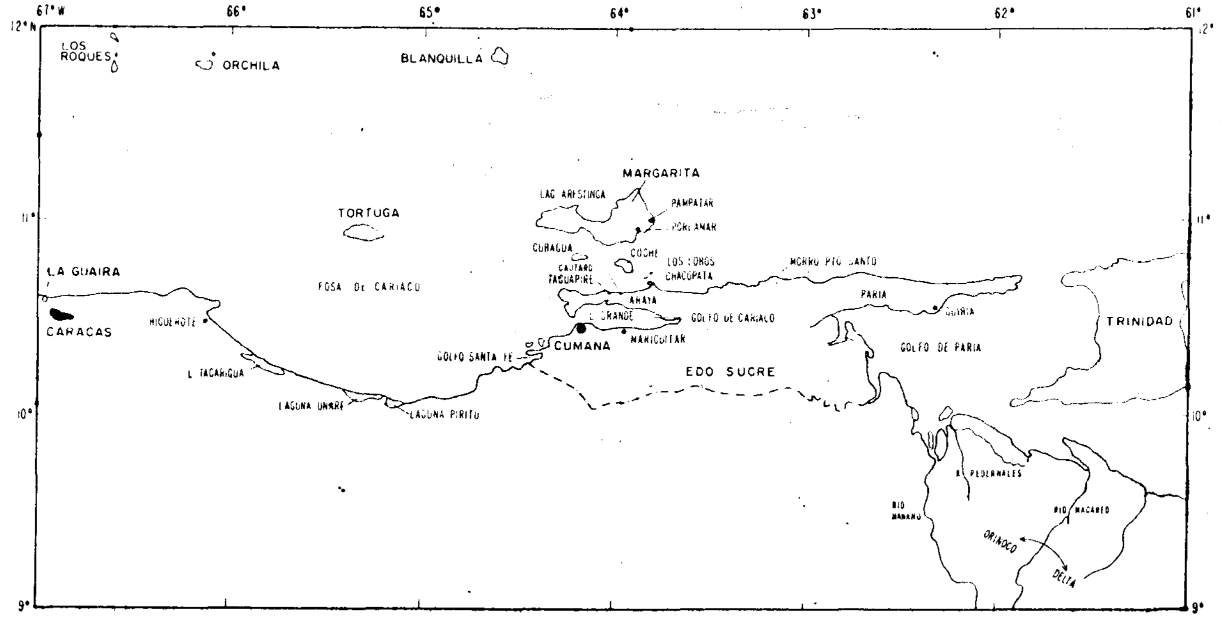


Figure 50. Purse seine--red barredera o cerco de playa (from Ginés, 1972).

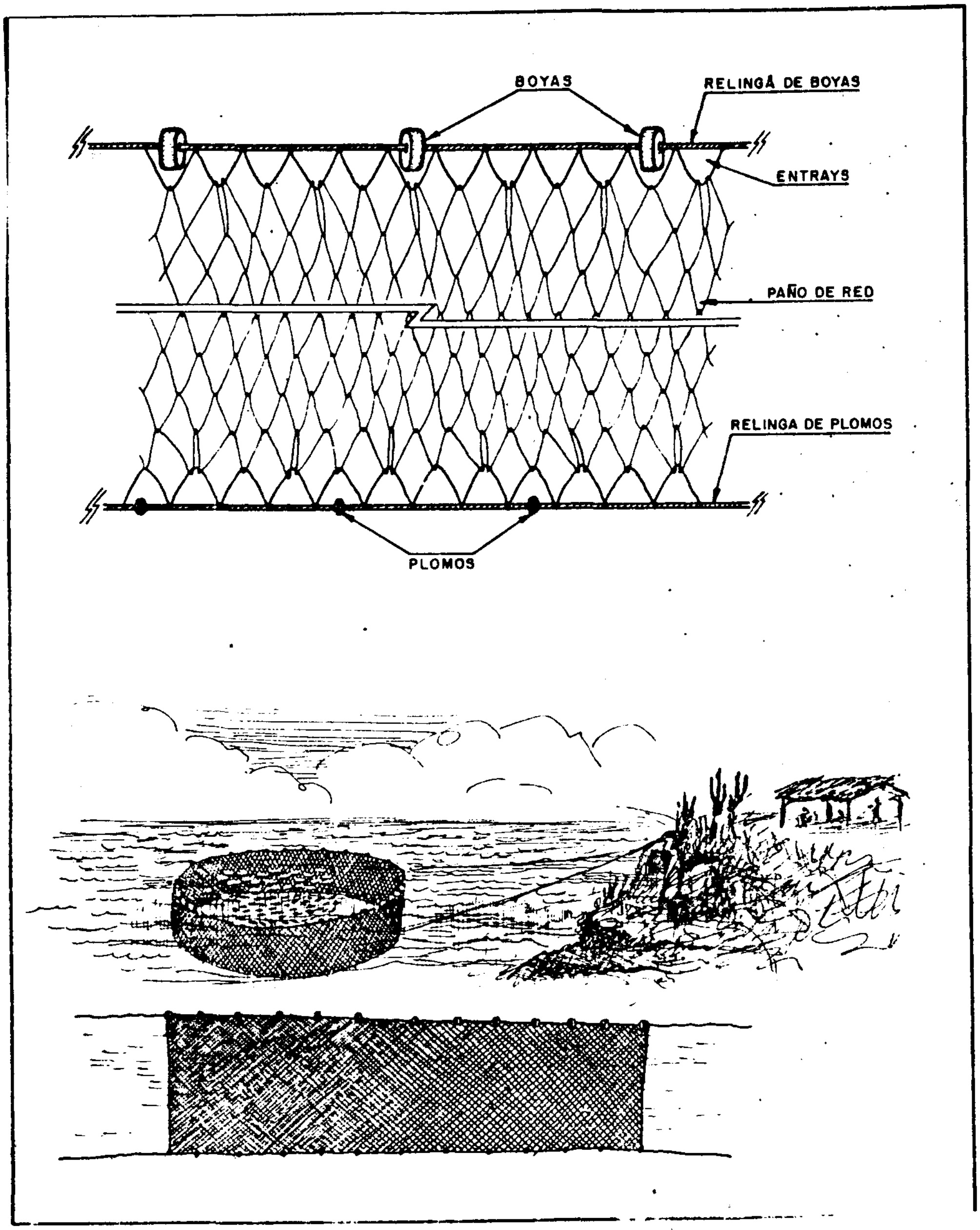


Figure 51. Tuna longline-palangre atunero derivante o japonés (from Ginés, 1972).

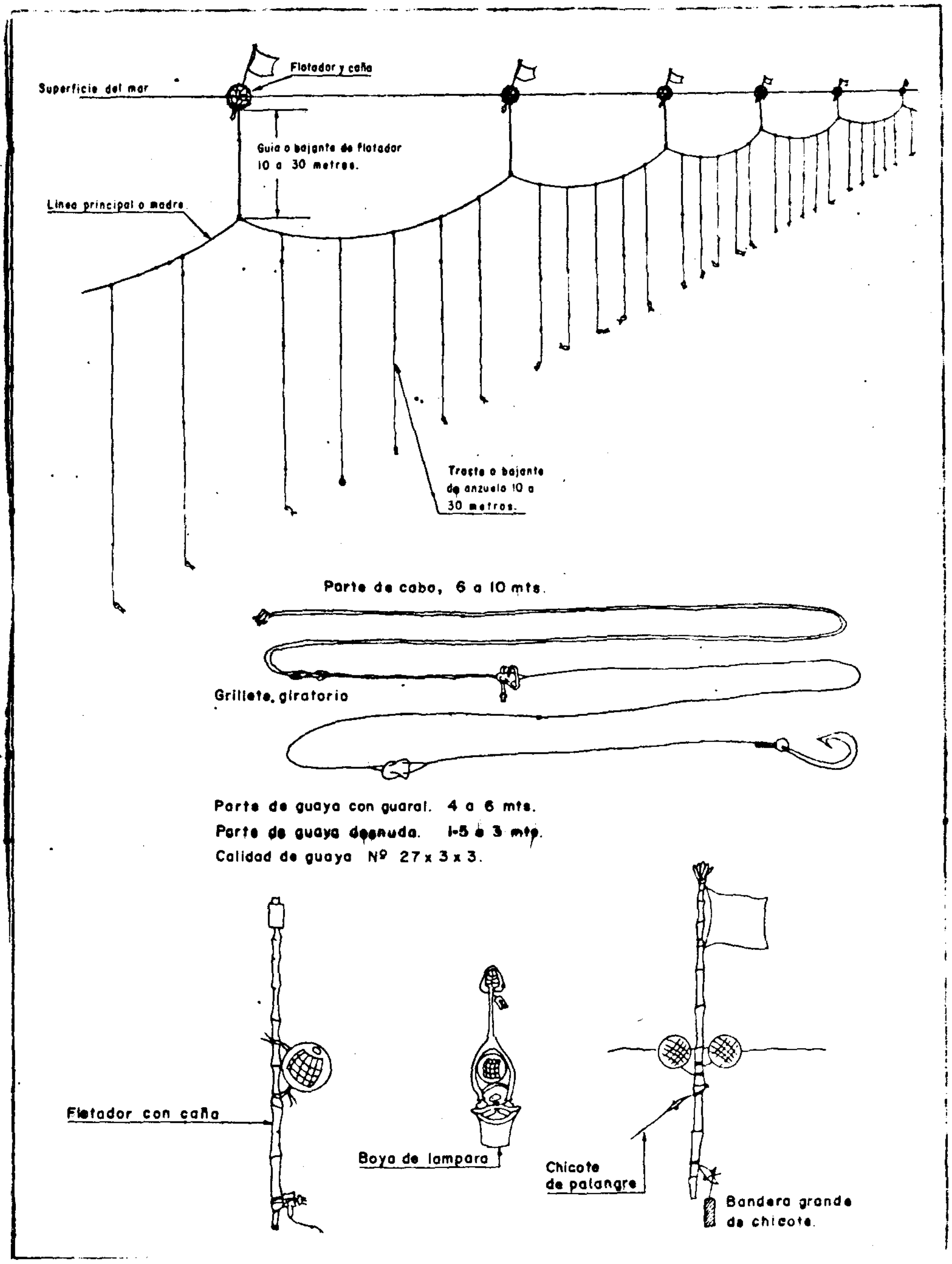


Figure 52. Trolling line-de señuelos naturales: a la vela, corrido o de línea (from Ginés, 1972).

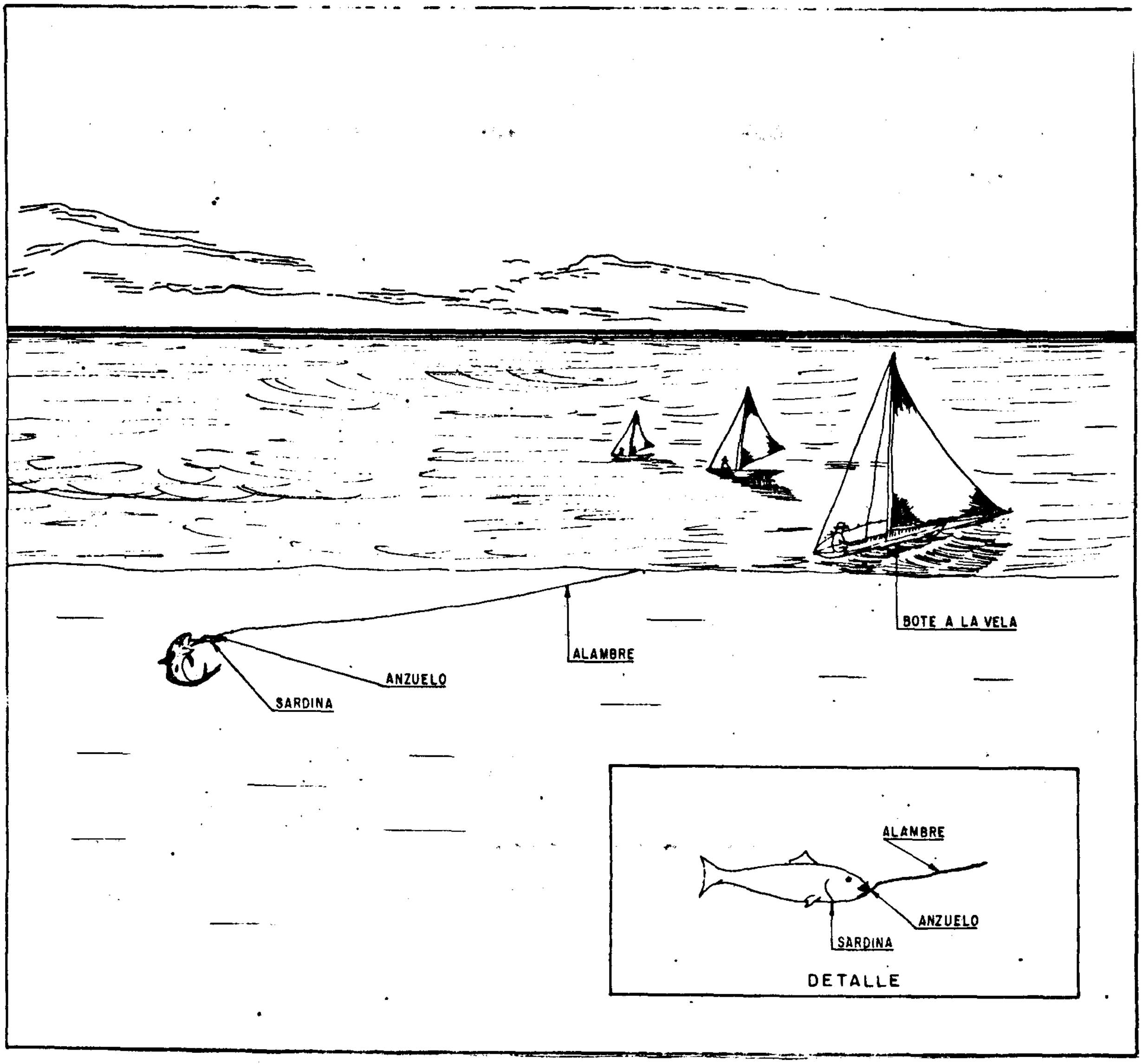
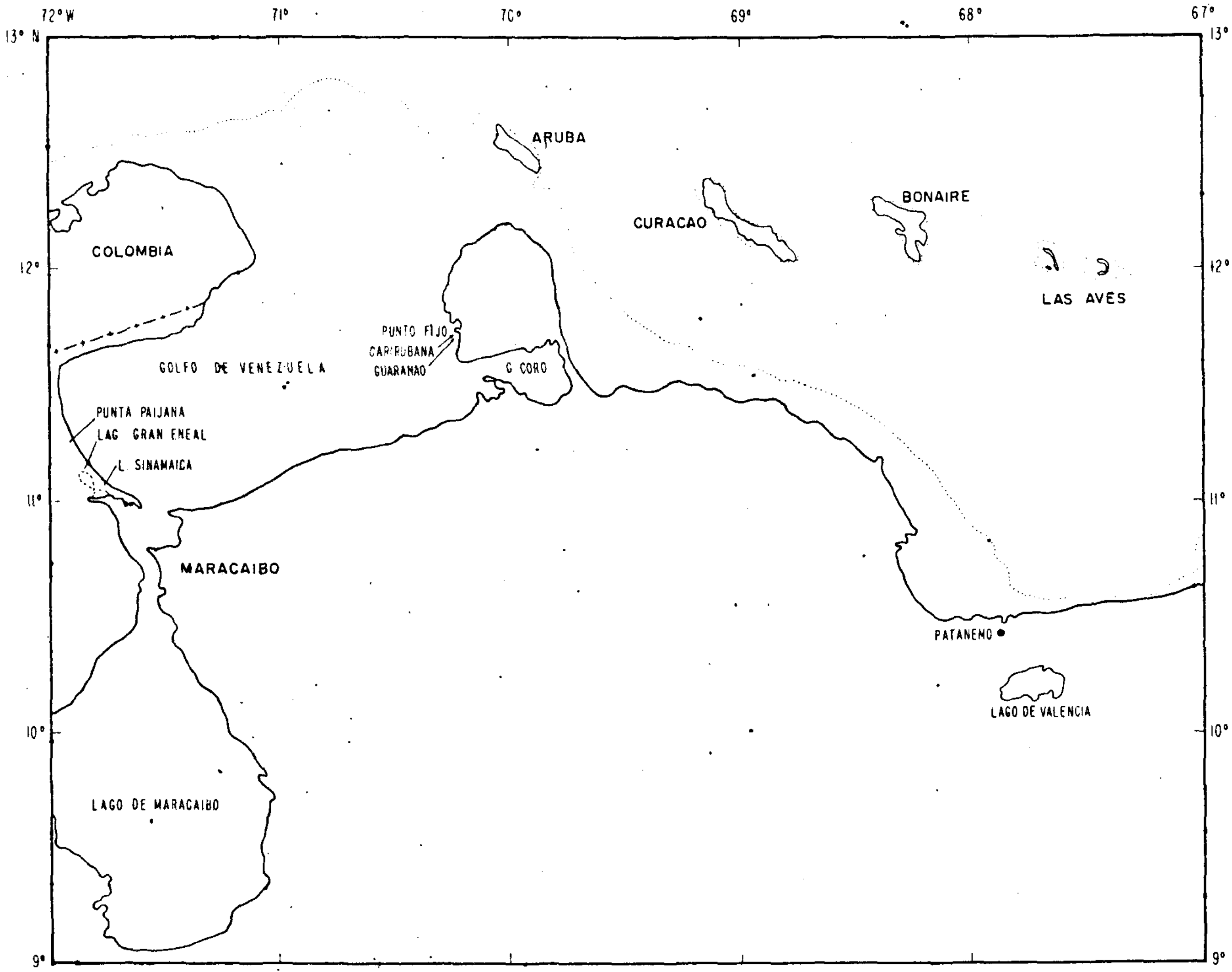
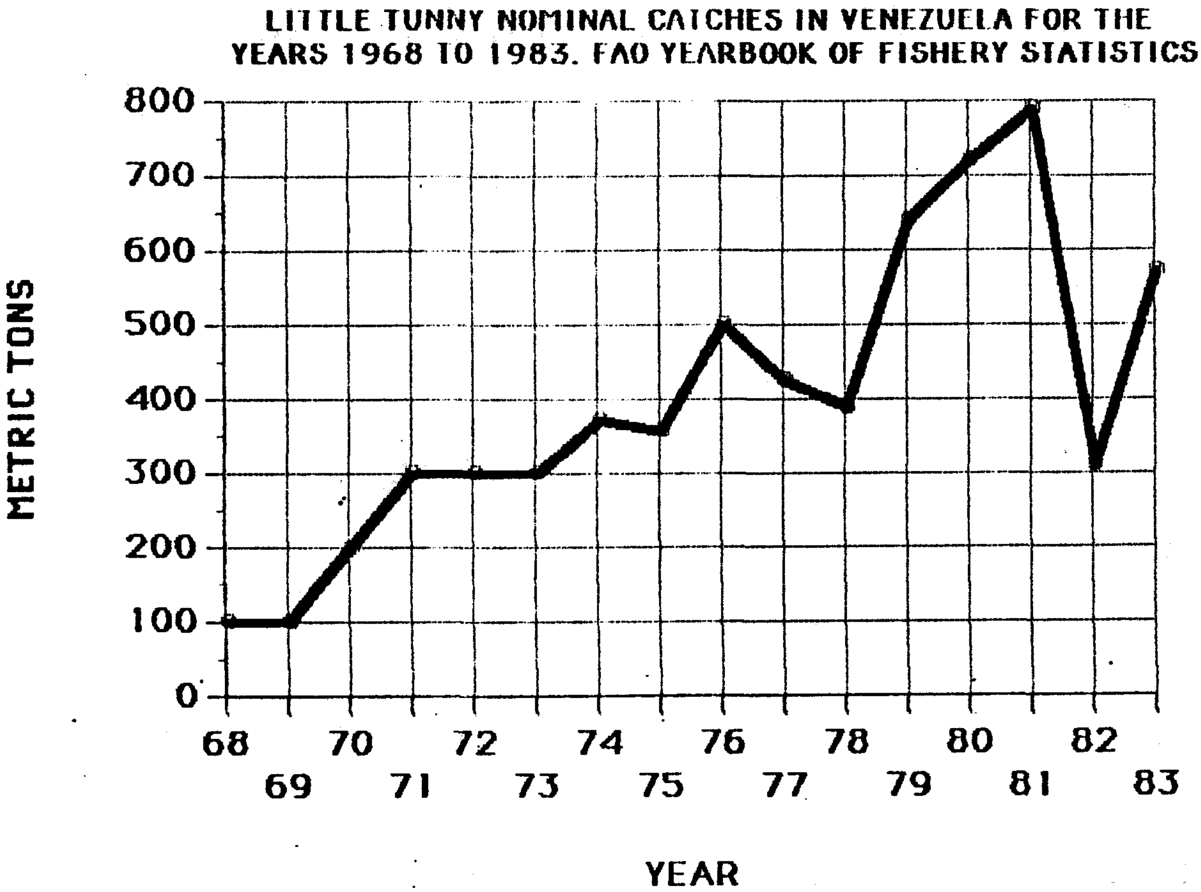


Figure 53. Northernwestern Venezuela (Simpson and Griffiths, 1967)



According to Ginés (1972) the little tunny is not abundant around Margarita Island, in eastern Venezuela. The same author state that this species and others of the "small" tuna group are an incidental catch in those waters, and that there were no fishery statistics at that time. Nevertheless, at the end of the 1960s and the beginning of 1970s the Yearbook of FAO (1983) (Figure 54), shows little tunny statistics for Venezuela.

Figure 54.


LITTLE TUNNY NOMINAL CATCHES IN VENEZUELA FOR THE
YEARS 1968 TO 1983. FAO YEARBOOK OF FISHERY STATISTICS
METRIC TONS
800
700
600
500
400
300
200
100
0
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
YEAR

Among the Venezuelan artisanal fishermen, who fish using nets in the coastal waters, there is a distinctive way to detect the schools of fish close to shore. In every group of fishermen who fish one or more gears (they give the name tren to each group) there are always one to five lookouts (vigías) who are in charge of detecting the schools when they approach the shore. Usually the lookouts are located on high promontories along the coast. When they find a school they notify the other fishermen, who will set and haul the net, by means of crying out or signaling, or they may send smoke signals to gain rapid attention. The lookout detects little tunny schools by their dark red color on the water (Méndez-Arocha, 1963).

f. **BRAZIL**

1) Fishing Areas

Albacore (albacora branca), yellowfin tuna (albacora amarela), blackfin tuna (albacora preta), bigeye tuna (atún patudo), and bluefin tuna (albacora azul) occur in offshore waters of the Brazilian coast, from Cape Orange, in the Territory of Amapá (approximately 4°N), to Chui south of the state of Rio Grande do Sul (approximately 34°S) (Paiva, 1962; see our Figs. 55-56).

Paiva and Cervigón (1971) consider that northeastern Brazil is from Cape São Roque to the mouth of Paranaíba River and northern Brazil from Paranaíba River to Cape Orange at the northern boundary of the Amapá Territory. The continental shelf is extremely narrow in the northeastern area but very wide in the north because of Amazon and Paranaíba river deltas. We add three more regions: east from Cape São Roque to 19° 59'S; southeast from 20°S to 26°59'S; and south from 27°S to 34°S.

Mather and Day (1954) stated that the distribution of the blackfin tuna in shoal waters and among the outlying islands of the Brazilian coast ranges from north to south from the Territory of Amapá to State of Rio de Janeiro. These authors reported catches of blackfin tuna and little tunny (bonito) also in 1°35'S and 38°10'W and blackfin tuna only in 22°21'S and 37°W.

Young specimens of blackfin tuna and little tunnies were collected from the stomachs of tuna and tuna-like fishes caught by longline gear in southeastern and southern Brazil, between 16°S and 33°S, approximately over the slope of the continental shelf, during 1972 to 1978 (Zavala-Camín and von Seckendorff, 1980), along the seashore of the State of Ceara. Aracati is an important and traditional artisanal fishing center of northeastern Brazil.

Figure 55. Main fishing areas of Brazil.

Figure 56. Main Brazilian cities along the Atlantic Ocean.

The most important center of blackfin tuna fishery is Formosa Bay (Baia Formosa) located near the border between the states of Rio Grande do Norte and Paranaíba, at 6°22'S and 35°00'W, at northeastern Brazil (Cruz, 1965). According to Maghan and Rivas (1971), the fisheries in this area are carried out between Ponta do Moleque and Ponta do Cotia, some 12 to 16 miles from shore over the area known as the "Paredes."

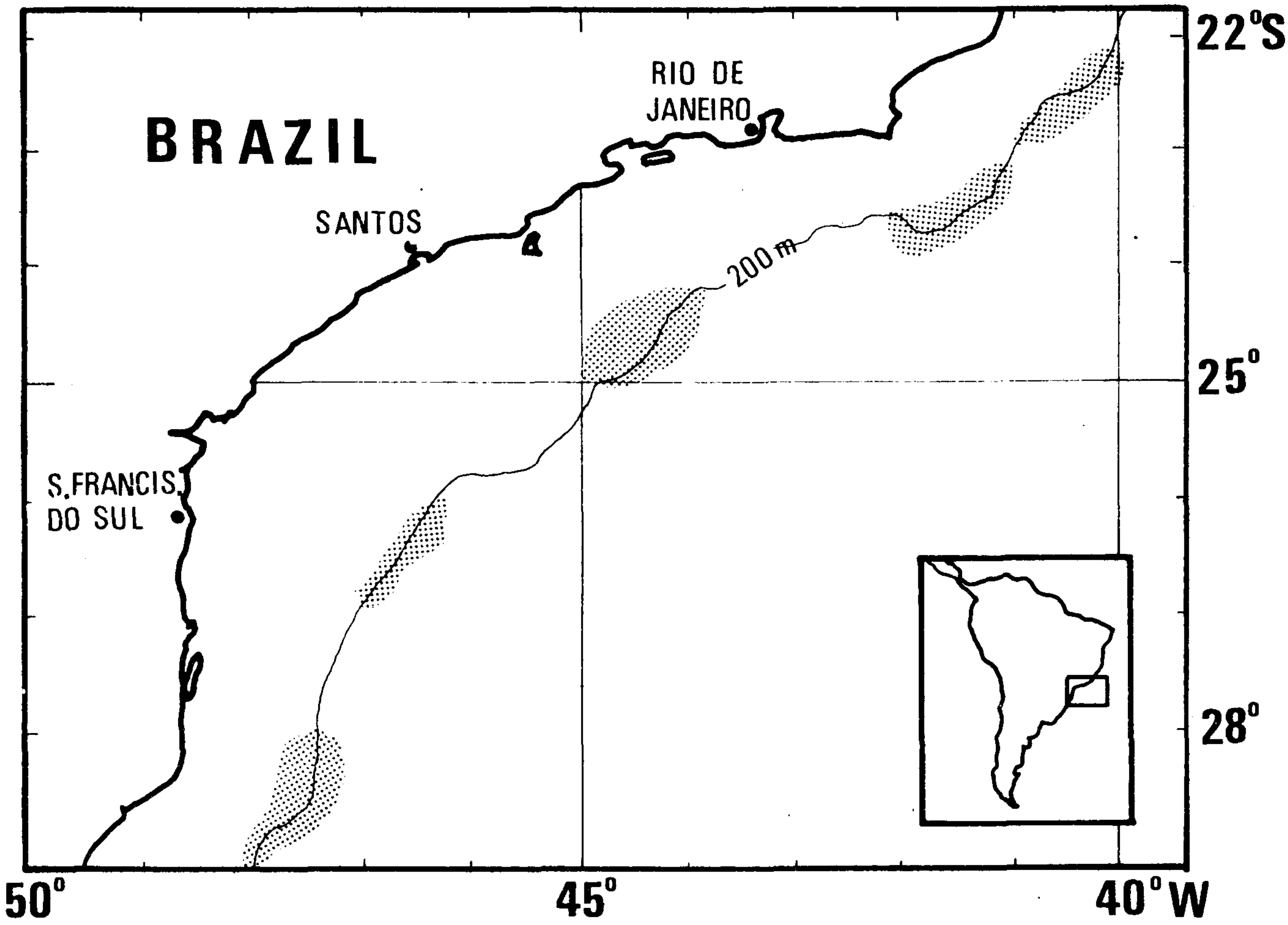
According to Meneses de Lima (1985, 1986) Brazilian longliners based in Santos (São Paulo) operate from Cabo Frio (23°S) to Tramandaí (31°S), except for one small longliner that started operating at the end of 1983 in the northeastern coast in near-shore fishing areas, between 0°S and 10°S latitudes. Other national longliners, based in Rio Grande (Rio Grande do Sul), concentrated their operations in the south, between Cabo de Santa Marta Grande (28°S) and Chui (34°S).

The leased longline fleet operated in tropical waters near Ascension Island in the first quarter of the year. Later on, fishing operations concentrated in the south (28° to 34°S).

The fishing area exploited by the baitboat fleet (Fig. 57) extends from south of the Abrolhos Bank (20°S) to the southern limits of Brazilian waters (34°44'S). In this area the continental shelf is from 20 to 100 miles long and the dropoff starts at between 60 to 160 m depth (Zavala-Camín, 1981).

Most fishing operations were concentrated between Cabo de São Tomé (22°S) and Tramandaí (31°S). Within these limits, there are five major fishing areas: southeast of Cabo São Tomé, southeast of Cabo Frio, south of Ilha Grande, east of São Francisco do Sul, and east of Cabo de Santa Marta Grande (Meneses de Lima, 1986-Fig. 1, p. 237). Fishing operations north of Cabo São Tomé and south of Tramandaí were carried out sporadically in the spring and summer by the leased baitboat fleet.

Figure 57. Major fishing areas of the baitboat fleets operating off the southeastern Brazilian coast (from Meneses de Lima, 1986).



bigeye tuna, yellowfin tuna, and swordfish (Lima and Jablonski, 1984). Probably some blackfin tuna are caught as incidental catches. Incidental catches of little tunny are taken also taken commonly by the sardine fishery with purse seine in the states in southern and southeastern regions of Brazil. Because these species are not target species in the fishery, they are sometimes not reported by the fishermen.

The Brazilian artisanal fleet has had no important changes in its composition and in its fishing technology during the last few years. Furthermore, according to Meneses de Lima (1986), there is no reliable information available on the number of boats in operation.

Off the coast of the state of Rio Grande do Norte the season for blackfin tuna is during the last quarter of the year and the fishing is intensified at that time between Macau and Baia Formosa. Both areas are two traditional fishing centers in northeastern Brazil.

Sailing balsa rafts (jangadas), which have a circular hull (Figs. 58-59) held together with reeds, are used typically in northeastern Brazil, and are used for pole and line fishing, but are no longer used at Baia Formosa. The blackfin tuna fishery is now prosecuted only by sailing vessels of the traditional northeastern Brazilian type (Cruz, 1965).

The number of sailboats in Baia Formosa increases greatly during the blackfin tuna season, since a large number of boats come from other areas to fish. These boats have a wooden hull, a shelter, and a fish box, as well as a lateen sail and a staysail. They are between 7.5 and 9 m long, with a 2.5- to 3-m beam and draw 1 m. The crew of each boat is made up of three men--the captain, the lookout, and a "bico-de-proa." The boats usually go out about 2 a.m., earlier if there is an east wind. They head for the fishing grounds, navigating by bearings on the coast. They begin to fish at 6 a.m., shortly after sunrise.

Table 15.Number of boats by gross tonnage (GRT) class (baitboats and longliners) and carrying capacity class (purse seiners) (from Meneses de Lima, 1986).

BAITBOATS			*LONGLINERS*			*PURSE SEI.*
GRT	*Brazilian flag*	*Japanese flag*	*GRT*	*Brazilian flag*	*Japanese flag*	*Carrying capacity (MT)*
50	04	--				
51-150	37	--	51-200	11	--	501-600
151-200	06	--	201-500	--	03	More than 1000
201-300	--	06				

Source: PDP/SUDEPE.

bigeye tuna, yellowfin tuna, and swordfish (Lima and Jablonski, 1984). Probably some blackfin tuna are caught as incidental catches. Incidental catches of little tunny are taken also taken commonly by the sardine fishery with purse seine in the states in southern and southeastern regions of Brazil. Because these species are not target species in the fishery, they are sometimes not reported by the fishermen.

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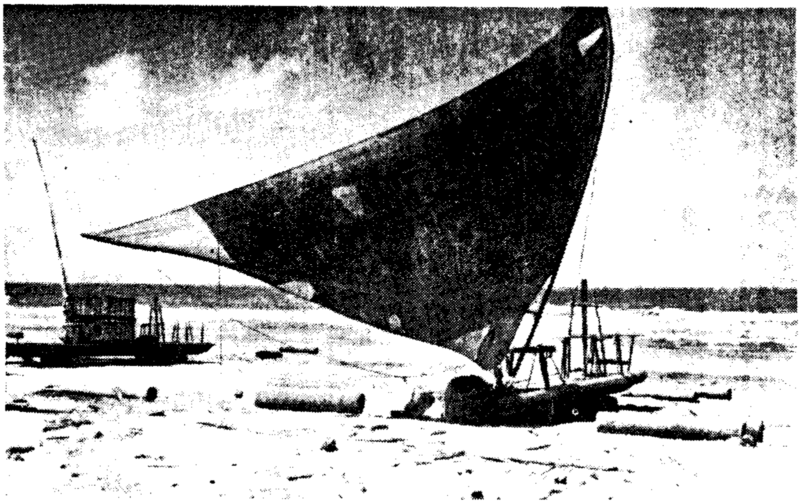

Figure 58. A typical jangada with sail.

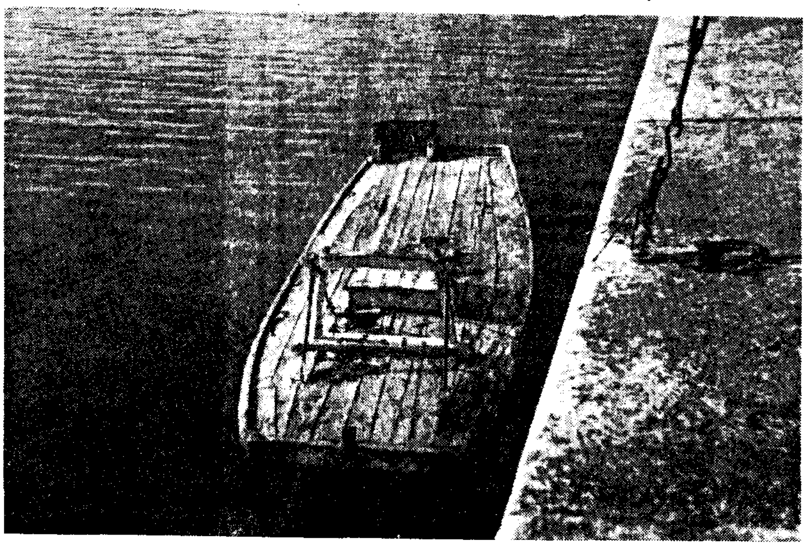

Figure 59. A jangada-bote with outboard engine mount (from Cruz, 1965).

In the 1964-1965 season the number of sailboats fishing varied considerably, with a short period of equilibrium between the second half of October and the first half of November. The number began to decline somewhat in the second half of November and the first half of December, having fallen markedly from then until the first half of January, when the season ended. The number of trips and the mean number of trips per boat showed a concentration from the second half of October until the first half of December (Cruz, 1965).

In 1961 in Macau, another important fishing center for the blackfin tuna fishery, the fishing vessels were classified as boats, keel-less boats, and canoes. According to Paiva (1961), there were no motor boats at that time, but there were sailboats, having one mast and of 2 to 5 gross tons, which were engaged in different type of fisheries including for blackfin tuna.

The state of Ceará (Estado do Ceará), in northeastern Brazil, is extremely important for artisanal fishery development and it is also important in blackfin tuna and little tunny fisheries (Fig. 60). Fontela-Filho and Mota de Castro (1982) outlined a project for artisanal marine fisheries development in that state. They presented a map showing different coastal regions of the state and main fishing centers (Fig. 1, Fontela-Filho and Mota de Castro, 1982). In 1975 a total of 2545 commercial fishing boats were fishing in the coastal waters of that state. There were 198 balsa rafts (jangada de piúba)[1], 742 board bálsa rafts (jangada de tabua), 402 rowboats (bote a remo), 416 sailboats (bote a vela), and 787 canoes (canoa).

The largest number of sailboats is based in Aracati and yet it represents only 5% of the total numbers of all boats in the state of Ceará (Estado dô Ceará). The highest production per year belongs to this type of boat and the lowest to the rowboat. The largest artisanal fishing fleets are based at Acarau and Caponga.

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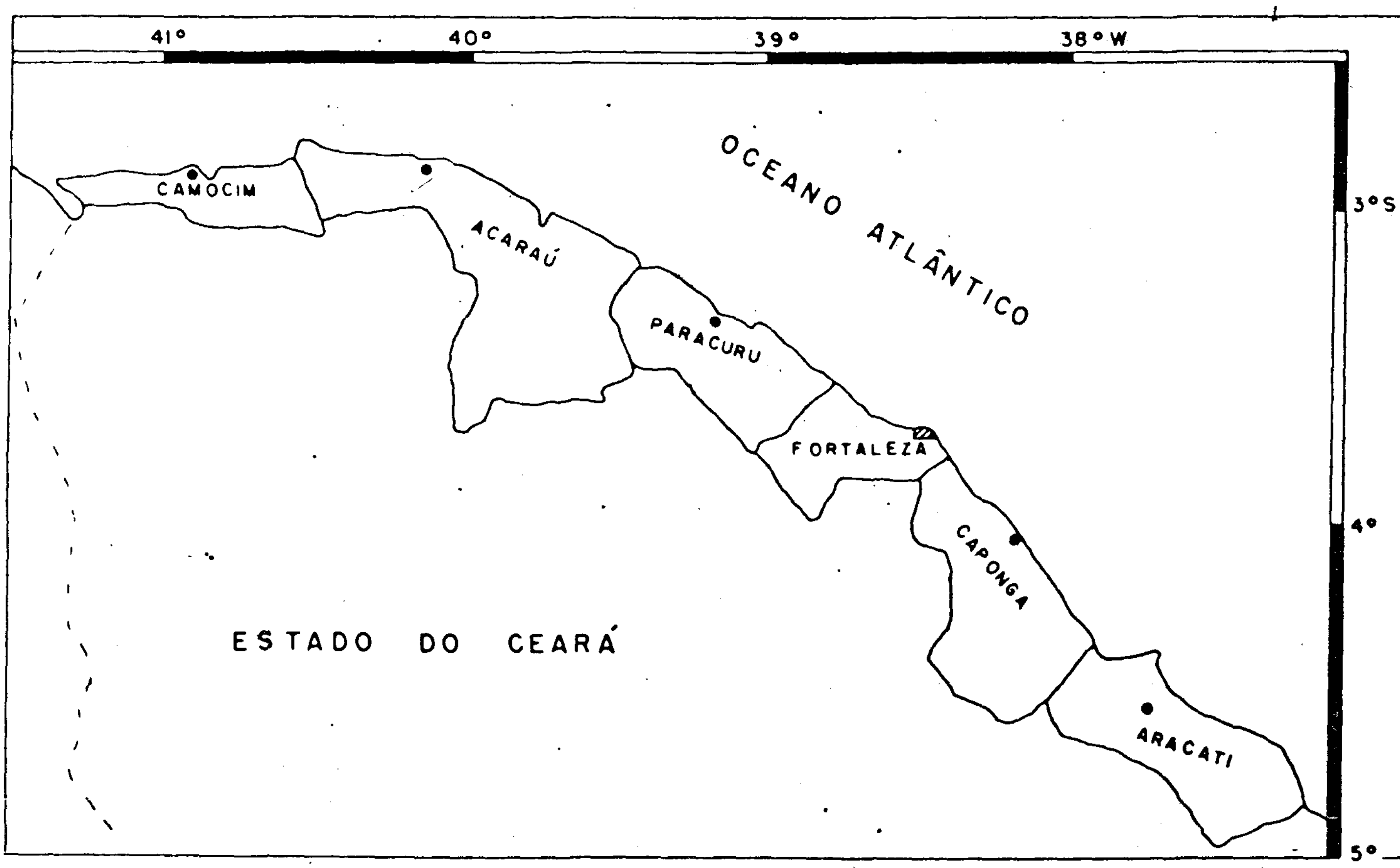
[1]piúba = Apeiba tibourbou, Tiliaceae

Figure 60. Coastal regions and main fishing center of the state of Ceará (Estado do Ceará) (from Fontela-Filho and Castro, 1982).



According to Paiva (1965) the artisanal fishing boats mentioned above are typical of all northeastern Brazil. Furthermore, there are motorboats but the author stated that this type of boat is confined only to urban centers and is used for lobster fishing.

2) Detection

Probably the detection of fish by means of electronic equipment such as Loran, Sonar, Asdic, and so forth is carried out in Brazilian waters only by large national or leased longliners, baitboats, and purse seiners of the so-called industrial fleet. The fishermen of the artisanal fleet detect fish using simple methods such as bird activities above the tuna schools, changes in water color, moving of the water produced by the fish at the surface, and tuna jumping.

2) Gear and methods

The industrial fleet such as longliners, baitboats, and purse seiners use the conventional gear and methods for each type of those boats to catch blackfin tuna in Brazilian waters. In contrast, in Baia Formosa (eastern Brazil) they use primitive gear and methods. Each boat uses a single 8- or 10- thread trolling line, 140 to 160 m long, with a half-fifteen hook (sic) on each end. When they start they use the tilefish (píla, Malacanthus plumieri) for bait. As soon as they catch a blackfin tuna they use its belly strip for bait with very good results, not only for blackfin tuna but also for dolphin (dourado, Corýphaena hippurus), mackerel (cavala, Scomberomorus cavalla), and for billfishes (Istiophoridae).

The captain steers the boat and takes care of the trolling line. The crew members keep a lookout to avoid collisions with other boats until the captain calls one of them to pull in a hooked fish. When this happens, the captain lets out the other line and continues trolling. Sometimes while they are trying to boat one fish, another is hooked.

When the blackfin tuna school is at the surface, depending on the fishing grounds, a sailboat can catch 40 or 50 blackfin tuna in a normal day's work. During the 1963-1964 season the largest catch in a single day by one boat was made December 1, 1963, when 72 blackfin tuna weighing 274 kg (gutted) were landed (Cruz and Paiva, 1965). However, the translator (J.P. Wise, 1967) pointed out that it is difficult to reconcile these figures with their Table 1, which we believe to be true.

Fishing is carried out only during the day, no later than 6 p.m. The boats usually return to port every day. The only boats which stay on the grounds are those which carry ice for the fish.

In the municipality of Macau (Estado Rio Grande do Norte), there are several fishing centers such as Macau, Barreiras, Diego Lopes, and Guamaré. The artisanal fishermen of these areas use different kinds of fishing gear and methods as the trolling line (linha de pesca), cotton cast net (tarrafa), harpoon (arpão), dipnet (gererê), coastal gill net (tresmalho de costa), and beach seine (rêde de arrasto).

Paiva (1961) stated that trolling lines have been improving faster than other fishing gear. In Macau the fishermen classify the fish landed into three categories: first, second, and third classes; they place blackfin tuna and little tunny in the second class. The state of Ceará (Estado do Ceará) artisanal fishermen catch little tunny using a surface trolling line (linha e anzol dé superficie), bottom line (linha de fundo), and gill net (rêde de espera) from balsa rafts (jangadas) and small boats fishing in coastal waters (Menezes and Aragão, 1977). Nevertheless, according to the information we have obtained on the Brazilian fishery, the principal gear and method used for catching blackfin tuna is by means of trolling with one line. In southern and southeastern regions of Brazil, such as in the states of Rio de Janeiro and Santa Catarine. There are less important fisheries using this method, as in the states of Rio de Janeiro and Santa Catarine.

For a long time the northeastern Brazilian fishermen have been fishing for tuna seasonally using balsa rafts and wooden boats (botes de madeira). According to Paiva and Mota (1961), since the Japanese longliners arrived in Recife (state of Pernambuco), the Brazilian fishermen have been modifying and adopting new fishing methods.

Several exploratory fishing trips and gear tests for tuna have been carried out by small Japanese longliners in Brazilian waters. In 1960 the ALBACORA, a small Japanese longliner of 11.45 m length, using a total of 210 to 228 hooks per day, fished between 7° 10' - 8° 50'S and 32° 50' - 34° 50'W off Recife, northeastern Brazil (Paiva and Mota, 1961; our Fig. 61). During 1962 and 1963 another small Japanese longliner, the TAMANDARÉ III, of 18.30 m length, using a total of 425 hooks (type 8/0) per day, fishing to 110 m depth, fished between 4° 13' - 13° 00'S and 30° -36°00'W, off the area between the ports of Natal and Maceio, in northeastern Brazil (Paiva and Muniz, 1964; our Fig. 62). Both longliners used ballyhoo (agulha preta, *Hemirhamphus brasiliensis*) preserved in ice as bait. Neither vessel caught blackfin tuna during the exploratory fishing.

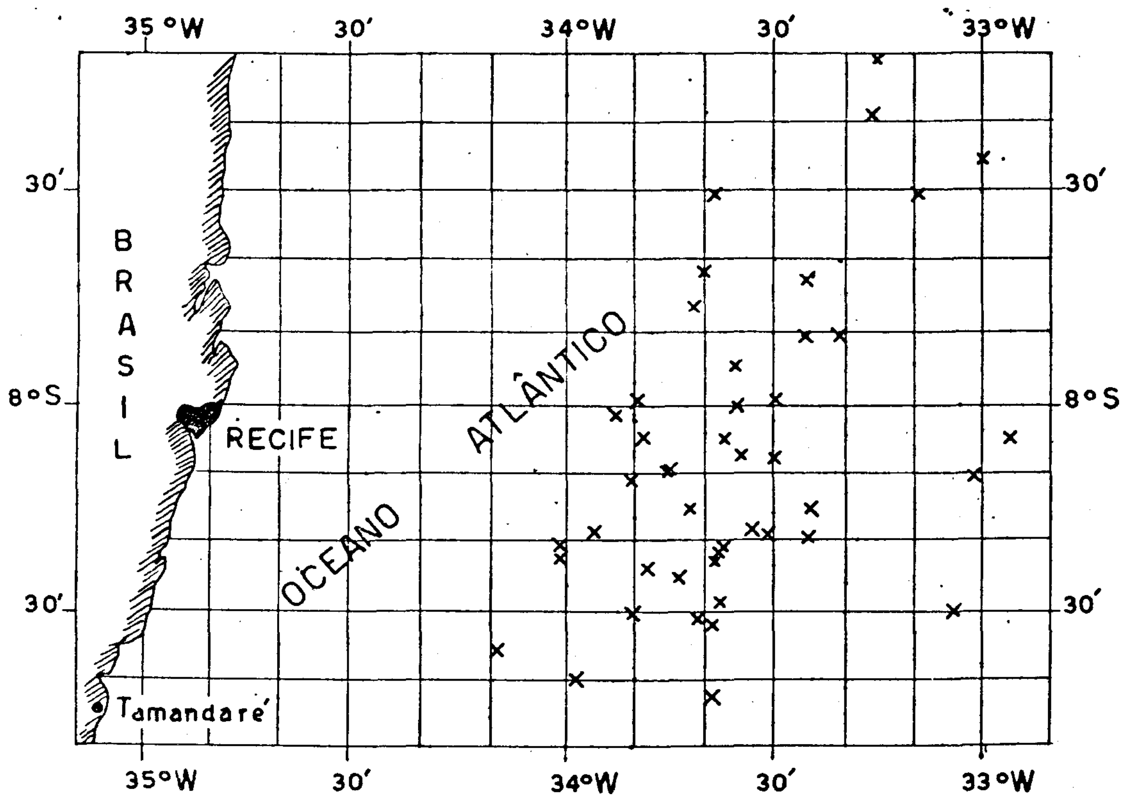
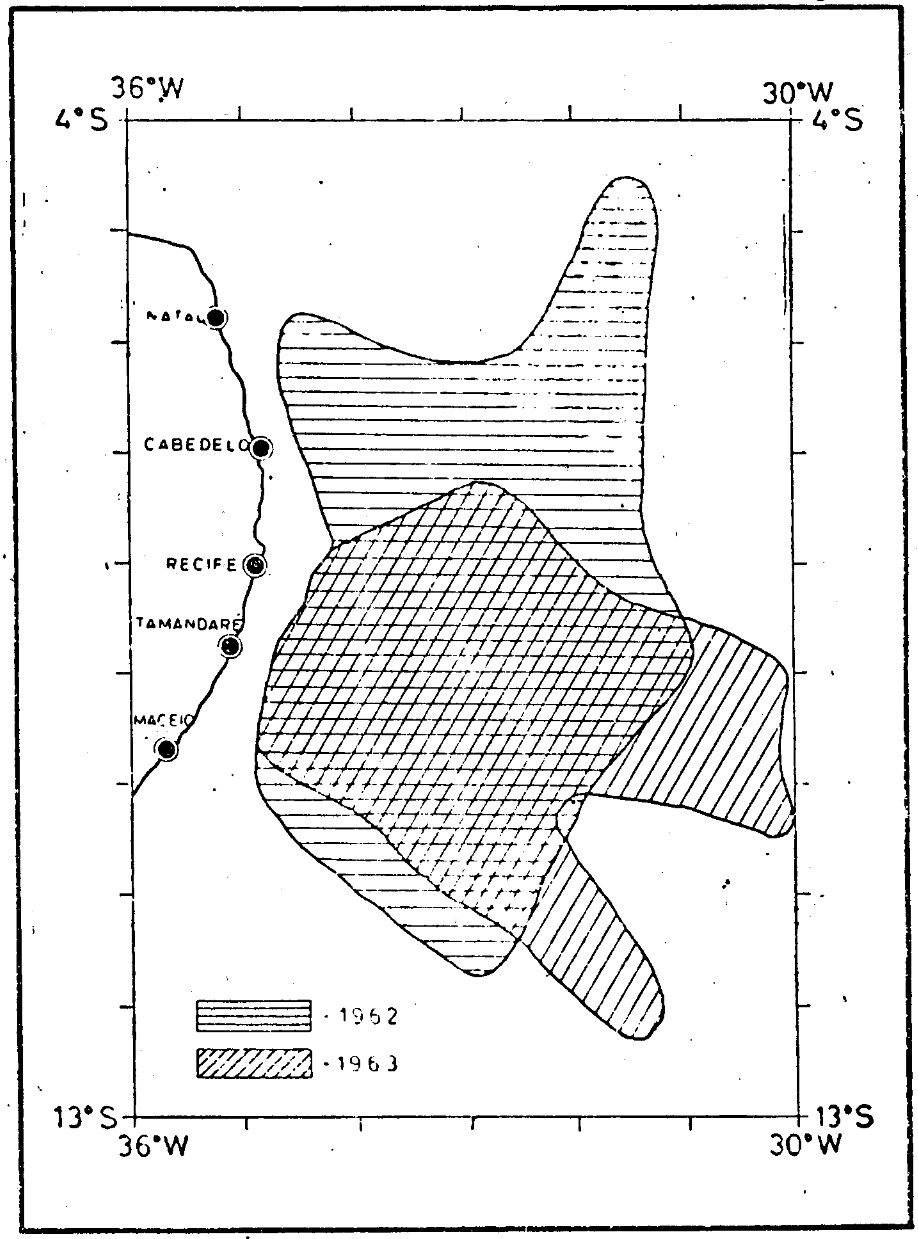


Figure 61. Longline stations in northeastern Brazil carried out by the exploratory fishing boat ALBACORA in 1960 (from Paiva and Mota, 1961).

Figure 62. Areas of exploratory fishing during 1962 and 1963, off northeastern Brazil, carried out by the TAMANDARÉ II (from Paiva and Muniz, 1964).



4) Landings

It is difficult to find information on catches of Brazilian tunas separated by species and by areas. Nevertheless, the following tables (Tables 16-19) may offer useful data for the purpose of this paper.

TABLE 16. Nominal reported catches in 1000 MT) of Atlantic small tunas (as of April 1986) (from ICCAT Reports 1982-1986).

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Blackfin tuna (_T. atlanticus_)	.2	12.8	1.9	1.8	11.9	.9	1.1	.8	1.0	1.2	1.3	1.1	1.1	1.8	1.8	1.6	1.7
Atlantic little tunny (_E. alletteratus_)	3.0	2.6	7.6	4.8	2.2	1.5	4.2	3.1	2.4	4.7	15.1	11.8	16.7	13.2	11.9	22.8	15.9
Frigate tuna (_A. thazard_)	6.4	13.4	9.2	7.1	10.2	6.6	9.6	7.9	6.5	16.6	4.2	8.1	11.2	6.5	9.5	9.9	13.6

Table 17

Catch in metric tons (MT for blackfin tuna-albacora preta for 1964 through 1974 in Brazil*.

1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.3	0.2

*From ICCAT, 1975

Table 18. Catch trends of the Brazil fishery for blackfin tuna in Baia formosa. State of Rio grande do Norte in four fishing seasons, 1963-1966 (from Cruz, 1967).

Year	Month	Number of Boats	Number of Fishing Days	TOTAL CATCH Individuals	Weight
1963	October	70	212	2,016	7,790.0
"	November	72	595	7,450	25,268.5
"	"	73	639	6,823	24,153.5
"	December	72	689	8,247	30,410.5
"	"	67	128	121	414.5
1964	January	61	267	81	306.5
SEASON TOTAL		75	2,530	24,738*	88,343.5*
1964	October	68	311	564	2,428.0
"	"	98	937	3,004	12,038.0
"	November	98	749	3,655	12,462.0
"	"	97	811	4,719	17,767.0
"	December	96	930	3,124	11,557.0
"	"	65	823	3,968	15,313.0
"	January	47	461	1,246	4,875.0
SEASON TOTAL		100	5,022	19,990*	76,440.0*
1965	October	53	687	222	1,083.0
"	"	90	941	3,564	15,345.0
"	November	95	946	5,661	21,343.0
"	"	95	1,074	6,115	23,208.0
"	December	96	1,122	7,952	31,584.0
"	"	89	860	5,392	19,038.0
SEASON TOTAL		96	5,630	28,960	111,601.0*
1966	October	83	848	1,026	4,518.0
"	"	110	1,198	5,083	18,838.0
"	November	108	948	2,314	9,038.0
"	"	101	1,033	3,479	12,287.0
"	December	92	1,014	1,600	5,277.0
"	"	97	1,075	3,262	12,343.0
SEASON TOTAL		112	6,116	16,764*	62,351.0*

* Values obtained by summing the samples.

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* Values obtained by summing the samples.

g. West Africa and Spain

1) Cape Verde

a) Fishing area

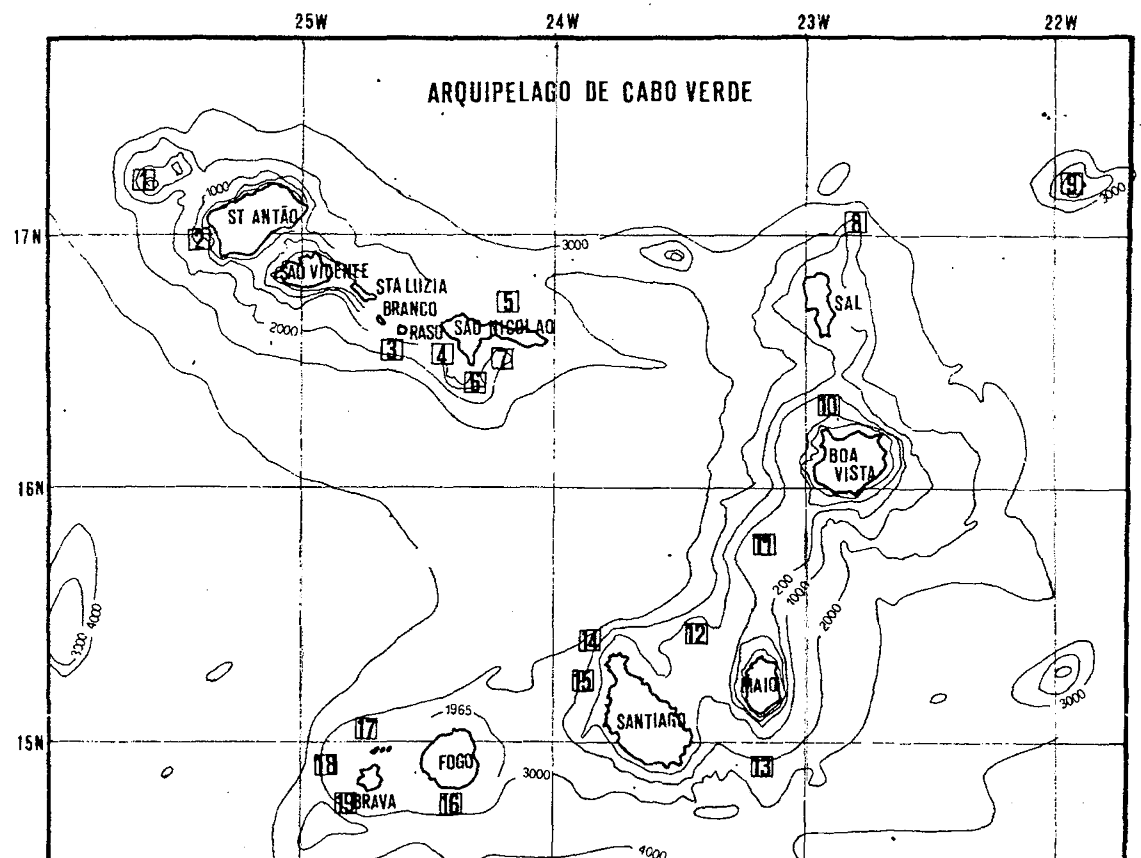
Most of the fishing activities for catching little tunny took place in Cape Verde's own waters in 1985 (Figs. 63-64). Occasionally a commercial or experimental vessel from Cape Verde fishes in other areas such as São Tomé, Azores, or Mozambique. Some boats fished in Angola during February or March and then return to Cape Verde after September. Usually those boats fish the schools around the islands. When the boats lack refrigeration they only can fish 10 to 12 hours close to the islands and return to port each day.

b) Vessels

As in other areas of the world, there are two types of fisheries in Cape Verde: artisanal and industrial fisheries. The artisanal fishery is composed of small wooden boats which vary greatly in size, shape, and capacity. The usual size is 4-5 m long and about 1.5 m beam. Oars, sail, and outboard motors or a combination of the three are used to propel these small boats (Vieira, 1986). About 1,173 vessels distributed throughout 75 landing sites operate almost all year around the islands, at the edges of the insular plateaus, or around shoals, with a crew of three to four fishermen per boat.

The so-called industrial fishery is composed of vessels of over 7 m, with an inboard motor and a closed hull and whose yield is exported either frozen or, after processing, canned. The fleet comprised small wooden or fiberglass vessels (7-25 m overall length), equipped as tuna baitboats, and steel oceanic tuna vessels (39 m overall length). These vessels are very old and are often immobilized at the port generally because of mechanical problems. A new fleet of eight fresh-fish baitboats of 15-18 m overall length should begin to arrive at the end of this year.

Figure 63. Details of the Archipelago of Cape Verde.



1. NW DE SANTO ANTAO
2. TARRAFAL DE MONTE TRIGO
3. ILHEU RASO
4. TARRAFAL DE S. NICOLAU
5. LARGO DE S. NICOLAU
6. PONTA DA VERMELHARIA
7. SUL DE S. NICOLAU
8. NE DO SAL
9. FIURA
10. BOA VISTA
11. BAIXO DE JOAO VALENTE
12. NW DO MAIO = BANCONA
13. SUL DO MAIO
14. NW DE SANTIAGO
15. TARRAFAL DE SANTIAGO
16. SUL DO FOGO
17. ILHEUS DO ROMBO
18. OESTE DA BRAVA
19. SUL DE BRAVA

c) Landings

The artisanal fishery catch is sold on the local market as fresh fish for local consumption. During the hot season some artisanal fishermen sell to the canning or freezing companies. A small canning company is almost entirely supplied by around 40 boats. Tuna comprise 40-60% of the total artisanal catch of which yellowfin is the most important species in terms of quantity (Vieira, 1986).

The total catch for 1984 and 1985 is shown in Tables 20-27. Statistics on the artisanal fishery for 1981 to 1983 are shown in Table 22 (Vieira, 1986). Other tuna catches are presented in Tables 23-26.

Table 20. Nominal catches in metric tons (MT) of little tunny in Cape Verde, according to FAO Yearbook of Fishery Statistics, for 1983.

	1980	1981	1982	1983
Eastern Central Atlantic	-	14	8	1240
Southeast Atlantic	128	234	212	-

Table 21. Cape Verde fleet operating in 1984 and 1985.

	1984	*1985*
Boats	1173	?
Baitboats without freezers	27	31
Freezer baitboats	2	4

Table 22. Cape Verde catch (MT) of tunas for 1984 (commercial and artisanal fisheries).

	Total	*T. albacares*	*T. obesus*	*K. pelamis*	*A. solandri*	*A. thazard & E. alletteratus*	Gear	Effort
Artisanal fishery	3,511	1,831	4	331	1,336	9	HAND	128,710
Artisanal fishery	1	–	–	–	–	1	UNCL	2,726
Artisanal fishery SUCLA	142	127	–	11	4	–	HAND	6,720
Commercial fishery	2,015	862	97	1,030	25	1	BBF&BB	1,788
Commercial fishery	5	–	–	–	–	5	PSS	5
TOTAL	5,674	2,820	101	1,372	1,365	16		

HAND = handline; UNCL = unclassified; BBF = freezer baitboat; BB = baitboat;

PSS = purse seiner

Table 23. Catch (MT) of tunas in 1985 (Commercial fishery up to the end of September).

Total	*T. albacares*	*T. obesus*	*K. pelamis*	*A. solandri*	*A. thazard & E. alletteratus*	*T. alalunga*	*Gear*	*Effort*	*Area*
826	431	15	360	10	10	–	BB	1,403	C. Verde
14	–	–	–	–	–	14	BBF	31	Azores
565	67	7	491	–	–	–	BBF	183	C. Verde
12	–	–	–	–	12	–	PSS	6	C. Verde
1,417	498	22	851	10	22	14		1,623	

Table 24. Cape Verde catches of tunas by the artisanal fishery, 1981-1983 (from Vieira (1986).

Year	*Total*	*T. albacares*	*T. obesus*	*K. pelamis*	*A. thazard & E. alletteratus*	*A. solandri*	*Effort (No. trips)*
1981	6,749	4,404	59	4	1	2,281	152,490
1982	4,282	2,691	63	53	40	1,435	130,271
1983	5,046	3,392	1	61	30	1,562	160,400

Table 25. 1981 catch and effort data (up to September 30, 1982)

Area	*Gear*	*Total*	*Yellowfin*	*Bigeye*	*Skipjack*	*Atlantic little tuna*	*Effort*
6415025	Baitboat	304.183	236.138	0.873	66.152	1.020	314
6415020	"	474.444	140.979	0.197	333.26	–	290
6410020	"	81.713	37.453	3.058	41.202		81
6410020	Purse seine	2.967	–	–	2.967	–	3
6415025	Troll harpoon	54.879	54.879	–	–	–	1,058
6415020	"	212.057	212.057	–	–	–	820
6410020	"	141.572	127.796	13.654	0.122	–	5,911
Angola	Baitboat	458.075	51.040	–	172.652	234.383	222
Total		1,729.890	860.342	17.782	616.363	235.403	8,699

Effort - Days at sea. We consider that boats which made 12-hour trips per day = 1 day at sea. ICCAT, (Part II 1981), 1982.

Table 26. Catch (MT) and effort data for 1983 (up to the end of September)

Catch	*T. alabacares*	*K. pelamis*	*T. obesus*	*A. solandri*	*A. thazard E. alletteratus*	*T. alalunga*	*T. thynnus*	*Gear*	*Effort*	*Area*
181	97	45	33	6	---	---	---	Hand	1500	Cape Verde
130	8	122	---	---	---	---	---	FBB	20	Cape Verde
4.5	4	0.5	---	---	---	---	---	FBB	30	Sao Tomé
166	1	1	144	---	---	10	10	FBB	85	Azores
884	446	351	68	17	2	---	---	BB	867	Cape Verde
1365.5	556	519.5	245	23	2	10	10			

ICCAT (Part II 1983) 1984

FBB = Freezer baitboat

BB = Baitboat

Skipjack, caught mainly during October and November, is the most important species of the baitboat catch (Vieira, 1986). The fleet, which was active during 1984 and 1985, is detailed in Tables 21-22 (from ICCAT, Rep. Part II 1985-1986).

d) Detection

Usually the artisanal fishery methods to detect schools of tuna in Cape Verde are the same as we have mentioned for similar types of fisheries in other countries. But the new fleet of eight baitboats which will arrive in November will improve these detection methods in the future.

e) Gear and Methods

According to Vieira (1986) many fishing gears are used which can catch tuna or other pelagic or demersal fish. Tuna are caught on the surface but more frequently in deep water. The gears are handlines of lengths varying from 150 to 450 m. As tuna are brought to the surface near the boats, if the size is judged too large, the fish is harpooned, the head is held out of the water with the aid of a hand hook inserted in the fish's eyes, and then the fish is beaten to death with hammers before being hauled on board. An average of 2-3 kg of bait is used per trip and the bait is either dead or alive. The live bait is kept in the bottom of the boat where the water is changed frequently. Little tunny and frigate mackerel are often caught with beach seines.

According to Wise (1986), catches in recent years have been on the order of 3000 MT/year, roughly half skipjack tuna in Cape Verde. Catch and effort sampling has been carried out since 1981, at rates approaching 100% for all species since 1982.

For recent catch statistics, see Table 27.

Summary of little tunny catches and catch and effort sampling 1976 to 1983 in Cape Verde.

	1976	1977	1978	1979	1980	1981	1982	1983
(1)	0	0	0	0	128	235	233	3
(2)	-	-	-	-	23	232		3

---

(1) Catch in MT

(2) "Weight" (MT) in catch-effort samples

Sources: Catches from ICCAT Statistical Bulletin, Vol. 14 Weight of samples from ICCAT Data Record, various numbers.

Table 27. Catch of little tunny (MT) reported by ICCAT countries (ICCAT, 1986).

****	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
TOTAL	2339	5190	4104	3888	6145	16595	12025	17549	13692	13012	22492

LTA CATCH BY GEAR•CAPTURES PAR ENGIN•CAPTURAS POR ARTE

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
BB	247	474	493	187	701	396	595	1316	1028	1391	1188
PS	47	1638	953	457	478	5573	66	835	2348	3614	4162
TROL	0	0	0	0	0	0	0	55	1	0	2501
TRAP	644	676	66	5	197	95	183	369	451	604	490
SURF	1189	1852	2327	2815	4249	10166	10879	14533	9509	5736	12960
UNCL	212	550	265	424	520	365	302	441	355	1667	1191

LTA CATCH BY COUNTRY•CAPTURES PAR PAYS•CAPTURAS POR PAIS

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
ANGOLA	970	1287	449	10	1326	826	646	1328	1171	1734	1632
ARGENTIN	0	0	0	0	0	0	0	0	0	36	0
BENIN	0	0	0	0	0	0	0	0	40	45	0
BRASIL	0	0	0	0	0	0	0	0	0	10	0
BULGARIA	0	0	8	0	1	9	0	0	0	0	0
CANADA	24	0	0	0	0	0	0	0	0	0	0
CAP VERT	0	0	0	0	0	0	0	128	235	233	5
CUBA	0	0	0	0	0	0	0	0	100	77	6
CYPRUS	6	5	7	7	18	11	17	17	22	33	17
1/ FRANCE	0	1583	860	400	431	38	57	177	1500	1500	1500
GER.D.R.	0	0	0	0	0	0	0	0	0	397	543
GHANA	26	66	138	76	54	6049	5547	4134	3287	2141	5009
ISRAEL	100	242	200	300	300	200	170	332	238	750	317
ITALY	0	0	0	0	0	1	**	0	0	0	0
MAURITAN	0	0	0	0	0	0	0	31	86	76	54
2/ MAROC	23	51	121	35	19	21	295	16	81	38	19
PANAMA	0	0	0	125	0	3	2	58	36	0	0
POLAND	0	6	2	0	0	0	0	0	0	0	0
PORTUGAL	0	0	0	0	0	0	5	121	8	0	0
ROUMANIE	100	297	46	10	86	2	17	9	12	291	216
2/ SENEGAL	0	537	1092	705	1540	1446	1697	2716	2285	3384	5891
ESPANA	761	688	737	1140	1092	1248	997	1285	13	708	2
SYRIA	0	0	0	102	105	109	89	80	73	73	73
USA	20	51	67	5	53	113	12	88	97	87	107
USSR	0	0	0	470	690	6127	2184	6307	3615	1085	6928
VENEZUEL	300	373	357	501	426	390	289	721	791	311	573
YUGOSLAV	9	4	20	2	4	2	1	1	2	3	2

1/ Includes catches by Ivory Coast and some by Senegal and Morocco./ Comprend des prises de la Côte d'Ivoire et quelques du Sénégal et du Maroc./ Incluye capturas de Costa de Marfil y algunas de Senegal y Marruecos.

2/ Local catches not reported under France./ Prises locales non déclarées à la rubrique France./ Capturas locales no informadas bajo Francia.

2) <u>Ghana</u>

According to Wise (1986) little tunny catches in 1981 to 1983 in the Atlantic Ocean have been around 16,000 MT/year. Ghana appears among other countries such as USSR, Senegal, Angola, and FISM* which take over 85% of the little tunny catches in the eastern Central Atlantic (see Table 27). The Ghanaian flag tuna fleet that operated during 1984 comprised 27 baitboats and four purse seiners. In addition, four Japanese-flag baitboats operated for the first four months of the year and then left the fleet. A significant event in the operation of the fleet was that since March, 1984, the fleet has been landing their catches in Abidjan. Generally, only local market catches (undersized tuna) were discharged in Tema. It was very seldom that a tuna boat unloaded its total catch in Tema (Mensha, 1986).

Ghana's increasing catches of Atlantic tunas reached 46,000 MT in 1983. More than half of the catch is surface-caught skipjack tuna. Yellowfin tuna plus small tunas and sailfish make up most of the rest. Sampling of small tunas had been irregular or lacking, particularly in recent years (Wise, 1986).

The following (Tables 28-29), taken from ICCAT, give us a picture of the little tunny fishery in Ghana:

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*FISM = France, Ivory Coast, Senegal and Morocco

Table 36

Summary of Atlantic little tunny catches and catch and effort sampling, 1976-1983.

	1976	1977	1978	1979	1980	1981	1982	1983
Ghana[1]	76	54	6049	5547	4134	3287	2141	5009
Weight[2]	45	96	25	10	0	-	0	0

1) Catch in metric tons (MT); 2) "Weight" in catch-effort samples. Sources: 1) Catches from ICCAT Statistical Bulletin Volume 14; 2) Weight of samples from ICCAT Data Record, various numbers.

Table 29

Landings in metric tons of "black skipjack" (Euthynnus alletteratus and Sarda sarda) made from 1980 to 1984 by Ghanaian and foreign flag vessels:

	1980	1981	1982	1983	1984
Ghana*	4216.016	3426.284	2140.146	2432.1	223.493

*Data taken from ICCAT Reports, various numbers.

3) Ivory Coast

The port of Abidjan, in Ivory Coast, in the Gulf of Guinea, West Africa, is the leading Atlantic tuna port (Fig. 64). There were many important changes in tuna fishing in Ivory Coast in 1984. The FISM fleet which was based at the port of Abidjan has gradually moved to new fishing grounds in the Indian Ocean. It was predicted that by the end of 1984 there would be no tuna vessels from this fleet based in Abidjan. On the other hand, the activities of the large Spanish purse seiners have continued. The baitboats usually based at Tema have shifted towards Abidjan and currently about 30 baitboats with Ghanaian and Japanese flags land their tuna catches at Abidjan. Four Ghanaian purse seiners and one Japanese seiner also regularly land their catches at this port (Kothias and Bard, 1986).

In 1985, fishing by the Ivory Coast tuna fleet had been reduced considerably. In the Atlantic, three vessels of the Ivorian fleet operated part of the year and caught 1,385 MT of tunas. As regards other fleets, landings and trans-shipments at the port of Abidjan reached 98,517 MT. Ghanaian baitboats (21 vessels) are more and more regularly landing their catches at Abidjan. At the end of 1985 it was estimated that the entire Ghanaian fleet is based in Abidjan (Bard and Kothias, 1986).

As we have stated before, Ivory Coast is among other western African countries which take over 85% of little tunny in the eastern Central Atlantic. All Ivory Coast tuna statistics and sampling are included in France-FIS-FISM complex (Wise, 1986). But there is no doubt that in Abidjan, Ivory Coast, they landed little tunny, according to Table 29 and 30, which show the catches of FISM and Ivory Coast, respectively.

Figure 64. Abidjan Port in Ivory Coast and Tema port in Ghana, two important tuna fishing ports in the eastern Central Atlantic.

Table 29. Summary of Atlantic little tunny catches (MT) and catch and effort sampling, 1976-1983.

	1976	1977	1978	1979	1980	1981	1982	1983
FISM[1]	400	431	38	57	177	1500	1500	1500
Weight[2]	0	0	0	0	0	0	0	0

1 = France, Ivory Coast, Senegal, and Morocco.

2 = "Weight" (metric tons) in catch-effort samples.

Sources: 1. = Catches from ICCAT Statistical Bulletin, Volume 14.

2. = Weight of samples from ICCAT Data Record; various numbers.

Table 30. Nominal catches of little tunny in the Ivory Coast, according to FAO Yearbook of Fishery Statistics, for 1983.

MT	1980	1981	1982	1983
	177	182F	150	146F

F = FAO Estimate

According to Kothias (1986) the quantities of small tunas (Euthynnus alletteratus and Auxis thazard) landed in Abidjan were estimated to be 1002 MT in 1984 and 417 in 1985. These values decreased from 65 to 91 % compared to those 1981 to 1983. The majority of the landings comprised one or the other species (56% little tunny and 28% frigate mackerel). In the mixed landings the ratio of the two species was 1:1.

4) São Tomé and Principe

The Democratic Republic of São Tomé and Principe is located in the Gulf of Guinea, off Gabon, West Africa. Currently these islands do not have a tuna fleet and for this reason it does not specifically target tunas. However, the artisanal canoe fishery occasionally catches tuna during its daily fishing for bottom and pelagic species, using hand lines. According to Santo (1985), this situation could change in the future when infrastructures capable of exploiting this important marine resource are developed. The fishing activities that are developing in Sao Tome and Principe waters are almost exclusively carried out by foreign vessels.

The total tuna catch by artisanal canoe fishery is as follow:

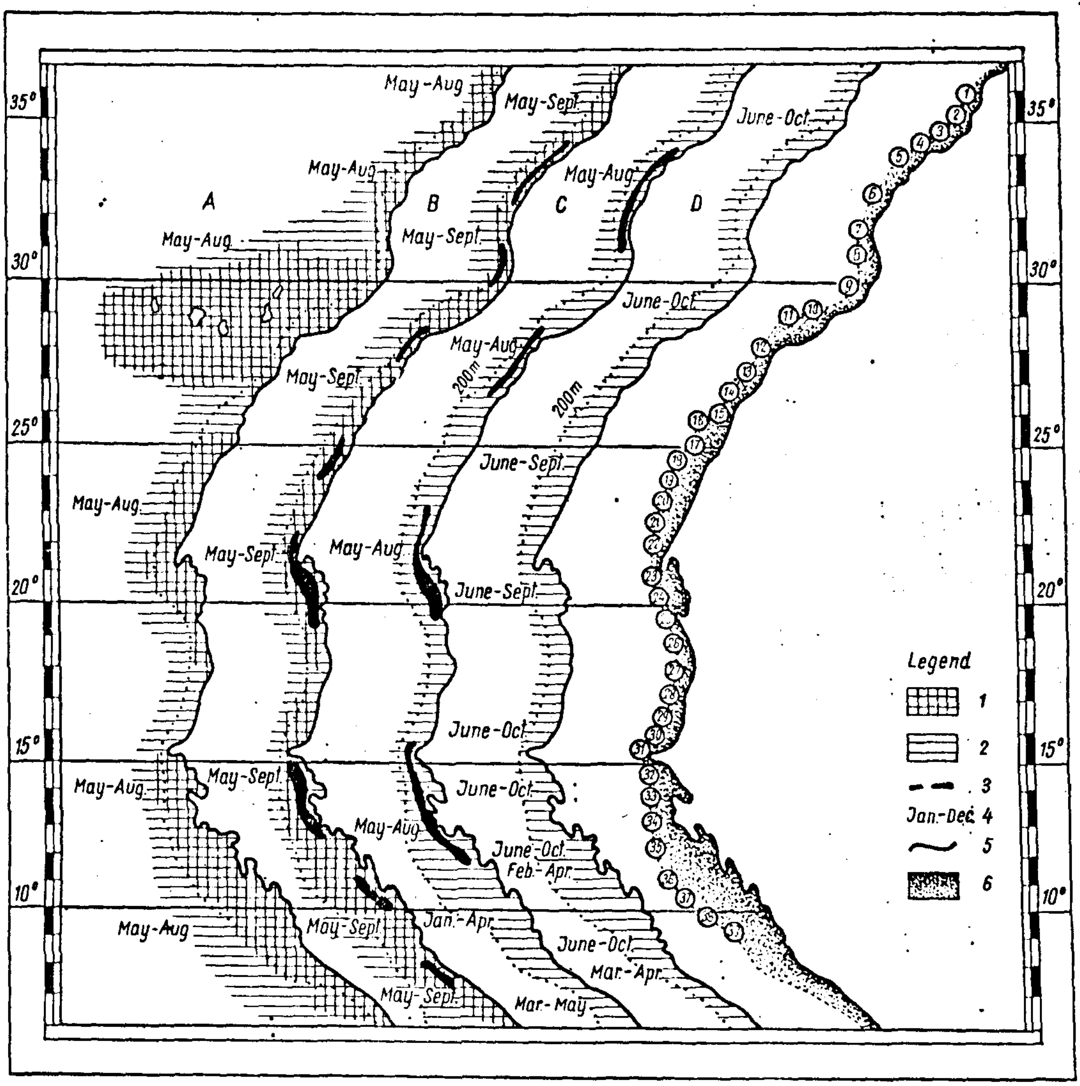
	1983	1984	1985
Metric Tons (MT)	149.3	103	215

According to Santo (1986), as regards fishery statistics, São Tomé and Principe has tried to comply with the ICCAT recommendations in providing catch data. Nevertheless, they have encountered great difficulties in obtaining data from foreign countries which fish under license.

5) Senegal

Senegal is another country which belongs to FISM (French, Ivory Coast, Senegal and Morocco). As we already know, these countries take over 85% of the little tunny (thonine) in the eastern Central Atlantic. The fishery for little tunny is carried out in region V -- the Senegambia-Guinea Shelf--between 15°00'N and 08°00'N (Klimaj, 1976). The largest concentrations of little tunny in this region occur on the shelf between Cape Verde (15°00'N) and Cape Roxo (12°30'N) as shown in Figure 65.

Figure 65. Biology, ecology and catches of mackerels and tunnies: I-regions with good catch yields; 2-location in which fish are taken; 3-spawning regions; 4- spawning months; 5-coastline, 6-shelf. A-Spanish mackerel, plain pelamid, Atlantic bonito; B-skipjack; C-frigate mackerel; D-little tunny, bluefin tuna, long-finned tuna, yellowfin tuna, bigeye tuna (from Klimaj, 1976).



The tuna fishing season south of Cape Verde (Cap Vert) lasts from November to the end of May. Among the species taken include little tunny and Atlantic bonito (bonite à dos rayé), Sarda sarda.

Dakar is the main port of Senegal. The tuna fleet of the industrial fishery based in Dakar, which operated in 1984, comprised 21 baitboats and four purse seiners. The main species of tuna landed by this fleet were yellowfin tuna, skipjack, and bigeye tuna (Cayré, 1986).

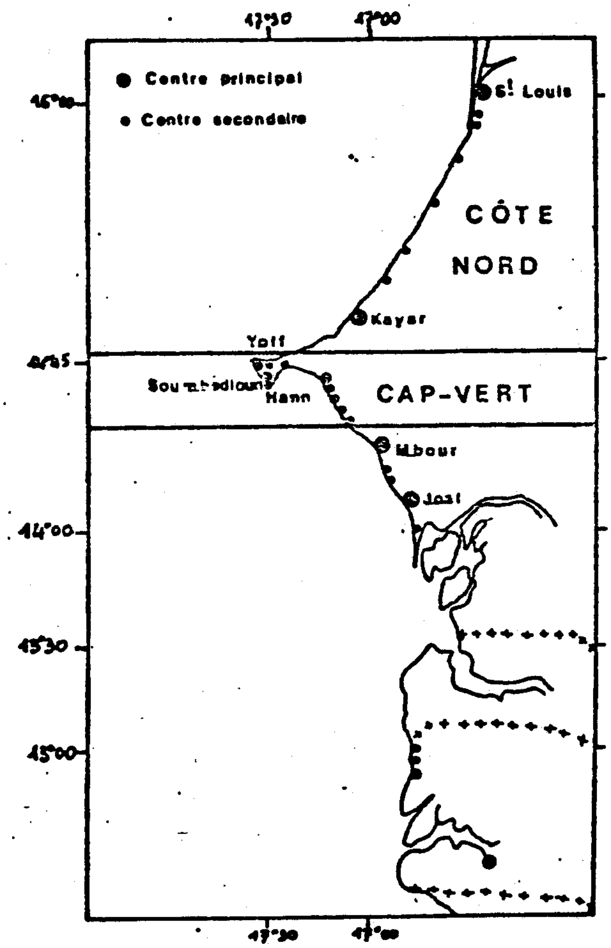
Little tunny are caught by artisanal and commercial fisheries (Table 31). Artisanal fishermen catch 74% of the little tunny and 26% is taken by the commercial fleet. The artisanal fishermen use trolling lines, hand lines, and haul seines from canoes provided with an outboard motor of 8 hp. The fishing areas and landing centers in Senegal are located at the north and south coast of Cape Verde (Fig. 66). Each canoe has a crew of two to four fishermen. Trollling-line canoes carried out demersal and/or pelagic fisheries according to the season. At Soumbédioune, on the Cape Verde coast, some trolling-line canoes fish only for small tunas such as little tunny and Atlantic bonito during April and May. From Kayar to Saint-Louis on the north coast, the captures of little tunny by trolling lines are important during the bluefish (Pomatomus saltatrix) season (April and June).

Table 31. Landings in metric tons (MT) of Atlantic little tunny in Senegal.

Years	Artisanal Fishery	Commercial Fishery	Total
1979	1,097	600	1,697
1980	1,622	1,095	2,717
1981	1,660	621	2,281
1982	2,378	1,006	3,384
1983	4,572	1,333	2,905
1984	4,444	796	5,240
TOTALS	15,773	5,451	21,224
PERCENTS	74%	26%	100%

Sources: ICCAT Reports, various numbers.

Figure 66. Artisanal fishery landings centers in Senegal (from Diouf, 1986)



6) Spain

Spain's tuna catches in 1981-1983 averaged just over 140,000 MT per year, a quarter of the total Atlantic tuna catch. More than half is yellowfin and skipjack tunas. Spain is the leading country in Atlantic fisheries for albacore and swordfish. There are also significant catches of bluefin tuna and "small" tunas (Wise, 1986). Spanish catches of tuna and tuna-like species in the Atlantic and Mediterranean in 1984 reached 148,423 MT, an increase of about 5,500 MT compared to 1983, and represented the highest catches for Spain of tuna and tuna-like species in these areas since the inception of the fisheries (Fig. 67).

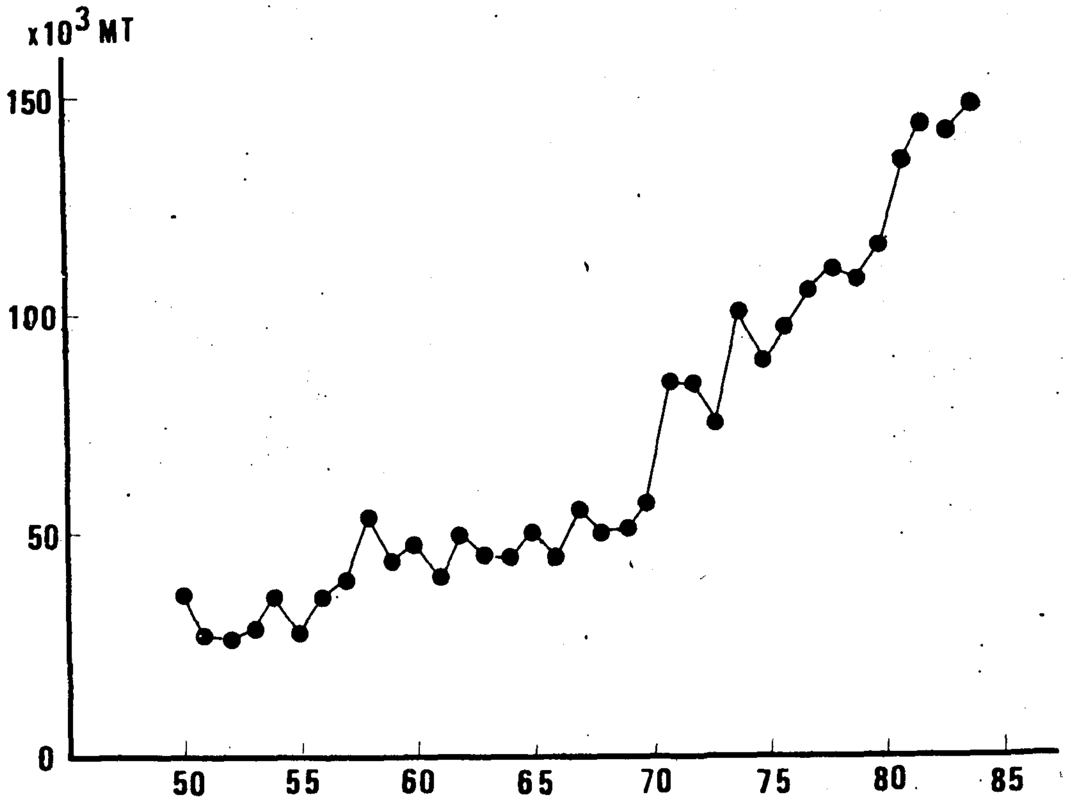


Figure 67. Total Spanish catches of tunas and tuna-like species from 1950 to 1984 (from González-Garcés, 1986).

Spain has traditionally fished in four different areas in the eastern Atlantic: the tropical eastern Atlantic, the Canary Islands, the northeast Atlantic, and the Mediterranean. Catches of the tropical western Atlantic fishery have considerably increased recently (González-Garcés, 1986). In addition, they also fish in the western Atlantic Ocean.

a) Tropical eastern Atlantic

Spain began its fishery in the tropical eastern Atlantic in the mid-1950's with a baitboat fleet that was gradually converted to a fleet of large purse seiners. In 1983 the Spanish tropical fleet in the eastern Atlantic comprised 52 vessels, whereas in 1984 there were 55 purse seiners operating in this area. On the other hand, in 1984, 14 boats (four in category 6 and ten in category 7) left the Atlantic and operated in the Indian Ocean. In 1985 there was no change in this fleet (41 vessels in the Atlantic and 14 vessels in the Indian Ocean). Some of the vessels in the Indian Ocean returned to the Atlantic during the summer because of the bad weather in the Indian Ocean (González-Garcés, 1986).

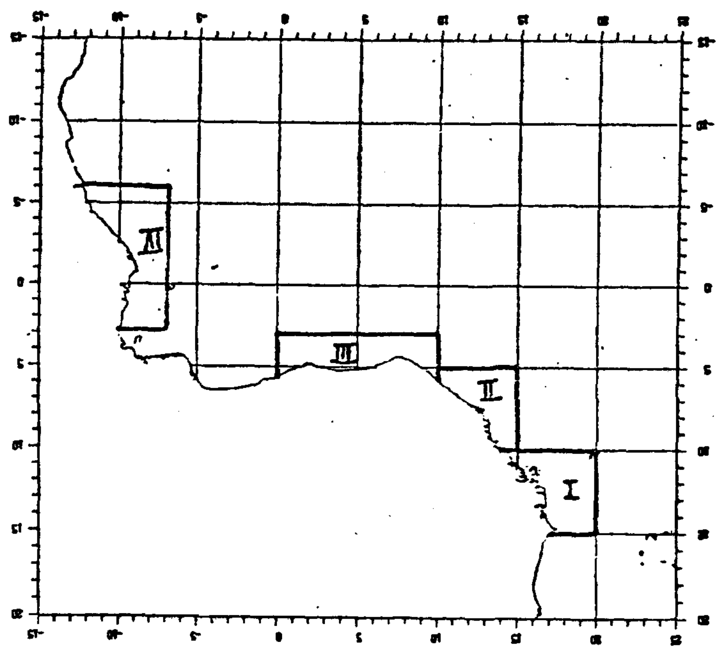
The following table shows Spanish catches of main tuna species from ETRO:

Table 32. Spanish catches of main tuna species from the eastern tropical fishery (ETRO) in 1978-1984.

Year	YFT	SKJ	BET	ALB	OTH	TOTAL
1978	33,393	24,508	2,999	0	600	61,500
1979	39,938	17,418	2,444	0	800	60,600
1980	38,682	24,222	4,396	0	5,800	73,100
1981	51,332	31,307	7,598	889	4,748	95,874
1982	53,779	34,650	7,496	106	2,562	98,593
1983	46,358	29,114	9,816	295	2,517	88,100
1984	39,532	45,621	7,742	307	5,453	98,655

YFT = yellowfin tuna: SKJ = skipjack: BET = bigeye: ALB = albacore: OTH = other species, (Source: ICCAT Report, 1984-85, II).

Figure 68. Areas of the Spanish purse-seine fisheries for "small" tunas in the eastern tropical Atlantic Ocean (ETRO), off the West African coast (from Diouf and Rey, 1986).



The main ports in the ETRO fishing zone are the following: I-Dakar, II-Freetown, III-Abidjan, and IV-Cap Lopez. The catches in these zones change from one year to another. Table shows Spanish purse-seine catches from 1980 to 1983.

The Spanish fishery of small tunas such as little tunny (bacoreta) and frigate mackerel (melva) are incidental catches in the purse-seine fishery for big tunas off the west African coast. Acording to Diouf and Rey, (1986) there are four well-defined areas in which these small species of tuna are caught by the Spanish purse seiners (Fig. 68).

Table 33. Spanish purse-seine catches (MT) of small tunas in the eastern tropical Atlantic Ocean, 1980-1983.

Year	little tunny	frigate mackerel	total
1980	83	3047	3130
1981	44	573	617
1982	156	1605	1761
1983	239	1734	1973
Totals	522	6959	7481
Percentage	7	93	100

Source: ICCAT, Vol. XXV (SCRS-1985)

The target of the purse-seine fleet in the eastern tropical Atlantic Ocean is the large tunas, while the "small" tunas are incidental catches. Diouf and Rey (1986) stated that these species are of more commercial value to Spain than to France. According to Table 33, 93% of the total catch of the Spanish purse seiners, from 1980 to 1983, are frigate mackerel. The catches decreased abruptly in 1981 but they stabilized starting in 1982. The distribution of the "small" tunas is related to the concentrations of the large tunas because, as we pointed out above, the target species of the purse seiners are yellowfin tuna, skipjack, bigeye tuna, and albacore. According to Diouf and Rey (1986) little tunny are usually found in the coastal zones together with frigate mackerel as well as with the larger tunas. "Small" tunas are found along the Atlantic coast of Africa, where they are exploited by Spanish and French fleets at the same time as they are fishing for large tunas.

b) Canary Islands

The Canary Islands fisheries are carried out between 30°00'N and 26°00'N. The following species of tunas are very numerous in this region: skipjack, yellowfin tuna, albacore tuna, and bigeye tuna. The biggest schools of tunas in this region concentrate to the south of Cape Yubi (Juby) in Morocco (Fig. 69). Skipjack, Spanish mackerel, Atlantic bonito, and frigate mackerel inhabit the coastal waters during the cool season from September to February.

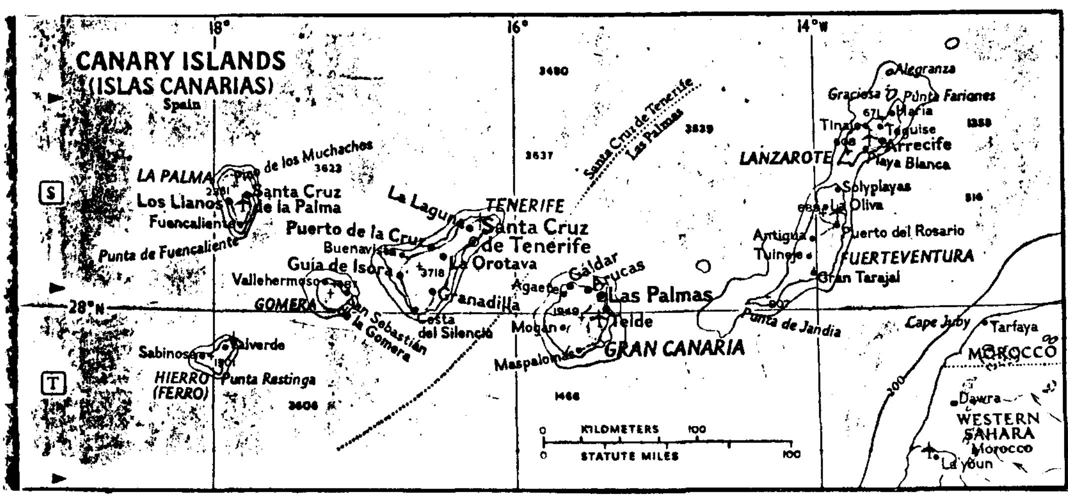


Figure 69. Canary Islands, Spain.

The tuna fleet in the Canary Islands mainly comprises small boats less than 20 GRT which use live bait The fleet, which increased by six boats with respect to 1983, comprises the following: 259 boats of less than 20 GRT, 35 boats in the 20-50 GRT class, 28 in the 51-150 GRT class, and one longliner of 750 GRT (González-Garcés, 1986).

c) The Northeast Atlantic Fisheries

In the northeast Atlantic zone there is a large Spanish fleet which carries out a diversity of fishing activities. The fleet that operated in 1984 comprised 228 baitboats, 505 trollers, 185 long-liners, 3 traps, and an indeterminate number of boats that sporadically catch tuna, usually bluefin, but which do not target this species (for example, purse seiners which target sardines or anchovies, trawlers that put out lines at night, boats using nets in which a tuna sometimes is caught). Catches in this area in the last few years are shown in Table 34 (González-Garcés, 1986).

Table 34. Spanish catches of (MT) main tuna species from the northeast Atlantic fishery (NE) in 1978-1984 (Gonzáles-Garcés, 1986).

Year	BFT	ALB	SWO	OTH	TOTAL
1978	2,477	24,244	3,622	2,624	32,967
1979	2,783	29,206	2,582	1,132	35,703
1980	1,938	24,684	3,810	1,150	31,582
1981	1,723	19,833	4,014	1,580	27,150
1982	2,781	24,959	4,554	1,501	33,795
1983	4,140	28,789	7,100	1,051	41,080
1984	4,802	14,708	6,315	6,532	6,478

BFT = bluefin tuna: ALB = albacore: SWO = swordfish: OTH = other species.
Source: ICCAT Report, 1984-85 (II)

d) Mediterranean fisheries

The Spanish artisanal fishermen catch three species of small tunas in the Mediterranean Sea: Atlantic bonito (Sarda sarda), frigate mackerel (Auxis thazard), and little tunny. These species are very important in the Spanish fishery in the Mediterranean waters. During 1984, the Spanish fleet caught a total of 8,646 MT of tuna and tuna-like fishes. Small tunas comprised 3317 MT of this total, which means 38.4% of the catch (Table 35). The distribution by species was as follows: Atlantic bonito, 29.6%; frigate mackerel, 69.3%, and little tunny, 1.1% (Camiñas et al., 1986). The main fishing gears used in this fishery for small tunas are purse seines (cerco), fish traps (almadrabas), gill nets (enmalle), and fixed gears (artes fijas). All these gears are of local or regional use. Spain caught only 32 MT of little tunny in 1984; of this total 66% was caught in the fish traps set in Ceuta, at the entrance to the Strait of Gibraltar (Fig. 70, location 2). The reminder of little tunny catches were distributed between the purse-seine fishery on the African coasts (8 MT);1 MT in Minorcan coasts and 3 MT using surface gears.

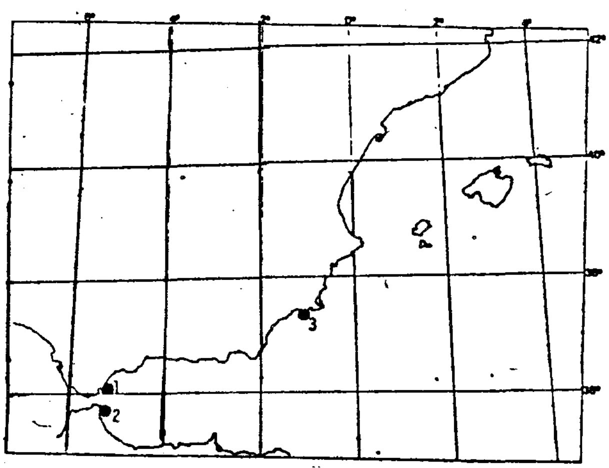


Figure 70. Location of the fish traps in the Mediterranean Sea. 1. -La Linea; 2. Ceuta; 3. -La Azohía (from Camiñas et al., 1986)

Table 35. Spanish catches (MT) in the Mediterranean Sea, by species and gear, in 1984.

Gear	*S. sarda*	*A. thazard*	*E. alletteratus*	TOTAL
Purse seine	634	1605	8	2247
Fish trap	250	655	21	926
Gill net	87	19	3	109
Fixed gear	13	22	-	35
Total	29.6	69.3	1.1	100

Source: ICCAT, Vol. XXV (SCRS-1985).

The little tunny is caught using purse seines from October to December; using gill nets in the Straits of Gibraltar during June to December; and by means of fish traps between June and September. During the remainder of the year catches are very low. According to Camiñas *et al.* (1986), it appears that the catches are made the second half of the year. The catch of small tunnies by species and gear in the Mediterranean Sea by the Spanish artisanal fleet in 1984 is shown in Figure 71. The most important areas of fishing for little tunny are located close to the Strait of Gibraltar.

According to the world catch statistics in the FAO yearbook (1983), the Mediterranean countries which catch little tunnies are Cyprus, Israel, Syria, Yugoslavia, Portugal, and Spain. The USSR also catches considerable quantities of little tunnies in this area (Rudomiotkina, 1985).

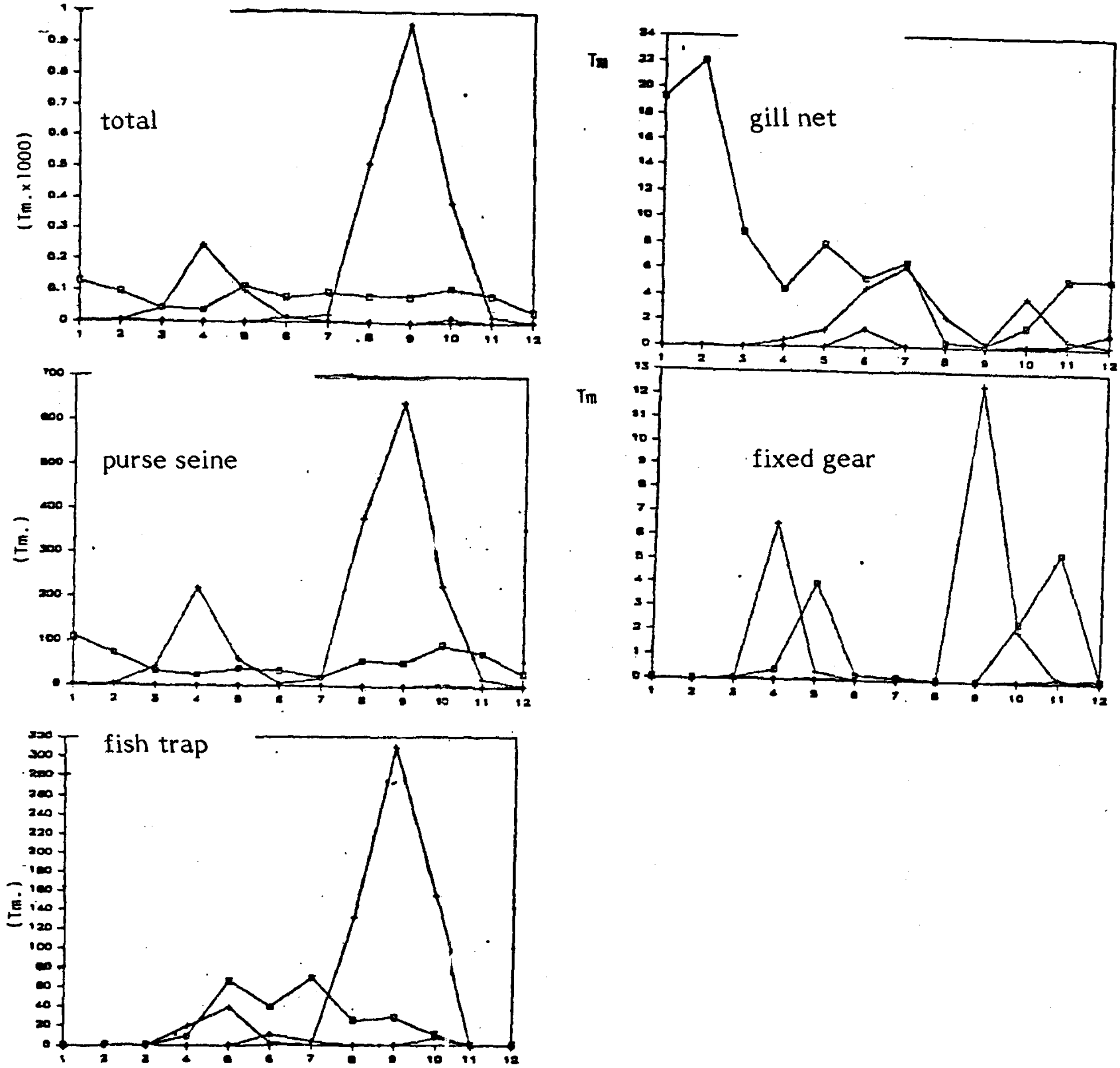


Figure 71. Catch by species and month for total and each gears.

Sarda sarda

Auxis thazard

Euthynnus alleteratus

Local gears as: almadrabilas, morunas, and artes locales

Source: ICCAT, Vol. XXV (SCRS-1985)

e) The tropical western Atlantic fishery

Spanish catches in the tropical western Atlantic are presented in Table 36. The specific limits of this fishing region are not stated by González-Garcés, 1986). It can be noted that after three years of no fishing in this area, subsequent catches for 1983 and 1984 are considerable, and the 1984 catches are the highest of the entire historical series (González-Garcés, 1986).

Table 36. Spanish catches of main tuna species from the western tropical fishery (WTRO) in 1978-1984.

Year	YFT	SKJ	TOTAL
1978	2,029	2,031	4,060
1979	1,052	1,052	2,104
1980	0	0	0
1981	0	0	0
1982	0	0	0
1983	1,957	209	2,166
1984	3,976	2,610	6,586

YFT = yellowfin tuna; SKJ = skipjack

Source: ICCAT Report, 1985-86 II.

2. Recreational

1. History

"On August 29, 1951, surfacing schools of tuna identified as blackfin were sighted from the research vessel OREGON early in the morning in the central Gulf of Mexico.... The OREGON continued a northerly course all of that day without once passing out of sight of surfacing tuna schools in the distance of more than 100 miles" (Springer, 1957).

Authentic reports such as this and other narrative accounts have intrigued the American angler for decades: "After December a great many blackfin appear in the Carayaca Venezuela hot spot and either stay there or move into the La Guaira.... They are an unforgettable sight as they jump about in large groups taking their favorite bait.... As a rule they are caught to make marlin bait themselves but afford some amusement with 8 to 12 pound spinning tackle for they fight very well and the angler needs strong wrists to boat them" (Jaen, 1964). Despite such numerous tantalizing reports, no directed U.S. recreational fishery for blackfin tuna has developed. Both angler preference and behavior of the tuna account for this. Anglers have preferred to catch the heavier, harder-fighting, "large" tunas often featured in tournaments for the prizes and the "macho" image attained from arduous fights with these giant species. Also, blackfin tuna and little tunny are highly migratory, travel fast, and blackfin tuna are usually far offshore, implying more costly expenditures for a recreational experience. When catches are made they are largely incidental to trolling for "any" pelagic species. Exceptions to this are the infrequent catches of little tunny made from jetties or fishing piers.

Early records of "small" tuna sport-fish captures are scarce and lack detail. Typical is Holder's (1913) comment that the blackfin "is a hard fighting little fish," and that he had caught this species off Malta, Barbados, Cuba, and Nassau. Note that all these locations imply "blue" water fishing areas for blackfin.

b. Users

Virtually all anglers may participate in "small" tuna fishing because catches are principally made while trolling in both inshore and offshore waters but some little tunny may even be taken by shore-fishermen. Most frequent catches--best opportunities--are offered by the large fleets of charterboats seeking pelagic fishes by trolling. Private boats when trolling and even head boats also afford opportunities to capture "small" tunas.

1) South Atlantic Area:

For example, Manooch et al. (1981) determined that the North Carolina fleet of 135 charterboats made 8449 trolling trips in the an 8-month season. In this especially prolific area, in 1978, anglers on trolling trips produced 4726 little tunny and 3934 blackfin tuna. Combined inshore and offshore trolling trips produced an average per trip of 4.48 pounds of little tunny and 4.49 pounds of blackfin tuna. The annual costs and profits for North Carolina charterboats are shown in Table 2 of Manooch et al. (1981) (our Table 37).

Brown and Holemo (1975) conducted a survey of the economics of the Georgia charterboat fishery. Although fishing in the Gulf Stream was reported, no species catch information was provided.

2 Florida - Dade County:

For this charterboat fishery, little tunny ranked second (16.3%) and blackfin tuna ranked sixth (4.3%) in abundance of the total catch (Gentle, 1977). He found that little tunny were most abundant during the summer (June-August) and blackfin tuna during the spring (March-May) (see Gentle, 1977; see our Table 38 for species composition of the catch and season). Length-frequency distributions by month are given for both species (Figs. 72 and 73).

Table 37. Catch and effort for North Carolina charter boats trolling inshore (4,216 trips) and offshore (4,233 trips), 1978 (from Manooch et al., 1981).

Species	Inshore				Offshore			
	No. caught	Wt. (lb.)	No./trip	Wt./trip	No. caught	Wt. (lb.)	No./trip	Wt./trip
King mackerel	46,104	419,511	10.94	99.50	3,207	27,230	0.76	6.43
Spanish mackerel	8,267	12,335	1.96	2.92	16	62	<0.01	0.01
Bluefish	79,117	256,574	18.77	60.86	628	5,526	0.15	1.31
Little tunny	4,381	34,779	1.04	8.25	345	3,071	0.08	0.73
Atlantic bonito	2,242	7,796	0.53	1.85	460	1,542	0.11	0.36
Cobia	54	1,554	0.01	0.37	12	356	<0.01	0.08
Barracuda	384	3,881	0.09	0.92	348	3,495	0.08	0.83
Amberjack	1,948	36,553	0.46	8.67	471	8,492	0.11	2.01
Blackfin tuna	167	1,926	0.04	0.46	3,767	35,978	0.89	8.50
Yellowfin tuna	31	662	0.01	0.16	4,166	150,590	0.98	35.58
Skipjack tuna	6	48	<0.01	0.01	1,097	7,166	0.26	1.69
Bluefin tuna	2	40	<0.01	0.01	31	1,627	<0.01	0.38
Bigeye tuna	—	—	—	—	13	588	<0.01	0.14
Albacore	—	—	—	—	14	428	<0.01	0.10
Frigate mackerel	125	323	0.03	0.08	3	3	<0.01	<0.01
Dolphin	214	1,434	0.05	0.34	52,266	273,559	12.35	64.63
Wahoo	16	496	<0.01	0.12	2,691	73,107	0.64	17.27
Sailfish	—	—	—	—	444	16,189	0.10	3.82
White marlin	—	—	—	—	3,137	142,844	0.74	33.75
Blue marlin	—	—	—	—	358	82,585	0.08	19.51
Longbill spearfish	—	—	—	—	7	370	<0.01	0.09
Bar jack	2	4	<0.01	<0.01	—	—	—	—
Crevalle jack	2	28	<0.01	<0.01	—	—	—	—
Sharks	98	1,825	0.02	0.43	227	7,808	0.05	1.84
Total	143,160	779,769	33.95	184.95	73,708	842,616	17.38	199.06

Table 38. Species composition of the catch in numbers of fish sampled by quarter with chi-squares (H_0: no change in frequency of observation in chatches of a given species by quarter, dF = 3) for abundant species, March, 1976 to February, 1977. Numbers in parentheses are expected frequencies based on chi-square goodness-of-fit expectations, weighted by the number of boat-trips sampled quarter (Gentle, 1977).

Species	Quarter: Mar. - May	June - Aug.	Sept. - Nov.	Dec. - Feb.	Total	% of grand total	Chi square
blackline tilefish	0	2	0	0	2	0.1	
tilefish	2(8.0)	4(5.6)	18(4.5)	0(5.9)	24	1.2	51.36*
misty grouper	1	0	0	0	1	0.1	
snowy grouper	3	1	2	2	8	0.4	
Warsaw grouper	2	2	1	2	7	0.4	
almaco jack	2(7.0)	4(4.9)	2(3.9)	13(5.2)	21	1.1	16.36**
bar jack	1	0	0	0	1	0.1	
greater amberjack	120(48.2)	5(33.3)	0(27.0)	19(35.5)	144	7.3	165.67**
blackfin tuna	62(29.1)	4(20.1)	15(16.4)	6(21.4)	87	4.3	61.29**
bluefin tuna	1	0	0	0	1	0.1	
bonito	8	0	0	0	8	0.4	
bullet mackerel	1	0	0	10	11	0.6	
little tunny	51(107.1)	170(74.1)	70(60.0)	27(78.8)	320	16.3	187.16**
skipjack tuna	5(7.7)	6(5.3)	8(4.3)	4(5.7)	23	1.2	4.73ns
cero	8	2	0	3	13	0.7	
king mackerel	55(93.4)	63(64.6)	113(52.3)	48(68.7)	279	14.2	92.51**

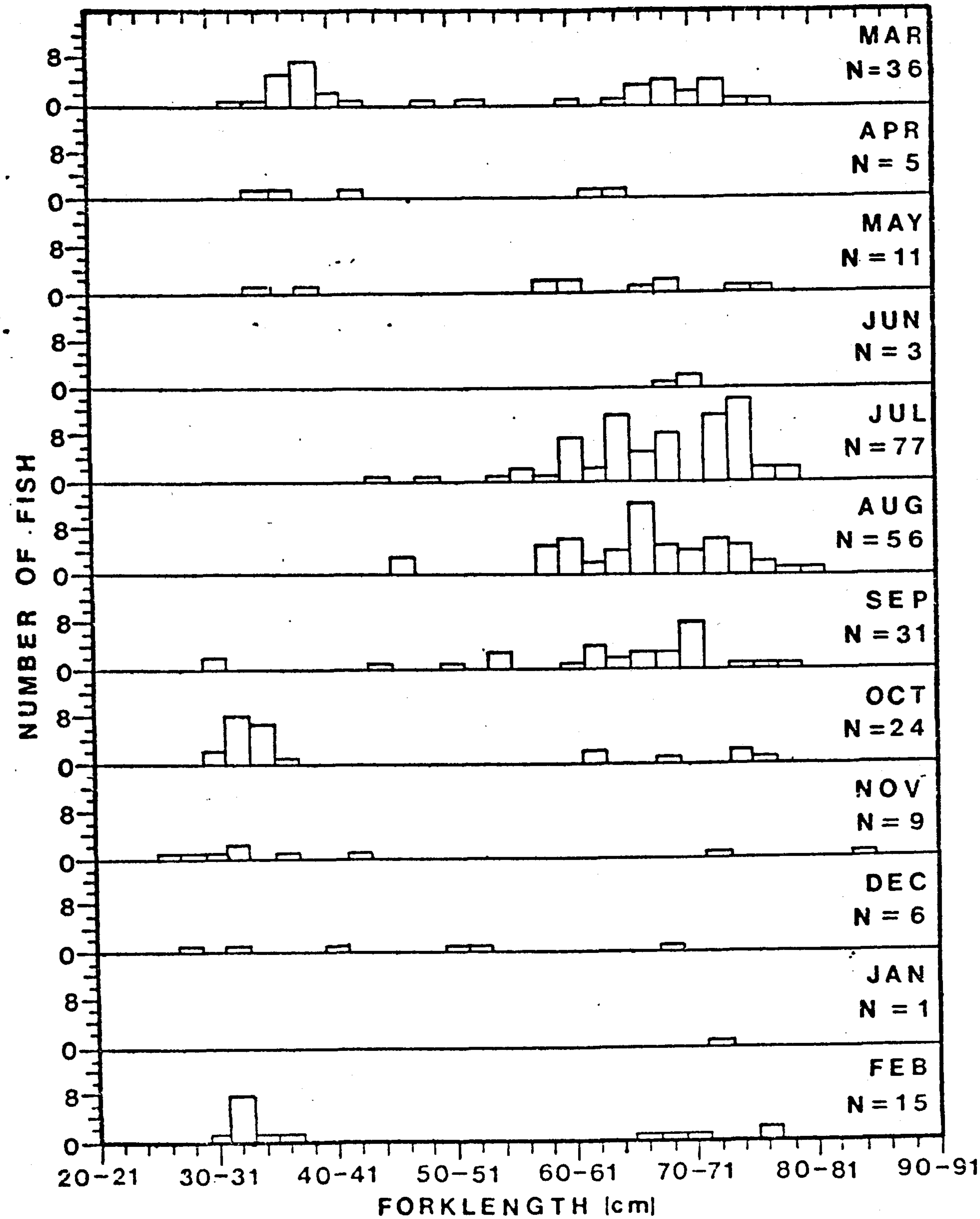


Figure 72. Length frequency by month of little tunny (N=320) from Gentle, 1977.

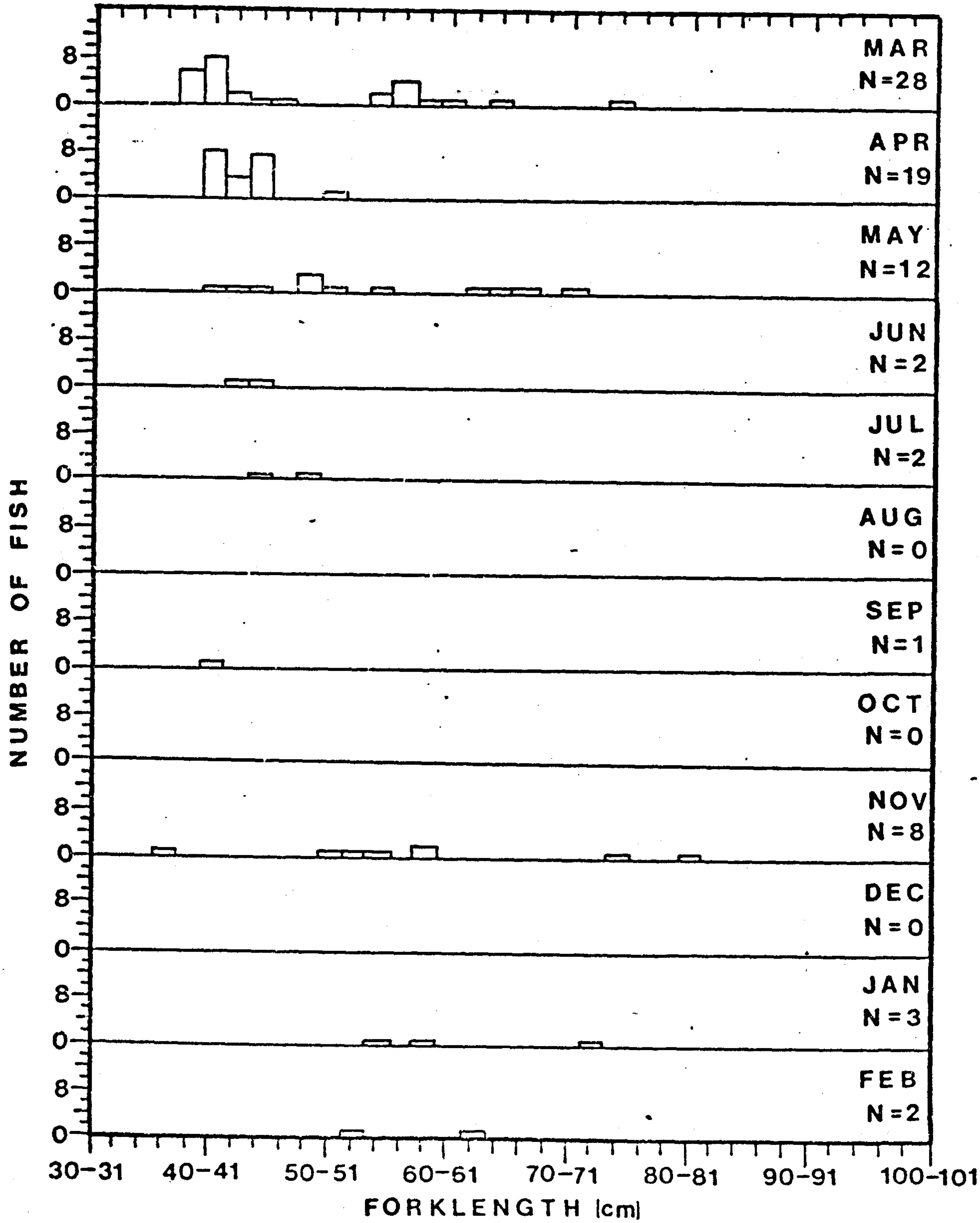


Figure 73. Length frequency by month of blackfin tuna (N=87) from Gentle, 1977.

The purpose of this study was to gather biological and life history data on sport fishes and to ascertain the economics of the fishery in Dade County, which was estimated to be $5.1 million in 1977.

3) Northwest Florida Area - Destin: Another area of abundance for recreational fishermen is the panhandle area of Florida. Irby's 14-month (1970-71) study of the Choctawhatchee Bay and adjacent Gulf waters reported that little tunny was the third (9.9%) most abundant species caught in the Gulf of Mexico. Blackfin tuna was relatively insignificant, comprising only 0.1% of the total catch. Irby further stated that 69% of the effort in the area was from charter- and party boats from Destin fishing for king mackerel. This again supports the contention that "small" tuna catches are primarily made as incidental catches because no mention was made of the nearly 10% captures of little tunny while specific mention was made of king mackerel being the mainstay of the "for-hire" fleet. The purpose of the Choctawhatchee area survey was to obtain information that could be used to mediate controversies between recreational and commercial fishermen.

4) Panama City: Sutherland (1977) determined the catches and catch rates of recreational anglers during 1973 for the St. Andrews Bay and adjacent waters. Little tunny were caught by anglers at two shore locations and from bay and coastal waters. No catches of blackfin tuna were reported, nor were any data given for numbers or catch rates for little tunny. This survey of the St. Andrews area was conducted to provide fishery managers with baseline information with which to evaluate future trends.

5) Panama City - 1970, 1971-79: Long-term percent composition (Fable et al., 1981, our Table 39) and catch rate data are best portrayed for this area by the charterboat records (Fable et al., 1981). Little tunny constituted 5.3% of their catch for this period and ranked fourth among the top seven species captured (Fig.

Table 39. Catches of coastal pelagic fishes from the Fu-Lin-Yu II by trolling in the Panama City, Florida, area (Fable et al., 1981).

	Year (and hours fished)																		
	1970 (552)		1971 (550)		1973 (495)		1974 (329)		1975 (592)		1976 (589)		1977 (676)		1978 (706)		1979 (781)		
Species	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Total
King mackerel *Scomberomorus cavalla*	2,263	92.9	1,963	86.9	1,400	81.5	650	81.5	2,270	88.4	1,426	65.3	976	38.7	909	18.9	1,742	57.2	13,599
Atlantic bonito *Sarda sarda*	18	0.7	0	0.0	1	0.1	2	0.3	8	0.3	9	0.4	742	29.5	2,266	47.0	216	7.1	3,262
Bluefish *Pomatomus saltatrix*	12	0.5	62	2.7	0	0.0	2	0.3	71	2.8	68	3.1	79	3.1	611	12.7	296	9.7	1,201
Blue runner *Caranx crysos*	15	0.6	0	0.0	109	6.3	27	3.4	11	0.4	381	17.5	150	5.9	290	6.0	205	6.7	1,188
Little tunny *Euthynnus alletteratus*	75	3.1	126	5.6	77	4.5	31	3.9	68	2.7	111	5.1	193	7.7	266	5.5	231	7.6	1,178
Spanish mackerel *Scomberomorus maculatus*	45	1.9	70	3.1	53	3.1	23	2.9	69	2.7	7	0.3	130	5.1	212	4.4	231	7.6	840
Dolphin *Coryphaena hippurus*	1	0.0	37	1.6	55	3.2	38	4.8	46	1.8	151	6.9	237	9.4	176	3.7	93	3.1	834
Ladyfish *Elops saurus*	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	19	0.9	0	0.0	79	1.6	8	0.3	106
Blackfin tuna *Thunnus atlanticus*	0	0.0	0	0.0	16	0.9	21	2.6	18	0.7	0	0.0	0	0.0	0	0.0	1	0.0	56
Crevalle jack *Caranx hippos*	5	0.2	0	0.0	7	0.4	1	0.1	6	0.2	3	0.1	3	0.1	6	0.1	20	0.7	51
Cobia *Rachycentron canadum*	1	0.0	0	0.0	0	0.0	0	0.0	0	0.0	5	0.2	6	0.2	2	0.0	4	0.1	18
Greater amberjack *Seriola dumerili*	0	0.0	0	0.0	0	0.0	3	0.4	1	0.0	3	0.1	0	0.0	0	0.0	0	0.0	7
Wahoo *Acanthocybium solanderi*	2	0.1	0	0.0	0	0.0	0	0.0	1	0.0	0	0.0	2	0.1	1	0.0	0	0.0	6
Great barracuda *Sphyraena barracuda*	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0	1	0.0	1	0.0	3
Total	2,437		2,258		1,718		798		2,569		2,183		2,519		4,819		3,048		22,349

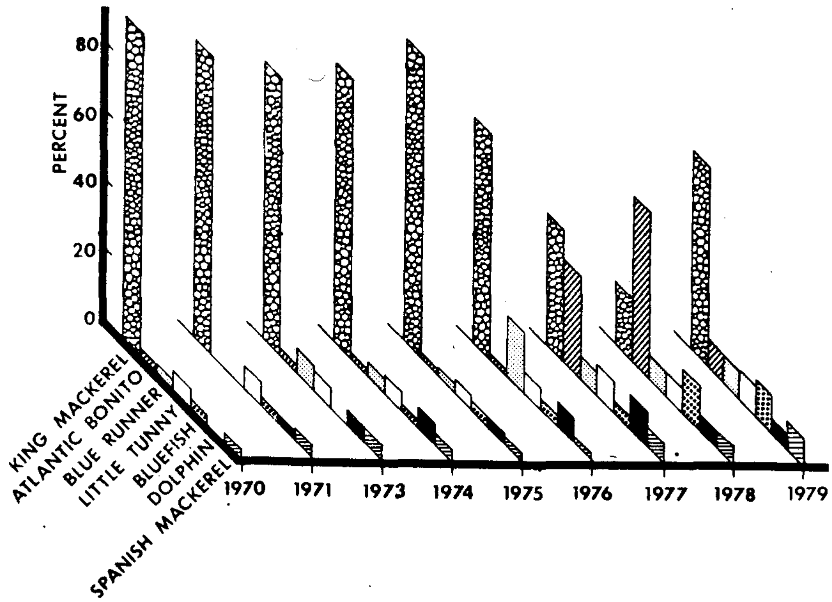


Figure 74. Percent composition of the seven most abundant species caught off Panama City, Florida, 1970-1971 and 1973-1979 (Fable et al., 1981).

74). Blackfin tuna were less than 0.5% of the catch. Again, this report emphasizes the importance of the king mackerel to the charterboat fleet. Nevertheless, the little tunny were important and regular contributors to anglers' successful trips. Fable et al. (1981) discussed the probable effect on charterboat catches of two winters having lower than usual temperatures.

6) Lousiana, Grand Isle, and Fourchon: Captures of little tunny, nearshore, and blackfin tuna, from blue water, characterize the areas of capture for these species off Louisiana. No other data were given on captures, although CPUE of 30 species and frequency of their occurrence were given. The paper of Table et al. 1981) also offers baseline information about species and catch rates from and adjacent to oil rigs off the Mississippi Delta.

7) Texas, three coastal areas: The charterboat and head-boat fishery was surveyed from September 1978 then August 1979 from upper, middle, and lower coastal areas off Texas (Mc Eachron and Matlock, 1983). Thirty four species of fishes caught by charterboats were listed. No information was given about "small" tunas. The information was obtained and analyzed to provide fishery managers with data for decisions regarding conservation. The Gulf of Mexico Fishery Management Council reported highly dispersed but significant amounts of recreational fishing off Texas but no specifics were given on catches there.

8) South Atlantic and Gulf of Mexico: Nine charterboat captains from five ports provide catch records for nine months (10 for Key West) (Brusher et al., 1984, our Table 40). In 4392 hours of trolling 1257 little tunny and 82 blackfin tuna were captured. Most little tunny were taken from inshore waters of less than 10 fathoms and all blackfin tuna were captured in depths of over 10 fathoms. This was a successful pilot study which sought to determine the practicality and reliability of using catch records from charterboats to obtain daily catch and effort data.

Table 40. Number of each species of species group caught by trolling in relation to area and fishing zone during the 1982 charterboat survey of the southeastern U.S. (Brusher et al., 1984).

Common name	Scientific name	North Carolina 1	North Carolina 2	North Carolina 3	North Carolina C	South Florida 2	South Florida 3	South Florida C	Northwest Florida 1	Northwest Florida 2	Northwest Florida 3	Northwest Florida C	Louisiana 1	Louisiana 2	Louisiana 3	Louisiana C	South Texas 1	South Texas 2	South Texas 3	South Texas C	Total Catch
Dolphin	*Coryphaena hippurus*			5,238		35	2,229	69		156	21	31			2,779			32	65	11	10,666
Bluefish	*Pomatomus saltatrix*	250	1,045	944	71				235	1		78		1	51	1		3			2,680
King mackerel	*Scomberomorus cavalla*			475		34	89	24		244	128	41			32			641	217	130	2,055
Spanish mackerel	*Scomberomorus maculatus*					1		1	239	275	1	455	9	15	327	13		393	2	8	1,739
Little tunny	*Euthynnus alletteratus*			262		31	86	13	98	431	6	113		2	162	32		20	1		1,257
Blue runner	*Caranx crysos*					1	2	2	6	406	2	629		1	139	5					1,193
Yellowfin tuna	*Thunnus albacares*			1,078			1								12						1,091
Great barracuda	*Sphyraena barracuda*					185	213	416				1			10						825
Atlantic bonito	*Sarda sarda*			26		1	81	12		42	1	74									237
Red drum	*Sciaenops ocellatus*								17				9	43	134	13			1		217
Crevalle jack	*Caranx hippos*						4	7				4		1	65	11		85	1		178
Yellowtail snapper	*Ocyurus chrysurus*					36	26	110													172
Wahoo	*Acanthocybium solanderi*			52		2	43	2							57						156
Cero	*Scomberomorus regalis*					30	63	59													152
Skipjack tuna	*Euthynnus pelamis*			114			1														115
Greater amberjack	*Seriola dumerili*						10	1		35	9	10			20			4			89
Blackfin tuna	*Thunnus atlanticus*			46		3	16	1				1			14	1					82
Cobia	*Rachycentron canadum*									2	1	4			8			37	1	19	72
White marlin	*Tetrapturus albidus*			70			1								1						72
Ladyfish	*Elops saurus*									37		24									61
Black grouper	*Mycteroperca bonaci*					6	7	29		8											50
Atlantic sharpnose shark	*Rhizoprionodon terraenovae*																	23	13	10	46
Sailfish	*Istiophorus platypterus*			3		1	28	6										1			39
Blacktip shark	*Carcharhinus limbatus*						1								3			20	8	3	35
Red snapper	*Lutjanus campechanus*																	6	22	3	31
Unident. sharks	*Squaliformes*			1			6								10			8			25
Bluefin tuna	*Thunnus thynnus*			20																	20
Gray triggerfish	*Balistes capriscus*			1					1	8	3	5						1			19
Albacore	*Thunnus alalunga*		5	4	9																18
Mutton snapper	*Lutjanus analis*					4	3	10													17
Blue marlin	*Makaira nigricans*			10			4														14
Spinner shark	*Carcharhinus brevipinna*														7					1	8
Tripletail	*Lobotes surinamensis*						4								3			1			8
Almaco jack	*Seriola rivoliana*														7						7
Silky shark	*Carcharhinus falciformis*						6														6
Red grouper	*Epinephelus morio*							5													5
Bar jack	*Caranx ruber*					1		3													4
Gag	*Mycteroperca microlepis*					2		1													3
Horse-eye jack	*Caranx latus*							3													3
Seatrout	*Cynoscion* sp.																3				3
Lesser amberjack	*Seriola fasciata*																	2			2
Gray snapper	*Lutjanus griseus*						1			1											2
Hammerhead shark	*Sphyrna* sp.			2																	2
Mako	*Isrus* sp.		1	1																	2
Rainbow runner	*Elagatis bipinnulata*					1		1													2
Dusky shark	*Carcharhinus obscurus*					1		1													2
Unident. triggerfish	Balistidae														2						2
Houndfish	*Tylosurus crocodilus*														1						1
Scamp	*Mycteroperca phenax*									1											1
Spadefish	*Chaetodipterus faber*																	1			1
Tarpon	*Megalops atlanticus*						1														1
Total		250	1,051	8,347	80	375	2,926	776	598	1,647	172	1,470	18	63	3,844	76	3	1,278	331	185	23,488

1 = Estuarine, 2 = Oceanic (< 10 fm), 3 = Oceanic (> 10 fm), and C = Combination of 1, 2, and/or 3.

c. **Fishing techniques**

1) Little tunny: Caught principally by trolling, also by casting at schools from boats. A few captures are made by casting from shore. Whole baits, strip baits, and small lures such as spoons, feathers jigs, and plugs are used (IGFA, 1979, 1986).

2) Blackfin tuna: Caught by trolling or casting at schools from boats. Ballyhoo, mullet, and other small fish and strip baits are used; spoons, feathers, jigs, and plugs are also employed. The use of yellow feathers has been mentioned as a preference in some area (IGFA, 1979, 1986, Mowbray (1956) recommended trolling methods and red-lure choices for small tuna based on experiences off Bermuda.

3) Fly-lining: Brusher et al. (1984) explained that pelagics including small tunas are caught off Louisiana by drifting a live bait on an unweighted line from a boat tied to an offshore structure. Such boats were not moving under power and thus those fly-lining captures were not listed under trolling catches.

d. **Artificial attractants**

Fish-aggregating devices (FADs) have been used successfully to concentrate pelagic fishes of recreational importance in many different regions, and de Sylva (1982) described different surface and midwater FADs to attract harvestable concentrations of pelagic species.

Wickham et al. (1973) reported that artificial midwater structures attracted pelagic game fishes and improved sportfishing catch rates off Panama City, Florida, in summer, 1971. Significantly greater catch rates of little tunny were made near midwater structures than in control areas (Table 41). The deployment of artificial structures was shown to be an effective method of improving catches for sport fishermen. The attractive differences of three FAD designs and fish

Date 1971	Sampling area	Hours fished	Little tunny *E. alletteratus* Number caught	Little tunny *E. alletteratus* Catch per hour	King mackerel *S. cavalla* Number caught	King mackerel *S. cavalla* Catch per hour	Spanish mackerel *S. maculatus* Number caught	Spanish mackerel *S. maculatus* Catch per hour	Dolphin *C. hippurus* Number caught	Dolphin *C. hippurus* Catch per hour	All species combined Number caught	All species combined Catch per hour	All species combined Number of strikes	All species combined Strikes per hour
August	All stations (18 meters)													
ase I	Control areas	20	5	0.25	0	0	0	0	0	0	5	0.25	12	0.60
	Single structures	10	4	0.40	1	0.10	0	0	0	0	5	0.50	12	1.20
	Multiple structures	10	6	0.60	12	1.20	0	0	1	0.10	19	1.90	38	3.80
4 August	Station I (18 meters)													
ase II	Control area	5	4	0.80	2	0.40	1	0.20	0	0	7	1.40	9	1.80
	Multiple structure	5	8	1.60	6	1.20	1	0.20	0	0	15	3.00	63	12.60
	Station II (26 meters)													
	Control area	5	1	0.20	0	0	0	0	4	0.80	5	1.00	9	1.80
	Multiple structure	5	3	0.60	1	0.20	0	0	51	10.20	55	11.00	137	27.40
	Station III (32 meters)													
	Control area	5	6	1.20	1	0.20	0	0	0	0	7	1.40	9	1.80
	Multiple structure	5	4	0.80	0	0	0	0	31	6.20	35	7.00	89	17.80

ncludes strikes which resulted in catches.

Table 41. Summary of catches, strikes and effort for experimental trolling around midwater artificial structures and control areas during Phases I and II (from Wickham et al., 1973).

the number of bait fish attracted and increased thereby the catches of little tunny and other pelagic species by Workman et al. (1985). They found that FAD deployment attracted harvestable concentrations of recreationally important species but blackfin tuna were sighted only once by these observers.

Installation of FADs is considered to be a method of concentrating fishes, thereby increasing catch rates, reducing scouting time, lowering costs, and enhancing the pleasure of recreational fishing. Bioeconomic models that consider varying levels of fishing effort and different reductions of fish stocks indicate that FAD deployment will not increase fishermen's profits if the fishery is open-access and unregulated as to effort (Samples and Sproul, 1985). Options for managing the fishing effort at FAD locations are considered.

e. Catch statistics

The number of blackfin tuna and little tunny caught and the catch rates per hour of trolling from charterboats are given in Appendix II, and are graphs and tables representing computer-generated programs of sport fishing catches from the southestern U.S. and Gulf of México. The sources of these data are the excellent voluntary charterboat surveys conducted by the Panama City Laboratory of NMFS and published as several NOAA Technical Memorandum (see Williams et al., 1985; Brusher and Palko, 1986). The 1982 data were provided separately for our analysis from the Computerized Data Base System of the NMFS/SEFC, Panama City Laboratory, Panama City, Florida.

Brusher and Palko (1985) warned against generalizing from these data because: 1) the effort distributed by fishing zone and the trolling fishing method may not be representative of the overall region; 2) their classification of fishing methods omits certain pelagic captures from the trolling category; 3) the CPUE probably reflects species targeted by charterboat clients rather than abundance; 4) species identification errors may have occurred even after careful checking. Nevertheless, this is the most authentic and continuous data base available.

Quarterly length-frequency distributions of little tunny and blackfin tuna from Beardsley and Richards (1970) are depicted in Figures 75 and 76. These were recreationally caught fish from south Florida during 1967-68.

A weight-frequency distribution supplementing those data (see Figure 77) has been prepared from unlimited test-line data for blackfin tuna caught during the five-month metropolitan South Florida Fishing Tournament. The weight range of these tournament-entered catches was from 14 pounds (6.4 kg) to 29 (13.2 kg) pounds.

It is important to note that the published studies previously mentioned under the heading "Users" also contain statistics pertaining to seasonal and areal catches of blackfin tuna and some instances of catch rate.

f. Economic benefits

We have not attempted to determine a value of the little tunny-blackfin tuna recreational fishing because: 1) the catches are totally opportunistic, 2) the reported data on catches and effort are not comparable, and 3) published economic values of the recreational small tuna catches (largely only for charterboat captures) are out of date.

The Marine Recreational Fishery Statistics Survey, Atlantic and Gulf coasts, 1985, provides the most recent information on the recreational fisheries in the region. Summaries of certain of these statistics are given in Thompson (1986). The very substantial increase in numbers of fishermen in both the south Atlantic and Gulf of Mexico subregions is probably the most significant statistical finding in these reports. In the Gulf subregion 4.0 million residents fished in 1985, considerably higher than the 1979-84 mean of 2.9 million. For the south Atlantic,

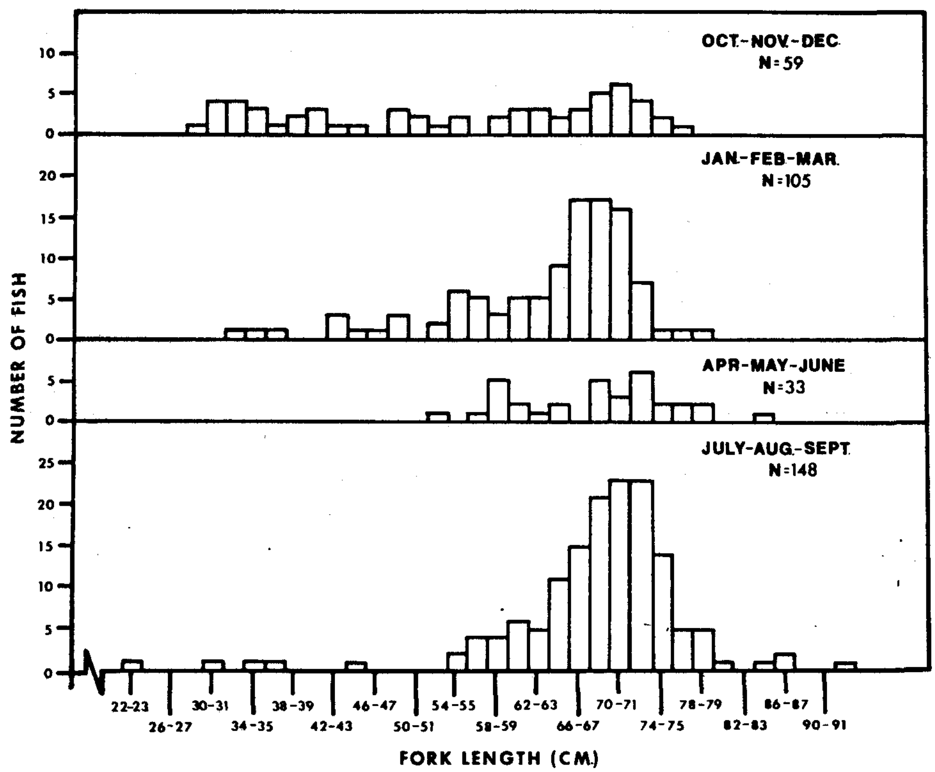


Figure 75 Length frequency distributions by quarters of the year for little tunny sampled from a taxidermy plant in south Florida from September 1967 through September 1968 (Beardsley and Richards, 1970).

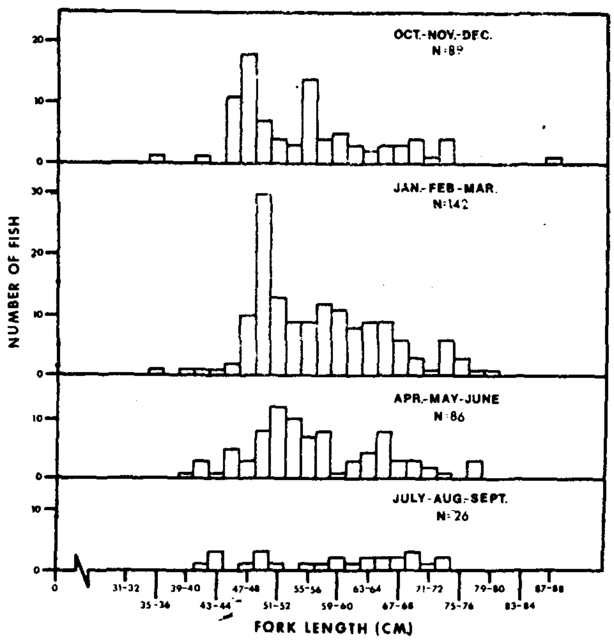


Figure 76. Length frequency distributions by quarters of the year for blackfin tuna sampled from a taxidermy plant in south Florida from September 1967 through September 1968 (from Beardsley & Richards, 1970).

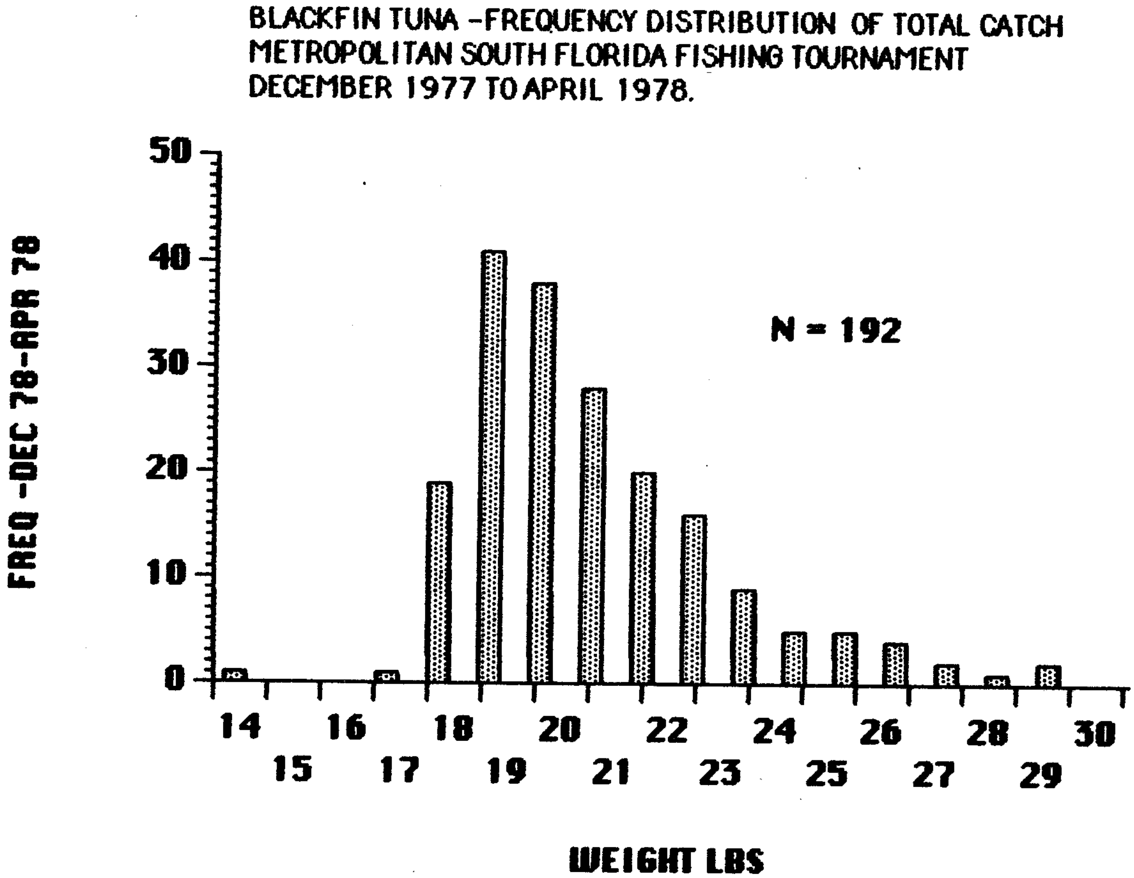


Figure 77. Blackfin tuna (all-tackle) frequency distribution of total catch Metropolitan South Florida Fishing Tournament, December 1977 to April 1978 (N=192).

2.4 million residents fished in 1985 compared to 2.1 the mean number for the preceding five-year period. These accelerating effort statistics certainly cry for development of fishing for alternative species and judicious, fair management regulations.

That a single species or several species does not dominate these subregional fisheries statistics also seems significant in terms of satisfaction to the angler. In the North Atlantic subregion three species clearly account for 50% of the catch. In the Gulf, one extremely large species group--the sciaenids--dominates the catch while no species group dominates in the south Atlantic. Anglers in the southern regions may find no temporary diminution of their fishing experience because of the greater number of species potentially available. More northerly anglers with few species could find fishing the less rewarding should adverse conditions or man's activities cause reduction in population abundance.

G. Fishery synopsis of "small" tunas

a. Users

Interest in use of blackfin tuna and little tunny has been limited due to a number of factors. Miyake (1981) listed low value, local nature of fishery, and lack of attraction to industrialized (processing industry) users. In spite of these factors, limited regular use has existed. Hildebrand (1981) indicated that over one million pounds of blackfin tuna had been landed from Texas waters during 10 months of 1980. Japanese market potential was identified by Smith (1980). It was expressed that this species was of interest in the raw fish (sashimi) market there. An earlier reference (Anonymous, 1970) also documented Japanese interest in the use of blackfin as sashimi and speculated on the possibility of propagation and rearing of this small tuna species.

Little tunny has long been valued as a source of bait, particularly for snapper fishing. Intermittent use for canning has been indicated (Carlson, 1952, Serventy, 1941). Due to confusion in identification and statistical classification there is a lack of clarity concerning the volume of little tunny being processed as a canned product. However, there is a strong suggestion that a quantity enters the pack of canned tuna product produced in southern Europe. It has been indicated (R. Juhl, personal communication, 1986) that pet food producers in the United States have considered little tunny as a raw material.

Wise (1985) discussed the "serious under-reporting" in the data available for "small" tunas from the Atlantic. Little tunny and blackfin tuna are listed as important components of this collective group. He provided reasoning which illustrates the probability that omissions and under-reporting occur regularly.

b. Fishing techniques

Due to the limited demand and scattered nature of the little tunny and blackfin tuna resources, a well-defined and clear picture of fisheries and techniques is lacking. Most of the catch is taken incidentally to directed fishing for other species. For an understanding of the overall problem see Wise (1985).

c. Vessels

Wise (1985) summarized the work of many authors and indicated that seine fishing directed for other species often produces catches of little tunny which are sometimes discarded due to the lack of market interest. These observations were made in the eastern Atlantic off Africa. Incidental captures by gill net were recorded by Trent and Pristas (1977) in the waters off northern Florida. Carlson (1951) mentioned handlining as an incidental catch method by the Tortugas (Florida) shrimping fleet. The same author (1951, 1952) reviewed the incidental catch by menhaden seiners. Hildebrand (1981) mentioned the catch of blackfin tuna using handlines off Texas from shrimp vessels and this method was recorded (Anonymous, 1967) for the northeast coast of Honduras. Catches of blackfin tuna have been recorded by longline vessels (Anonymous, 1970), although catches by this technique are not normally significant. Troll-fishing from vessels not necessarily designed for trolling probably accounts for most of the catches of this species. In the Caribbean, Wagner and Wolf (1974) indicated that more blackfin tuna were captured by trolling than any other method. Oswald (1983) reported similar experiences off Jamaica where over 50% of troll-catches comprised blackfin tuna. It is also mentioned by the same author that a converted 43-foot shrimp trawler could be considered as an economically viable vehicle for troll-fishing in that area (Jamaica). Juhl et al. (1970) reported on experimental fishing in the western tropical Atlantic by state-of-the-art tuna vessels, NORMANDIE (140-foot bait vessel) and the QUEEN MARY (153-foot seiner), although limited success was experienced.

d. Fishery techniques

1) Detection

Various surveys by experimental vessels (Anonymous, 1953-1970; Juhl, et al. 1970; Idyll, 1971) suggest that water color, bird flocks, and troll-captures offer the basis for detection of both little tunny and blackfin tuna. The above sources and other undocumented information strongly suggests that little tunny are most often found in "green" or turbid water (de Sylva and Rathjen, 1961) over the continental shelf typically associated with large continental masses. Blackfin tuna, on the other hand, are usually expected in "blue" water which is clearer. It is usually agreed that the two species are normally separated. Bird-flock activity is a primary indicator of blackfin tuna presence. Oswald (1963) suggested that the trolling technique was most effective along the edges of steep bank edges, particularly when the current was flowing onto the bank from deep water. Carlson (1952) observed that off the east coast of Florida during the summer months, little tunny were frequently found over depths of 10-15 fathoms at distances of 5-50 miles offshore, particularly at locations where there was evidence of uneven bottom.

2) Capture

From the information available in the literature the most regular capture mode appears to be troll-fishing; Wagner (1974), Oswald (1963), Carlson (1951, 1952), and others attest to this for blackfin tuna and for little tunny. Seining has been advocated for catching little tunny (Carlson, 1952) and blackfin tuna (Juhl et al., 1970). However, with some few local exceptions this has not been a regular occurrence. Wise (1985) offered a variety of information which indicates seine by-catch is a frequent means of producing both species, particularly little tunny in the eastern Atlantic. Occasional longline catches of blackfin tuna (Anonymous, 1970) do not appear to represent significant promise for regular catches. Likewise, although gill-net captures of little tunny have been recorded (Miyake, 1981), it is not likely that this will be a regular, productive mode of fishing. The primary harvest mode in Cuba is with the live-bait/jack-pole technique, and, while this method has been successful there for over 40 years, it has not been that productive elsewhere (Wagner, 1974) on a regular basis. Whiteleather and Brown (1945), Morice and Cadenat (1952), and Marcille (1985) reported catches of little tunny with seine nets in the eastern Caribbean. Beach seines have also produced little tunny off Cape Hatteras, N.C., in the fall of the year Carlson (1951). Occasional but significant catches by handline around shrimp vessels have been reported by Carlson (1951) for little tunny and by Hildebrand (1981) and Anonymous (1967) for the Texas coast and northeast Honduras, respectively. Trolling is a regular production method off eastern Brazil where the fishery is productive in coastal waters from November and December (da Cruz and Paiva, 1964). During the 1960's a considerable amount of attention was given to the possible potential for blackfin tuna by the Bureau of Commercial Fisheries. These data are summarized by Maghan and Rivas (1971), who advocated experimental seining for blackfin tuna.

3) Artificial devices

It has been observed (by Rathjen) during a cruise of the OREGON (Anonymous, 1956) that large aircraft-tire inner tubes used as floats during longline operations accounted for the aggregation of bait which in turn attracted blackfin tuna which could then be trolled or handlined. Attraction devices deployed in the northern Gulf of Mexico (Klima and Wickham, 1971; Wickham et al., 1973) suggest the utility of this technique. These devices, known collectively as FADs are reviewed by de Sylva (1982) and Bergstrom (1983). Carlson (1951, 1952) and others suggest that chum may be a useful approach to attracting little tunny. These techniques offer some potential to aggregate the often scattered small schools of both little tunny and blackfin tuna.

4) Gear/methods

Collette and Nauen (1983) have pointed out that trolling is the major method used for blackfin tuna in the important sport fisheries of the Bahamas and off Florida. Cruise 118 of the OREGON in May and June 1967 (Anonymous, 1967) demonstrated that multiple-line trolling at slow speeds (5 knots) were productive in capturing blackfin (245/1,346 pounds) and little tunny (47/197) pounds. The UNDP Caribbean Fisheries Development Project (Wagne and Wolf, 1974) determined that the blackfin tuna was more abundant to troll-gear captures than other species taken. Oswald (1963) reported similar experience for waters near Jamaica. Innovative trolling demonstrations (Yesaki, 1977 and Yamaha Fishery Journal, 11, 1980) is one approach which is recommended for demonstration fishing.

Another consideration in conjunction with troll experiments is the use of FADs or other aggregation devices to attract bait species (Wolf, 1974; de Sylva, 1982; Bergstrom, 1983; Anonymous, 1986). One hundred and fourteen blackfin tuna weighing 866 pounds were taken by trolling and handlines during the CALAMAR drift-cruise of 14 days, when the purpose of the drift from southeast of Barbados to St. Lucia was to attract commercial species.

Due to apparent water-transparency preferences, satellite technology may be particularly appropriate to consider for both little tunny and blackfin tuna exploitation (see for example NASA, 1986a and b; National Academy of Science, 1985). These developmental considerations must await increased demand for both or either of these species to justify commercial demonstration costs.

5) Future development

"The fisheries for blackfin tuna comprise around 1500-1800 tons a year (ICCAT, 1984), if one includes the Cuban fishery of about 500-700 tons per year, where this species is captured by pole and line and live bait at the same time as the skipjack tuna. The blackfin tuna is very little exploited in the Lesser Antilles and the potential catches are certainly greatly superior to the present catches (see our Fig. 78).

"The principal species are the blackfin tuna, little tunny, frigate mackerel, wahoo, king mackerel, and Spanish mackerel. In the zone of the Lesser Antilles and on the Venezuelan coast, the first two species undoubtedly offer the greatest potential for increase in catch.

"Catches of small tunas approach 4,000 tons per year in the Lesser Antilles and 6,100 tons per year in Venezuela, according to ICCAT, but these figures are probably incomplete since the statistics are lacking for several countries in which certain of them have significant fisheries. The catches per kilometer of coastline are estimated a 1.8 tons per year in the Lesser Antilles, if one bases this estimate on the available statistics (Table 14 of Wise in prep.) and 3.1 tons per year per kilometer of coastline in Venezuela. If one only considers that some six countries have furnished these statistics, one can arrive at a catch value extrapolated to the entire zone, permitting a 'real' catch estimate at 5,800 tons instead of 4,000 tons, or a total catch of about 12,000 tons for the entire region including Venezuela.

"The values of yield per kilometer can be compared to those of other countries bordering the Atlantic, and having active fisheries for small tunas; at Senegal and at Ghana, two countries in which the coasts are enriched by coastal upwelling, the annual yield approaches 10.5 and 13.0 tons per kilometer of coastline in the total potential apparently exploited. A productivity of 8 to 10 tons per kilometer could reasonably be applied to the Venezuelan coast, including the

Netherlands Antilles and Trinidad and Tobago, there being 2,800 kilometers of coast, and a production potential of about 20,000 to 30,000 tons per year. The productivity estimated for Martinique, 6.5 tons per kilometer per year, could be easily overestimated in its measurement because these also include catches of albacore and skipjack tunas; an average productivity figure of from 2 to 5 tons per kilometer per year of small tunas, without doubt, is more realistic, conveyed for the Lesser Antilles, at a potential of 6,000 to 7,000 tons per year (translation of Marcille, 1985). See our Table 42 and Figure 78 for estimates of potential production.

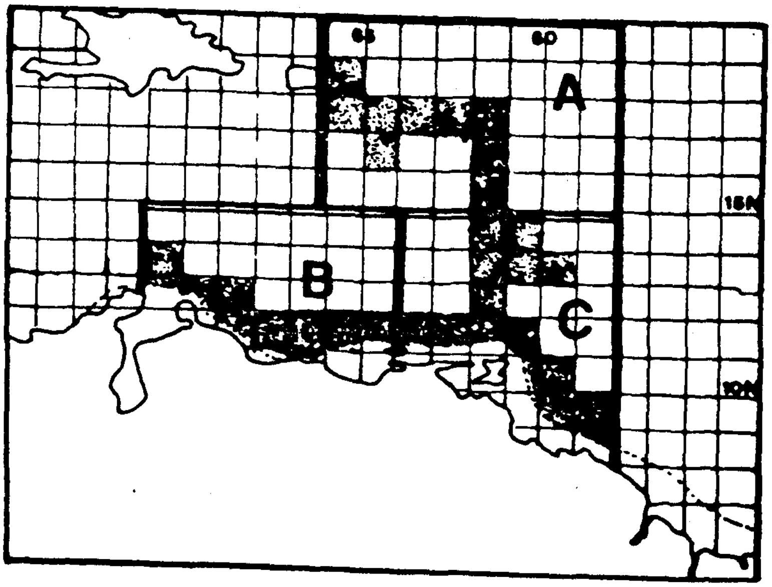


Figure 78. Zones A, B, and C with, in grey, the sectors considered as coastal or influenced by the island effect (Marcille, 1985).

Table 42. Potential catch and present catch (tons) of small tunas in the region of the Lesser Antilles and Venezuela (Marcille, 1985).

	Coast length (km)	Production est. (t/km/yr)	Annual potential, (t)	Present catch, (t)
Venezuela, Trinidad and Tobago; Netherlands Antilles	2,800	8 to 10	22,400 to 28,000	8,000
Lesser Antilles	1,400	4 to 5	5,100 to 7,000	2,000 to 4,000
Total	4,200		28,000 to 35,000	10,000 to 12,000

6) Processing Techniques

As the existing fisheries for both blackfin tuna and little tunny are nebulous and somewhat intermittent, there is very little specific documentation on processing and/or utilization techniques.

a) On board

An early reference to the Cuban fisheries (Rawlings,1953) indicated that the tuna (75% blackfin, 25% skipjack) taken from the Isla de Pinos fishery were preserved as eviscerated whole fish on ice for periods of 4 to 7 days. In Brazil the fish may be iced or not depending on circumstances, in that fishery trips are of short duration. Where little tunny or blackfin tuna are taken incidently by fishermen targeting on other tuna species, such as occurs off West Africa (Miyake, 1981) or on the high seas (Anonymous, Fish. News Intl., 1970), they are blast- or brine-frozen as is the practice with industrialized tuna fisheries (Finch and Courtney, 1963). Looking to possible future markets such as sashimi, handling-quality aspects must be stressed. There has been a very high level of concern for this objective in New Zealand where high-quality tuna have made an impact on international markets both in Japan and in the United States. In a recent review of essential handling considerations required for a superior quality product (Dubbin, 1986) suggested: 1) land the fish carefully, 2) kill the fish quickly, 3) bleed the fish properly, 4) gill and gut the fish properly, 5) slurry and cool the fish quickly, 6) trim the fish carefully, and 7) pack the fish in the hold to continue chilling on ice.

The same discussion (cited above) includes an opinion concerning the desirability of fish captured by longline due to reduced stress by that method as compared to other fishing techniques. The handling of blackfin tuna aboard the vessel is discussed by Smith (1980). A number of points are raised which include rapid killing of the fish, cleaning and washing of the body cavity, and immediate chilling of the eviscerated fish in ice. The maximum time tuna should be kept aboard the vessel is two days.

b) Preservation

Blackfin tuna mixed with skipjack was canned and marketed as bonito en aceite in Cuba during the early 1940's (Rawlings, 1953). Chilton (1949) mentioned that little tunny was canned in 1946 and 1947. Carlson (1952) noted that the same species was canned during World War II and mentioned interest during 1951 by a South Carolina packer in producing a canned product. Hildebrand (1980) referred to high mercury levels observed in blackfin tuna as a deterrent to its use as a canned product. Klawe (letter to Warren Rathjen, Aug. 7, 1986) indicated that little tunny can be canned and identified as "tuna." However, regulations established by the FDA (Food and Drug Administration) necessitate that the product be designated as "dark meat pack"; he goes on to say that the little tunny is acceptable as a raw material for canned pet food.

c) Chemistry

Little information is available on chemical analysis for these species. Some information pertaining to analysis on little tunny was supplied by Regier (personal communication, 1986); an appropriate exerpt is as follows:

"We do not have any chemical compositional data on the blackfin tuna, but some is available for the little tuna. Sidwell, in NOAA Technical Memorandum NMFS F/SEC-11, reported the following proximate compositions and averages (and ranges) for 5 samples of little tuna: 74.1% moisture; 25.3% protein (22.3-29.6); 4.0% fat (1.6-9.3); 1.7% ash (1.4-2.0). We have analyzed a couple of little tunny samples at Charleston, with the following results:

Date Caught	Source	Fork Length, cm	Wt., kg	Percent Moisture	Protein	Fat	Ash
9/82	Gulf	69	4.76	72.5	24.23	1.04	1.41
8/85	Atlantic	61	3.12	75.6	22.19	0.97	1.37
8/85	Atlantic	(same, cooked)		69.6	29.55	1.28	1.40

"The 8/85 sample of little tuna was evaluated for edibility characteristics by our sensory panel. The cooked sample was very dark (6.00 on a 7-pt. scale), and was relatively firm, flaky, and fibrous. The standard cooking method is in a boiling pouch and without seasonings. Flavor ratings were high for total flavor intensity (TIF) and for sourness, with a fairly high gamey rating."

d Product development

In a paper by Balachandran et al. (1982), it is pointed out that in India, the black or dark meat of mackerel tuna, Euthynnus affinis, is considered unsuitable for canning because of the dark color of the meat, unpleasant flavor, and poor yield. They pointed out that a variety of canned fish products including white and light-meat tuna canned with vegetables and spices to improve the flavor and appearance are popular in several countries. With this in mind, they used mackerel tuna caught with gill nets which were kept in ice until used for canning. Dry red chilly (Capsicum annum) was used to impart color and flavor to the canned product. After removing the seeds and stalk, the dry chilly and powdered well and gently warmed after suspending it in vegetable oil used as a canning medium, and then decanted. This was continued until most of the color was extracted and the combined oil extracts were filtered through fine cloth to remove solid particles; the concentrate thus prepared was suitably diluted with fresh oil. They discussed their method of canning. The tuna packed in spiced oil had a better appearance, as the brownish color of the meat was marked by the pigments of the chilly, whereas in the plain pack the brownish color of the meat was visible through the oil. Taste, flavor, and odor were better in the meat packed in spiced oil.

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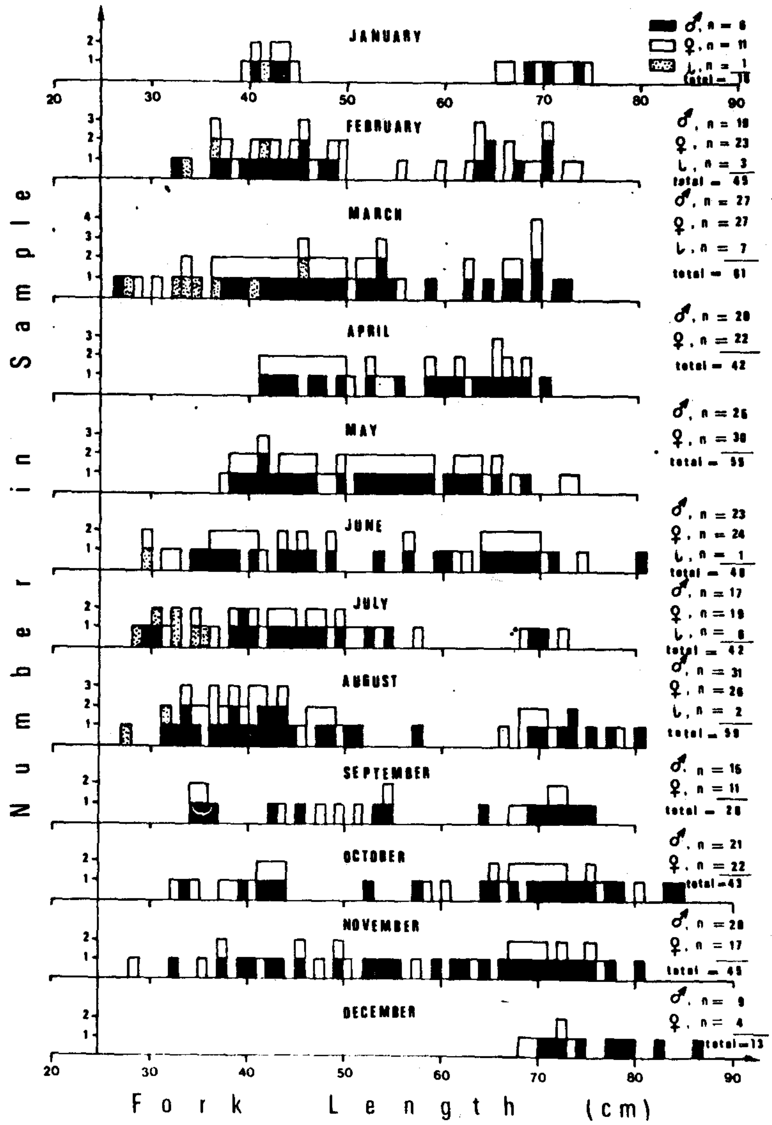
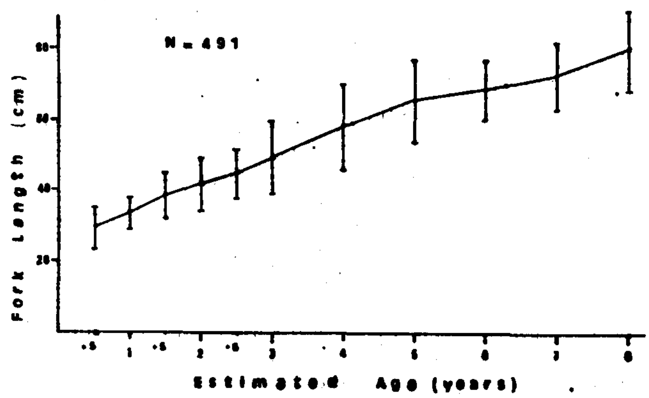
I. Appendix I.



Appendix I Figure 1. Fork lengths of monthly samples of 491 little tunny caught off Senegal during 1979 (Cayré and Diouf, 1983).

Appendix I Table 1. Estimated ages, corresponding mean fork lengths, interval of fork lengths, and standard deviation (SD) for males, females, and total samples (males, females, immatures) for 491 little tunny caught off the coast of Senegal during 1979 (Cayré and Diouf, 1983).

	Males				Females				Males, females, immatures			
Estimated age (yr)	*N*	Mean FL	FL intervals (cm)	SD	*N*	Mean FL	FL intervals (cm)	SD	*N*	Mean FL	FL intervals (cm)	SD
0.5	0				3	30.1	28.6-33.0	2.484	5	29.4	27.6-33.0	2.094
1	13	33.2	26.5-36.5	3.218	12	34.3	29.5-44.9	4.057	39	33.4	26.4-44.9	2.249
1.5	14	38.4	32.4-43.3	3.440	21	38.0	32.8-44.0	2.927	38	38.5	32.4-45.0	3.238
2	47	41.8	33.6-52.8	3.730	43	42.0	35.2-49.6	3.810	91	41.9	33.6-52.8	3.730
2.5	14	43.5	40.5-49.5	2.507	16	46.4	39.6-51.5	3.721	30	45.0	39.6-51.5	3.453
3	39	49.6	41.5-62.0	5.327	46	49.6	41.5-61.1	5.129	85	49.6	41.5-62.0	5.186
4	32	58.6	47.7-67.0	6.275	28	58.0	49.7-66.3	6.078	60	58.3	49.7-66.3	6.123
5	30	66.9	52.5-79.5	5.806	25	65.3	52.5-72.5	6.010	55	66.2	52.5-79.5	5.895
6	25	68.9	57.0-78.8	5.333	30	69.5	62.8-76.6	3.311	55	69.3	57.0-78.8	4.257
7	20	73.5	66.0-86.0	4.661	8	72.2	65.5-80.8	4.831	28	73.1	65.5-86.0	4.658
8	5	80.2	75.5-84.8	4.011					5	80.2	75.5-84.8	4.011
Total	239				232				491			



Appendix I Figure 2. Estimated age (years) and corresponding mean folk length (cm) ± standard deviation (vertical bars) for 491 little tunny caught off Senegal during 1979. (Cayré and Diouf, 1983).

Appendix I Table 2

LENGTH FREQUENCIES OF 827 LITTLE TUNA IN ANGLERS' CATCHES AT PIER 5, MIAMI, FLORIDA, FROM SEPTEMBER, 1952 TO AUGUST, 1953

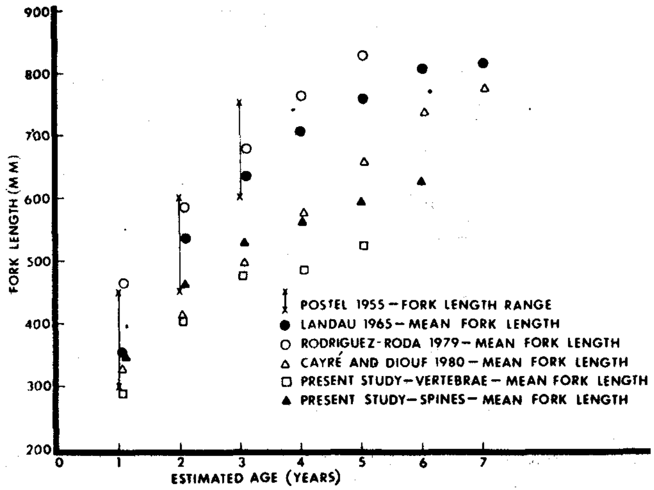
Class interval, fork length, mm	1952 Sept.	Oct.	Nov.	Dec.	1953 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Tot.
240-279	—	3	—	—	—	—	—	—	—	—	—	—	3
280-319	1	4	2	—	—	—	—	—	—	—	—	—	7
320-359	1	16	2	1	—	—	1	—	—	—	—	—	21
360-399	—	1	2	5	1	—	1	1	—	4	2	3	20
400-439	1	—	5	1	1	3	—	1	—	3	15	2	32
440-479	—	—	1	—	2	2	2	1	—	1	18	6	33
480-519	—	—	5	4	13	1	4	20	14	10	8	5	84
520-559	1	—	4	2	7	3	3	23	8	27	26	22	126
560-599	—	—	1	—	9	10	7	33	2	16	15	10	103
600-639	—	—	—	2	7	4	14	43	6	24	14	14	128
640-679	—	1	1	1	1	2	14	44	5	23	26	10	128
680-719	—	2	5	—	2	2	10	20	9	15	18	6	89
720-759	—	1	3	2	4	1	6	8	1	6	7	3	42
760-799	—	—	—	—	—	—	2	—	1	1	1	1	6
800-839	—	—	—	—	—	—	—	1	—	1	1	1	4
840-879	—	—	—	—	—	—	—	—	—	1	—	—	1
Total	4	28	31	18	47	28	64	195	46	132	151	83	827

(from de Sylva and Rathjen, 1961).

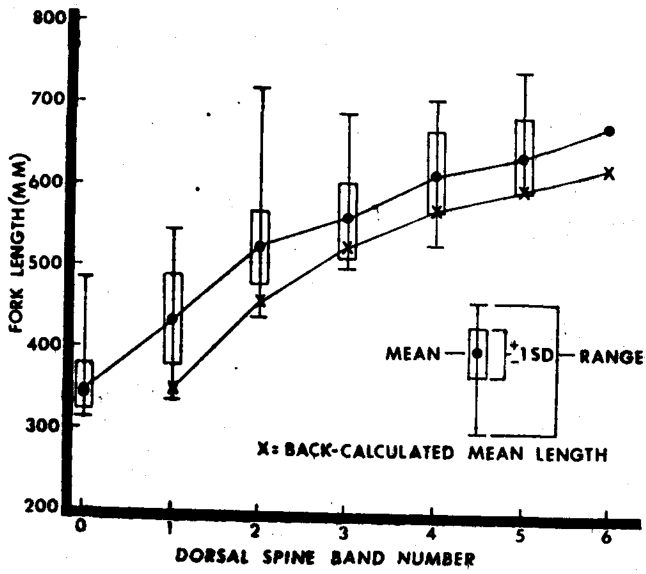
Appendix I Table 3. **Age-length and ag -weight relationship for** Euthynnus alletteratus in the Mediterranean Sea (from Landau 1965, table 1).

Age	Length (SL[1]) in mm		Approximate mean wt (kg)
	Range	Mean	
I	28-49	358.4	0.8
II	46-68	539.1	2.8
III	54-75	637.2	4.5
IV	61-79	701.9	6.0
V	65-84	755.0	7.5
VI	74-86	801.5	8.5
VII	75-84	810.0	9.0

[1]SL is standard length defined by the author as the distance from the snout to the insertion of the caudal fin.



Appendix I Figure 3. Summary of age-length information on little tunny (Cayré and Diouf, 1983).



Appendix I Figure 4. Length at capture and back-calculated length at spine band formation for little tunny from northwest Florida (Johnson, 1983).

Date	Locality		No. of larvae	Date	Locality		No. of larvae
	Lat.	Long.			Lat.	Long.	
February 1964	04°20'N	08°09'W	78	October 1964	04°23'N	01°04'E	3
	04°51'N	05°30'W	1		02°53'N	01°02'W	1
	05°02'N	03°53'W	2		03°38'N	02°00'W	1
	04°15'N	01°32'W	1		04°00'N	02°38'W	4
	02°45'N	01°30'W	4		04°09'N	03°10'W	5
	02°51'N	01°25'W	1	February 1965	07°57'N	16°53'W	1
	04°20'N	01°30'W	1		06°29'N	16°28'W	5
	04°30'N	00°54'W	5		06°15'N	16°29'W	1
	04°34'N	00°49'W	1		09°00'N	16°02'W	1
	05°31'N	00°10'E	2		06°11'N	15°30'W	1
	05°28'N	00°10'E	2		07°30'N	15°00'W	2
	04°48'N	00°01'E	4	February 1965	08°30'N	15°27'W	1
	04°59'N	01°00'E	15		08°14'N	15°00'W	7
	04°30'N	01°30'E	3		07°26'N	15°01'W	1
March 1964	04°31'N	01°55'E	2		07°00'N	14°29'W	1
	05°01'N	03°58'W	1		07°01'N	14°28'W	1
April 1964	04°32'N	05°01'W	5	March 1965	07°08'N	13°30'W	1
	04°56'N	01°11'W	11		07°03'N	13°06'W	1
	04°54'N	00°30'W	33		06°49'N	13°04'W	4
	04°15'N	00°33'W	1		04°35'N	02°32'W	3
	03°52'N	01°03'W	1		04°06'N	02°33'W	1
	02°55'N	02°04'W	10		04°20'N	01°59'W	1
	03°31'N	02°04'W	10		04°08'N	01°28'W	1
August 1964	04°20'N	06°59'W	2		04°10'N	00°29'W	1
	04°32'N	06°19'W	1		04°22'N	00°06'W	9
	05°00'N	04°30'W	1		05°35'N	00°32'E	3
	04°21'N	02°02'W	1		05°05'N	00°25'E	1
	04°18'N	01°09'W	1		05°59'N	01°30'E	2
	04°27'N	01°44'W	8		05°45'N	01°30'E	1
	06°00'N	01°39'E	1		05°53'N	01°58'E	1
	06°09'N	02°37'E	1		04°15'N	02°30'E	2
September 1964	02°30'N	07°57'W	1				
	03°50'N	06°41'W	5				

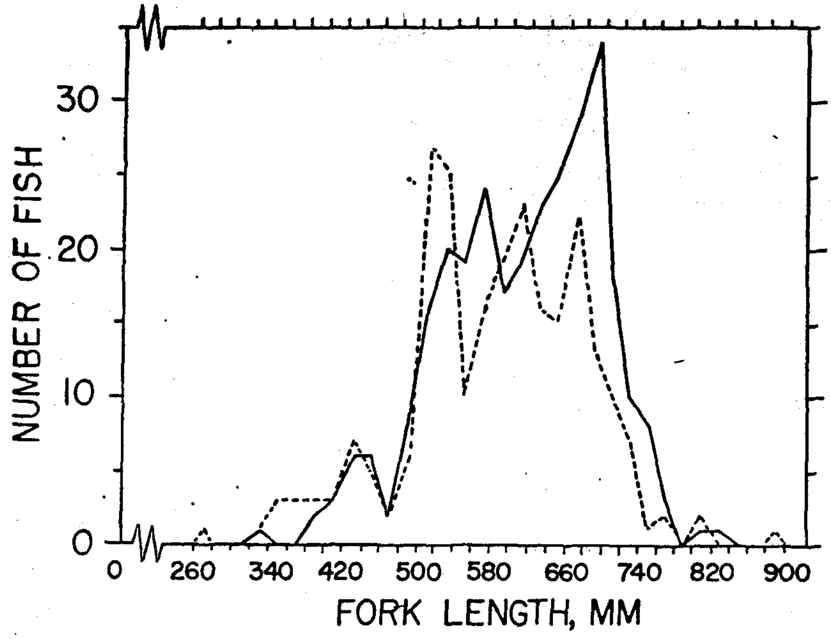
[1]Marine area code. See Rosa (1965).

Appendix I. Table 4. Record of larval Euthynnus alletteratus in the northwestern Gulf of Guinea and off Sierra Leone (ASE[1]) (from Richard et al., 1969a, 1969b, 1970).

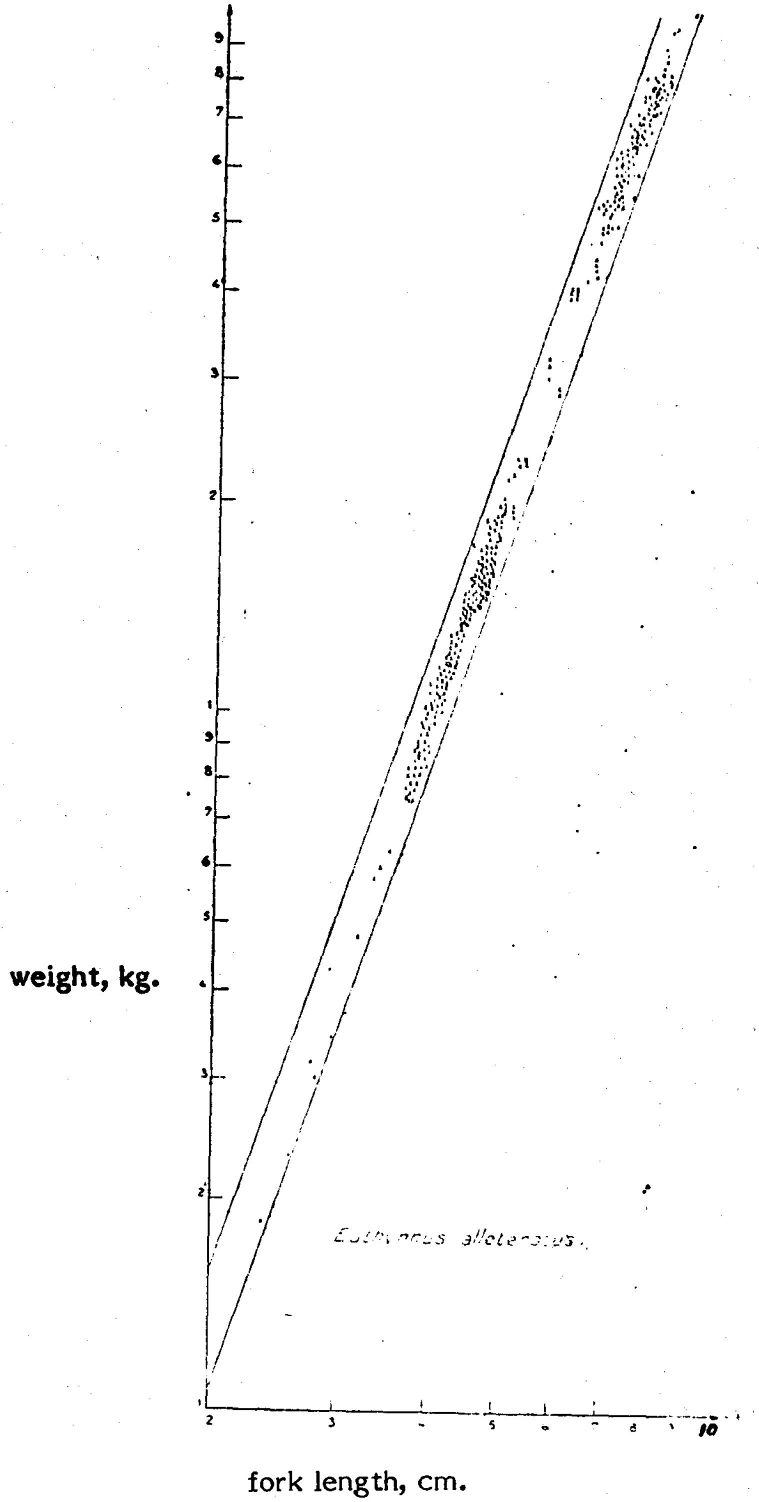
Date	Locality: Lat.	Locality: Long.	Marine area code [see Rosa (1965)]	Number: Larvae	Number: Juveniles	Length (mm)	Reference	Remarks
June 1920	18°00'N	64°14'W	ASW	1	—	—	Matsumoto (1959)	
July 1920	33°07'N	77°00'W	ASW	4	—	—	Matsumoto (1959)	
	33°07'N	77°00'W		5	—	—	Matsumoto (1959)	
May 1921	17°55'N	64°48'W	ASW	1	—	—	Matsumoto (1959)	
Nov. 1921	07°22'N	46°51'W	ASW	1	—	—	Matsumoto (1959)	
	05°35'N	51°08'W	ASW	1	—	—	Matsumoto (1959)	
	05°35'N	51°08'W		2	—	—	Matsumoto (1959)	
	05°35'N	51°08'W		10	—	—	Matsumoto (1959)	
	05°06'N	51°35'W	ASW	1	—	—	Matsumoto (1959)	
	05°06'N	51°35'W		14	—	—	Matsumoto (1959)	
	05°06'N	51°35'W		2	—	—	Matsumoto (1959)	
May 1922	35°42'N	73°43'W	ASW	5(?)	—	—	Matsumoto (1959)	
June 1953	25°35'N	79°25'W	ASW	—	1	8.8	Klawe (1960)	(1)
July 1954	34°35'N	75°15'W	ASW	—	2	25, 35	Klawe (1961)	(1)From stomach of *Euthynnus*
	28°59'N	88°07'W	ASW	—	4	27-41	Klawe and Shimada (1959)	(1)
	28°36'N	87°58'W	ASW	—	4	28-33	Klawe and Shimada (1959)	(1)
	29°05'N	88°10'W	ASW	—	86	21-44	Klawe and Shimada (1959)	(1)
	27°34'N	89°00'W	ASW	—	3	26-38	Klawe and Shimada (1959)	(1)
	27°58'N	88°03'W	ASW	—	2	76-80	Klawe and Shimada (1959)	(1)
Aug. 1954	29°28'N	87°30'W	ASW	—	38	11-47	Klawe and Shimada (1959)	(1)
	28°59'N	88°02'W	ASW	—	4	56-108	Klawe and Shimada (1959)	(1)
	28°46'N	88°40'W	ASW	—	5	24-36	Klawe and Shimada (1959)	(1)
	29°12'N	88°34'W	ASW	—	29	22-174	Klawe and Shimada (1959)	(1)
June 1955	28°40'N	88°58'W	ASW	—	10	21-31	Klawe and Shimada (1959)	(1)
Aug. 1955	28°50'N	87°50'W	ASW	—	4	3.5-5.3	Klawe and Shimada (1959)	(1)
	28°50'N	87°48'W	ASW	—	88	30-53	Klawe and Shimada (1959)	(1)
	28°47'N	87°57'W	ASW	—	16	31-55	Klawe and Shimada (1959)	(1)
	28°45'N	87°56'W	ASW	—	4	6.2-8	Klawe and Shimada (1959)	(1)
	28°55'N	88°00'W	ASW	—	90	29-65	Klawe and Shimada (1959)	(1)
	28°55'N	87°57'W	ASW	—	116	4-80	Klawe and Shimada (1959)	(1)
	29°01'N	87°48'W	ASW	—	60	17-68	Klawe and Shimada (1959)	(1)
	28°12'N	88°43'W	ASW	—	11	49-86	Klawe and Shimada (1959)	(1)
	28°17'N	88°37'W	ASW	—	12	32-94	Klawe and Shimada (1959)	(1)
Sept. 1955	29°27'N	86°55'W	ASW	—	52	24-49	Klawe and Shimada (1959)	(1)
—	Gulf of Mexico		ASW	—	8	19-29	Klawe and Shimada (1959)	(1)
Aug. 1956	28°50'N	87°50'W	ASW	—	33	21-82	Klawe and Shimada (1959)	(1)
Oct. 1957 – Dec. 1958	Off Takoradi, Ghana		ASE	Single specimen	—		Kazanova (1962)	Length not defined
July 1960	Off Dakar, Senegal		ASE	Up to 60 specimens per catch	—	4.14-6.10	Kazanova (1962)	Length not defined
Aug.-Sept. 1964	Around Cuba		ASW	20	—	3.0-5.4	Gorbunova and Salabarrí (1967)	Length not defined
Feb.-Mar. 1963	06°18'N	23°20'W	ASE	2	—	3.8, 3.7	Zharov and Zhudova (1969)	Length not defined
	04°40'N	24°28'W	ASE	1	—	4.4	Zharov and Zhudova (1969)	Length not defined
	10°00'S	34°33'W	ASW	1	—	8.7	Zharov and Zhudova (1969)	Length not defined
	03°00'N	30°00'W	ASW	1	—	4.2	Zharov and Zhudova (1969)	Length not defined
	03°37'S	30°04'W	ASW	1	—	4.4	Zharov and Zhudova (1969)	Length not defined
Apr.-July 1960-67	24°30'N	82°50'W	ASW	—	47	29-135	Potthoff and Richards (1970)	Standard length
Oct., Dec., Feb. 1964-66	07°S 05°N 04°30'N	12°E 04°30'W 04°30'W	ASE	4	—	4.2-10.2	Zhudova (1969a)	Approximate locations Length not defined
Aug.-Oct. 1964	09°20'N	19°41'W	ASE	No numbers given	—	—	Zhudova (1969b)	
Throughout the year	Ivory Coast and Ghana		ASE	—	Numerous	—	Marchal (1963)	
June-Aug.	Haifa Bay		ASE	—	Numerous	80-240	Ben-Tuvia (1957)	Length not defined
Aug.-Oct. 1959	Dardanelles		ASE	—	Numerous	145-220	Demir (1963)	Fork length
Aug.-Sept. 1959	Sea of Marmara		ASE	—	Numerous	180-250	Demir (1963)	Fork length

[1]Total length measured from tip of snout to shortest median ray of caudal fin.

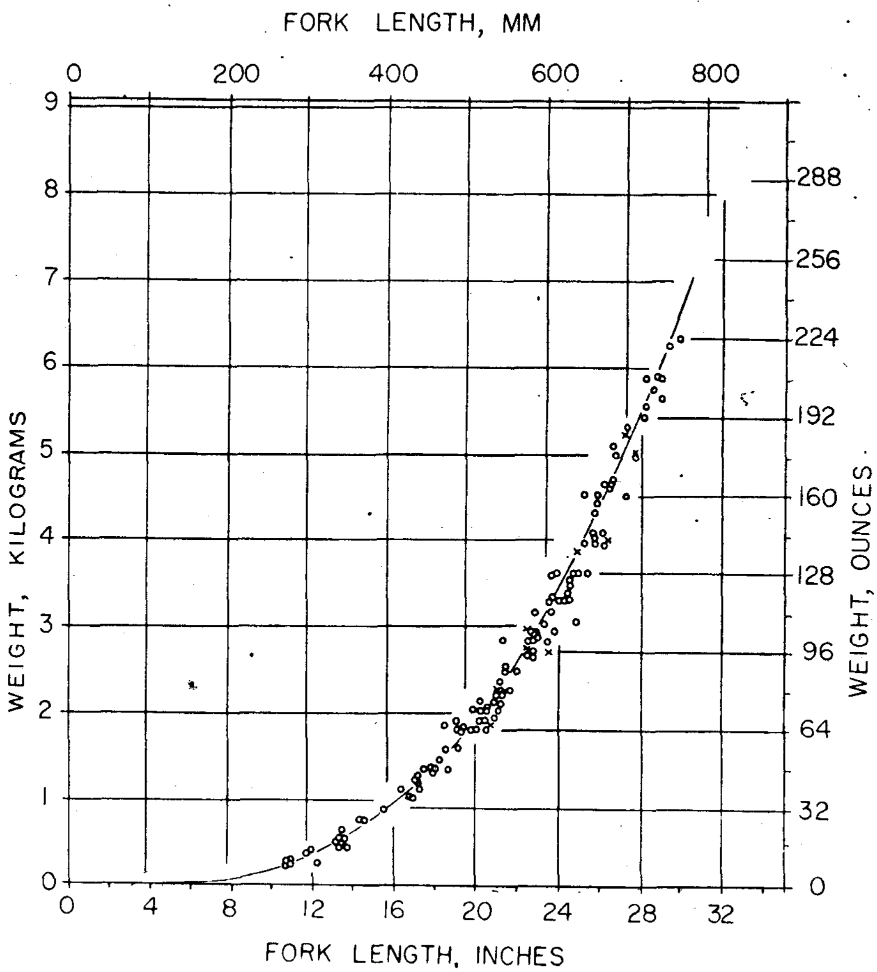
Appendix I Table 5. Records of larval and juvenile Euthynnus alletteratus in the Atlantic and Mediterranean (from Yoshida, 1979).



Appendix I Figure 5. Frequency distribution of male and female little tunny caught by anglers off Miami, Florida, September, 1952 to August, 1953. Solid line represents males (N=295); dashed line represents females (N=242) (de Sylva and Rathjen, 1961).

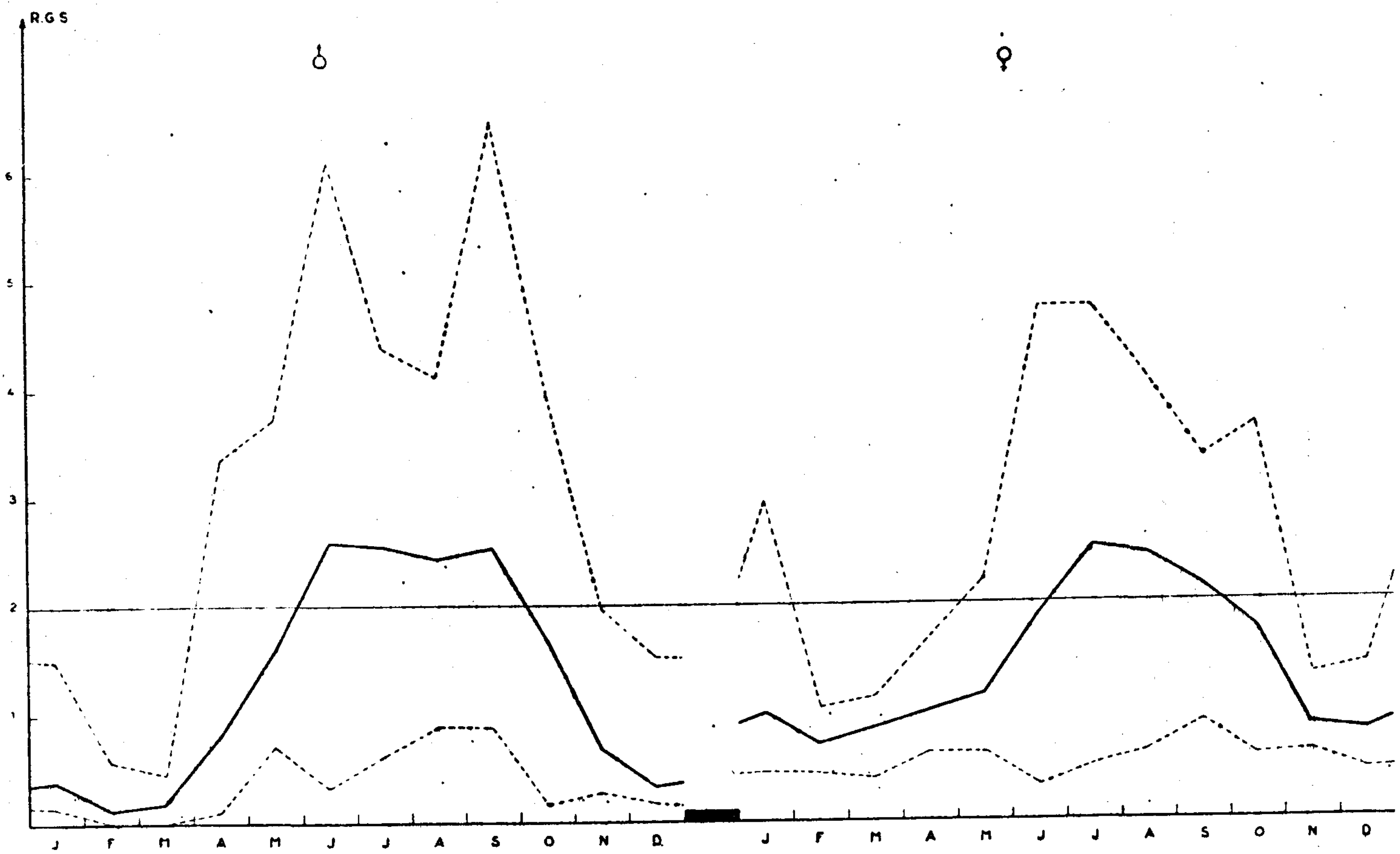


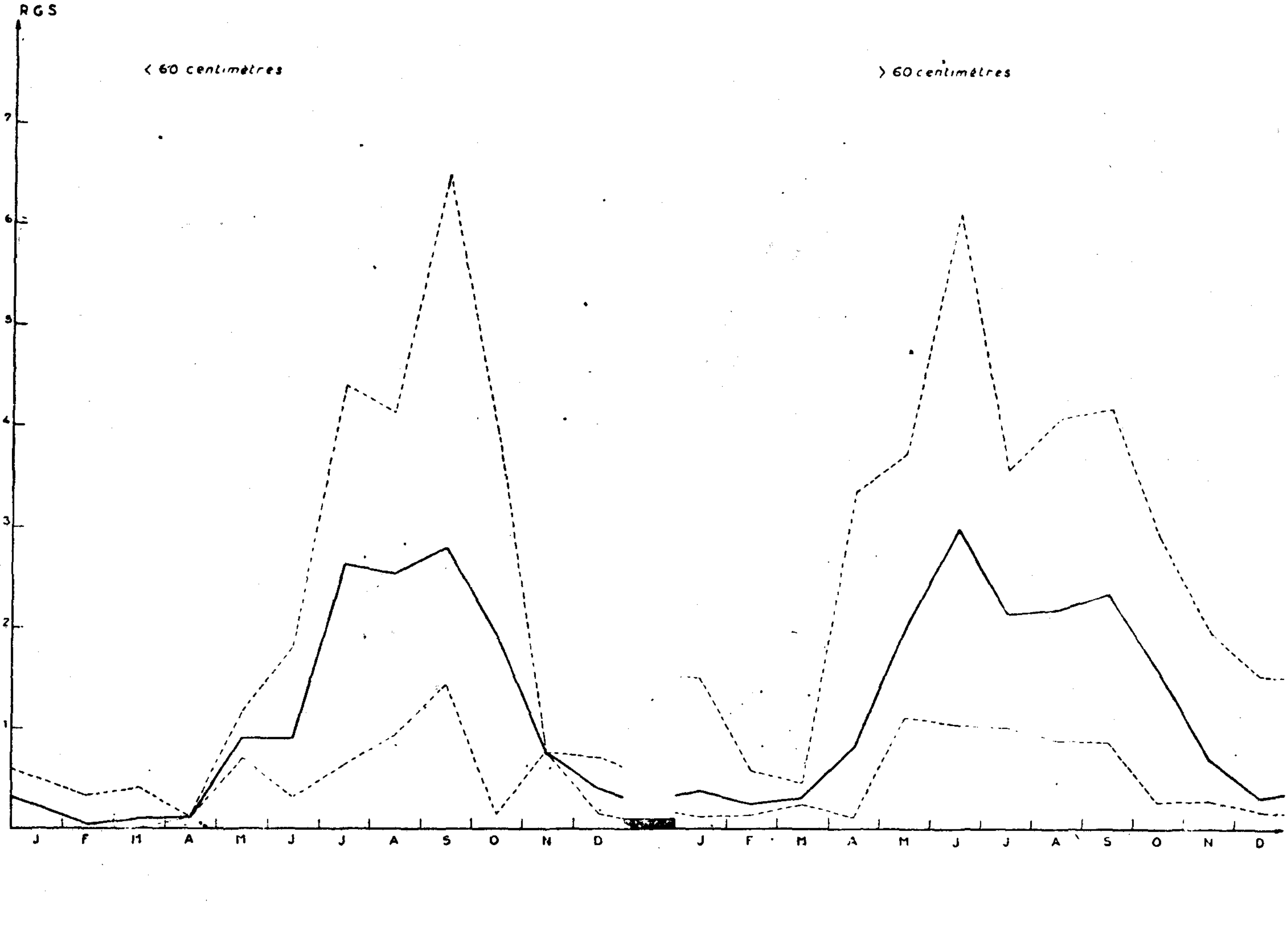
Appendix I Figure 6. **Length-weight relation** in E. alletteratus, sexes combined; logarithmic scale (Postel, 1955).



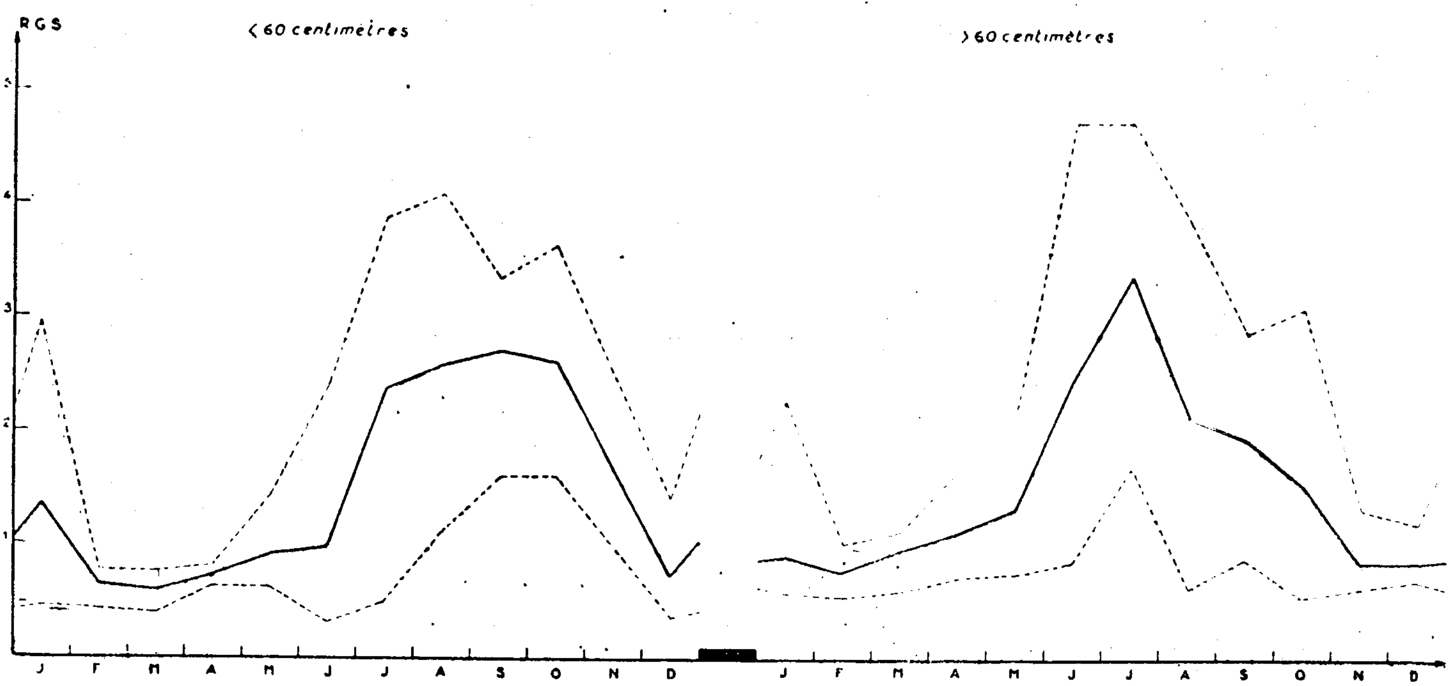
Appendix I Figure 7. Length-weight relationship of 115 little tunny caught off Miami, Florida, September, 1952 to August, 1953, sexes combined. Crosses represent data of Morrow (1954) from East Africa (de Sylva and Rathjen, 1961).

Appendix I Figure 8. Variations of the gonosomatic rates in E. alletteratus (from Postel, 1955).

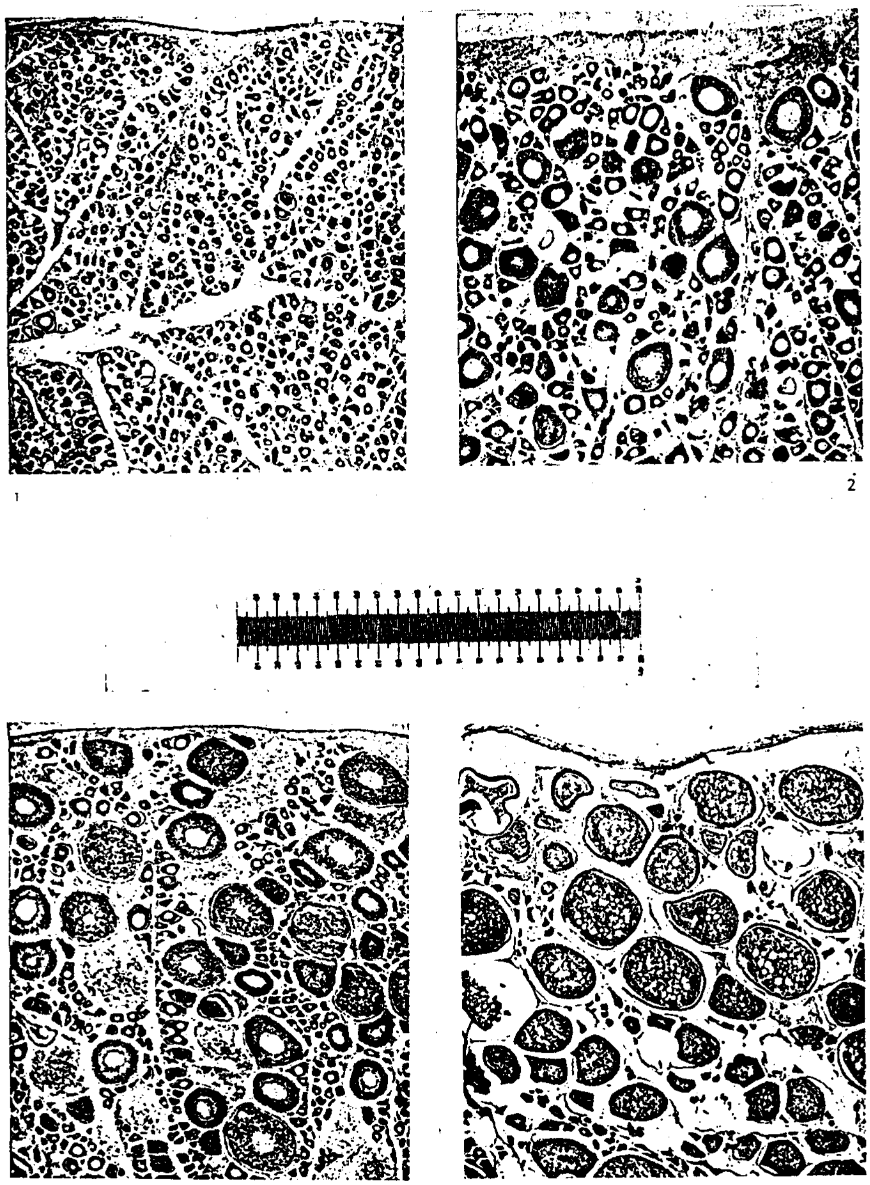




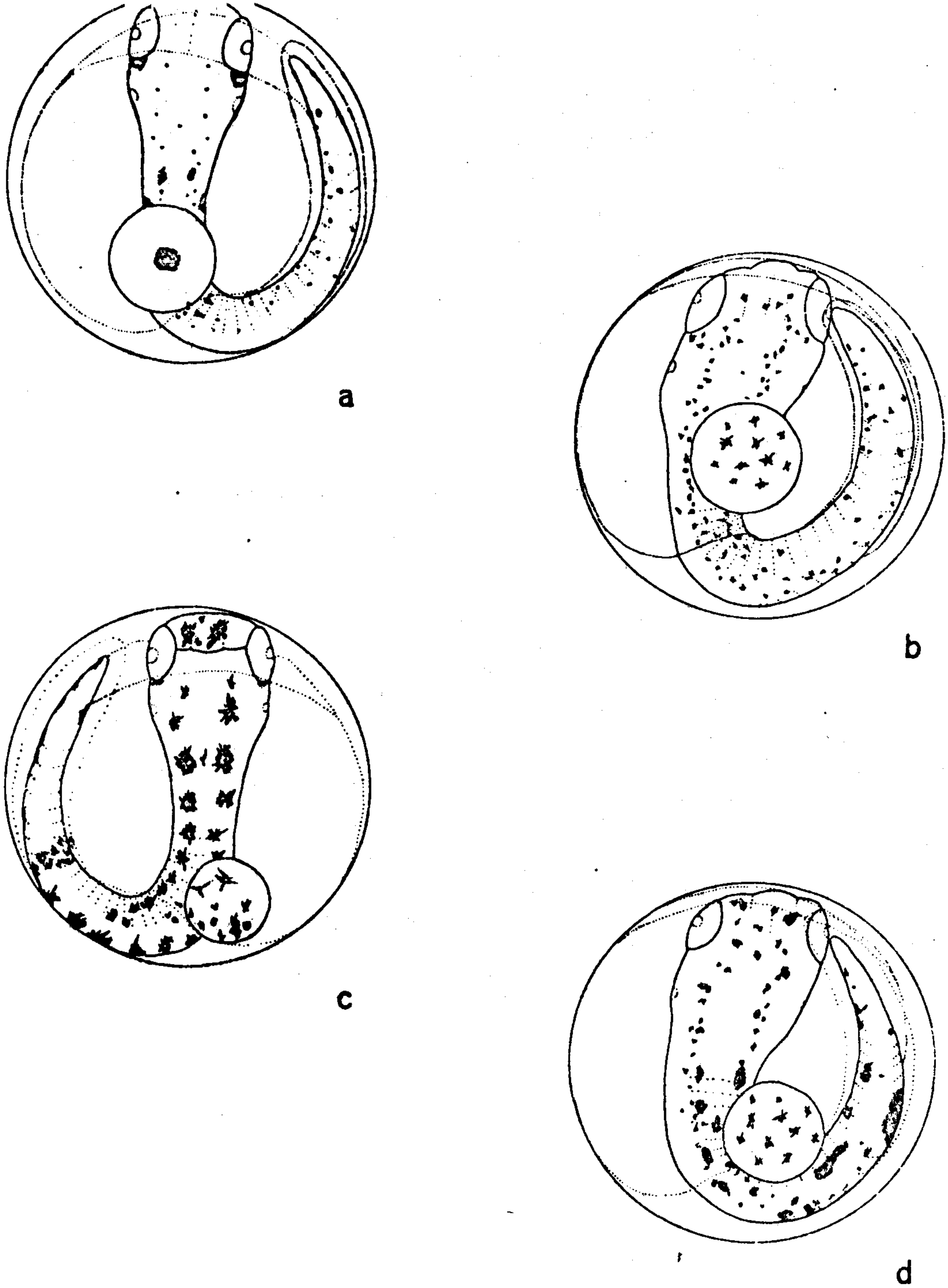
Appendix I Figure 9. Influence of size on the variation of the gonosomatic ratio in E. alletteratus (females) (from Postel, 1955).



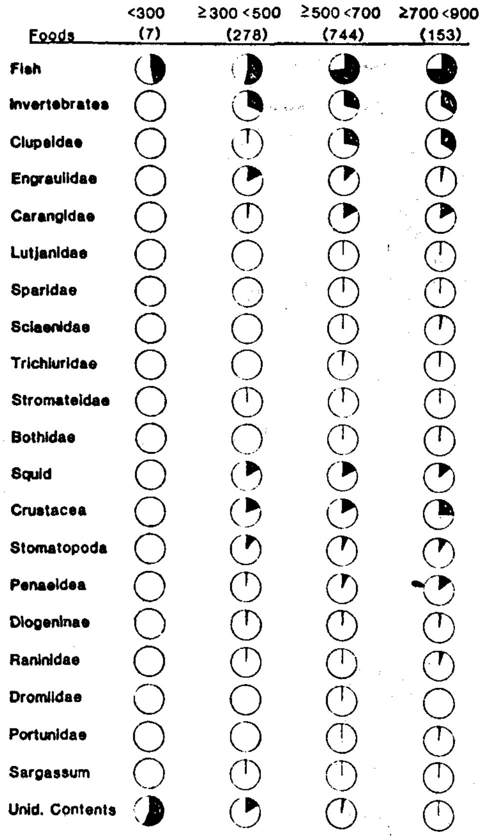
Appendix I Figure 10. Influence of size on the variation of the gonosomatic rates in E. alleteratus (males) (from postel, 1955).



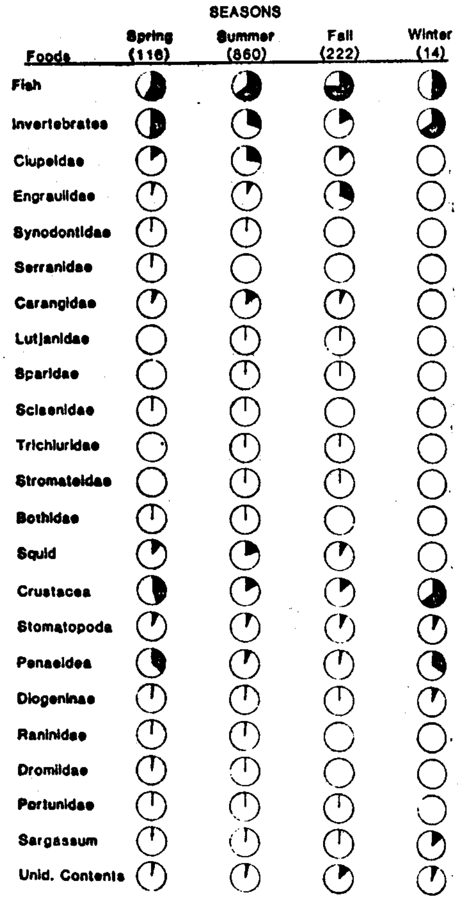
Appendix I Figure 11. Photomicrographs of ovarian sections of E. alletteratus at different stages. Note the parallel between the evolution of the ovocytes and the gonosomatic ratio. Note the transformations in the ovarian cortex (from Postel, 1955). 1. RGS = 0,42. 2. RGS = 1,13. 3. RGS = 1,73. 4. RGS = 2.



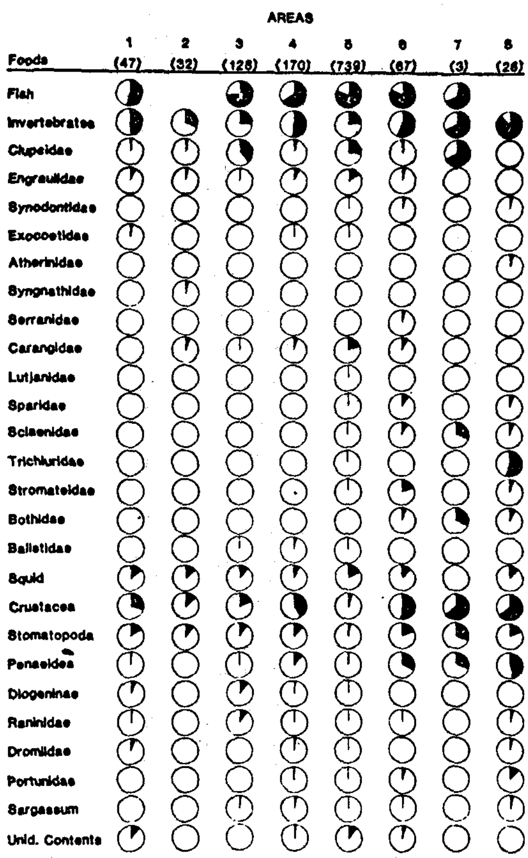
Appendix I Figure 12. Eggs. (a) Euthynnus alletteratus, 0.89 mm diameter, (b) Auxis sp. a, 0.85 mm diameter, (c) Katsuwonus pelamis, 0.94 mm diameter, (d) Auxis sp. b 0.88 mm diameter. The gray patches represent the colored pigment described in the text (from Mayo, 1973).



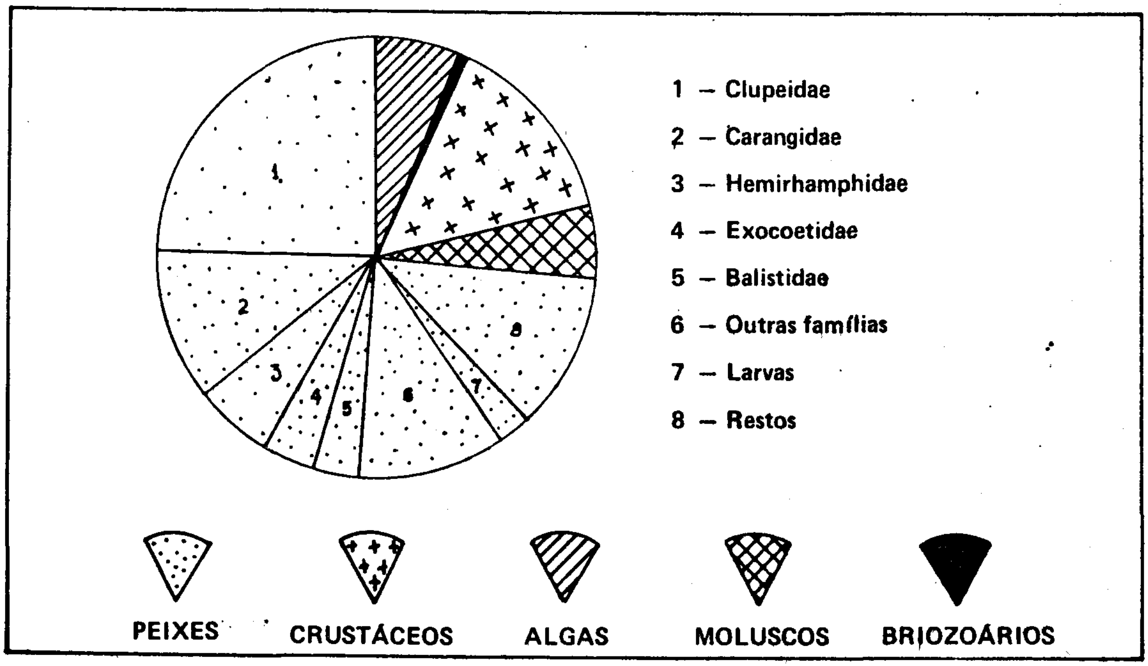
Appendix I Figure 13. Frequency of occurrence percentages for selected foods of little tunny, Euthynnus alletteratus, by predators size (mm FL) (Manooch et al., 1985).



Appendix I Figure 14. Frequency of occurrence percentages of selected foods of little tunny, Euthynnus alletteratus by season of collection (Manooch et al., 1985).



Appendix I Figure 15. Frequency of occurrence percentages for selected foods of little tunny, Euthynnus alletteratus, by area of collection (1=North Carolina, 2=South Carolina, 3=east coast of Florida, 4=south Florida, 5=northwest Florida, 6=Mississippi Delta, 7=northeast Texas, and 8=south Texas) (Manooch et al., 1985).



Appendix I Figure 16. Graphic representation of the food habits of the <u>bonito</u>, <u>Euthynnus alletteratus</u>, from the State of Ceará (from Menezes and Aragão, 1980).

BLF
****

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
TOTAL	836	1011	712	916	1171	1203	1048	1046	1810	1697	1527
	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====

BLF CATCH BY GEAR•CAPTURES PAR ENGIN•CAPTURAS POR ARTE

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
LL	0	0	6	++	0	0	0	0	2	11	1
BB	0	0	0	0	0	0	0	0	700	631	569
PS	0	21	7	0	0	0	0	0	15	0	0
TROL	0	0	0	0	0	0	0	0	0	0	++
SURF	836	990	699	916	1171	1198	1048	1046	1093	1014	957
UNCL	0	0	0	0	0	5	0	0	0	41	++

BLF CATCH BY COUNTRY•CAPTURES PAR PAYS•CAPTURAS POR PAIS

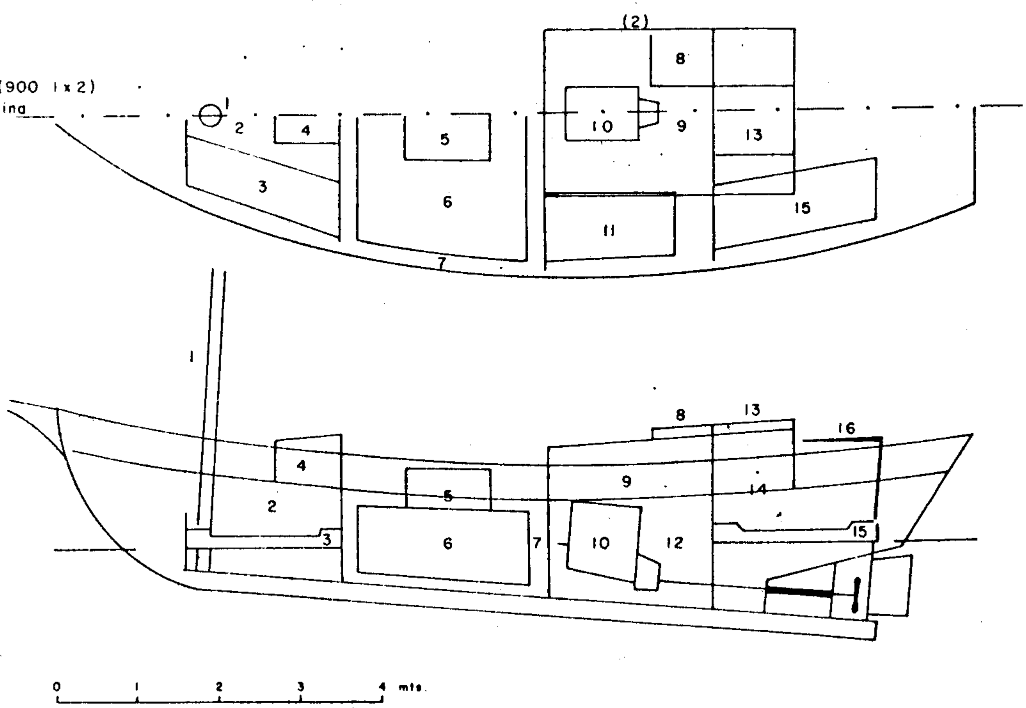
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
BRASIL	296	194	129	56	273	195	173	181	87	100	36
CUBA	0	0	0	0	0	0	0	0	700	622	558
DOMIN.R.	200	136	86	90	68	78	105	125	124	144	144
FRANCE	0	21	7	0	0	0	0	0	0	0	0
1/ GUADELOU	240	240	220	190	530	530	470	440	460	490	482
1/ MARTINIG	100	420	270	580	300	400	300	300	300	300	300
USA	0	0	0	0	0	0	0	0	139	41	7

1/ Includes other tunas./ Comprend d'autres thonidés./ Incluye otros túnidos.

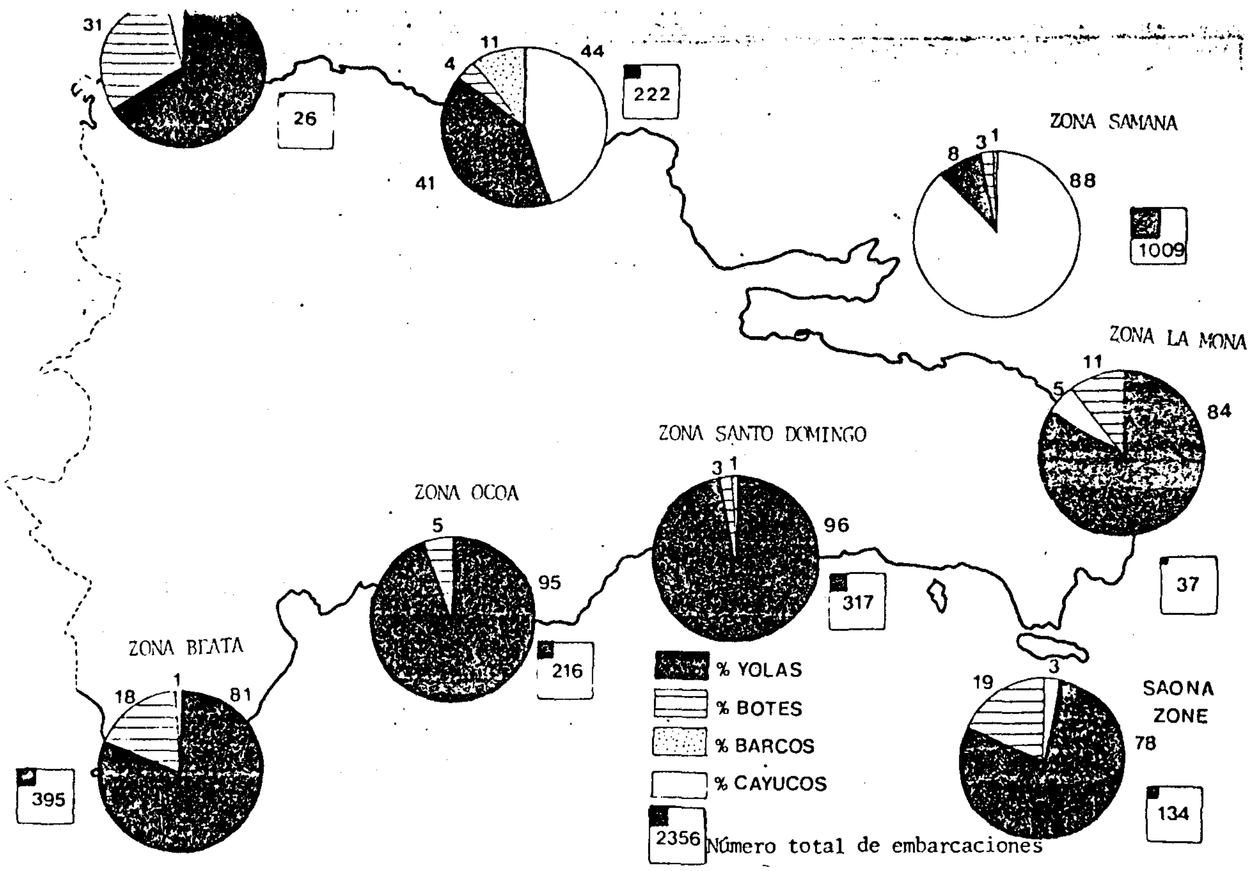
Appendix I Table 6. Catches of blackfin tuna (MT) reported by ICCAT countries (ICCAT, 1985).

Appendix I Figure 17. Scheme of a boat (barco) of 11 m long used by Dominican Republic fishermen (from Giudicelli, 1979).

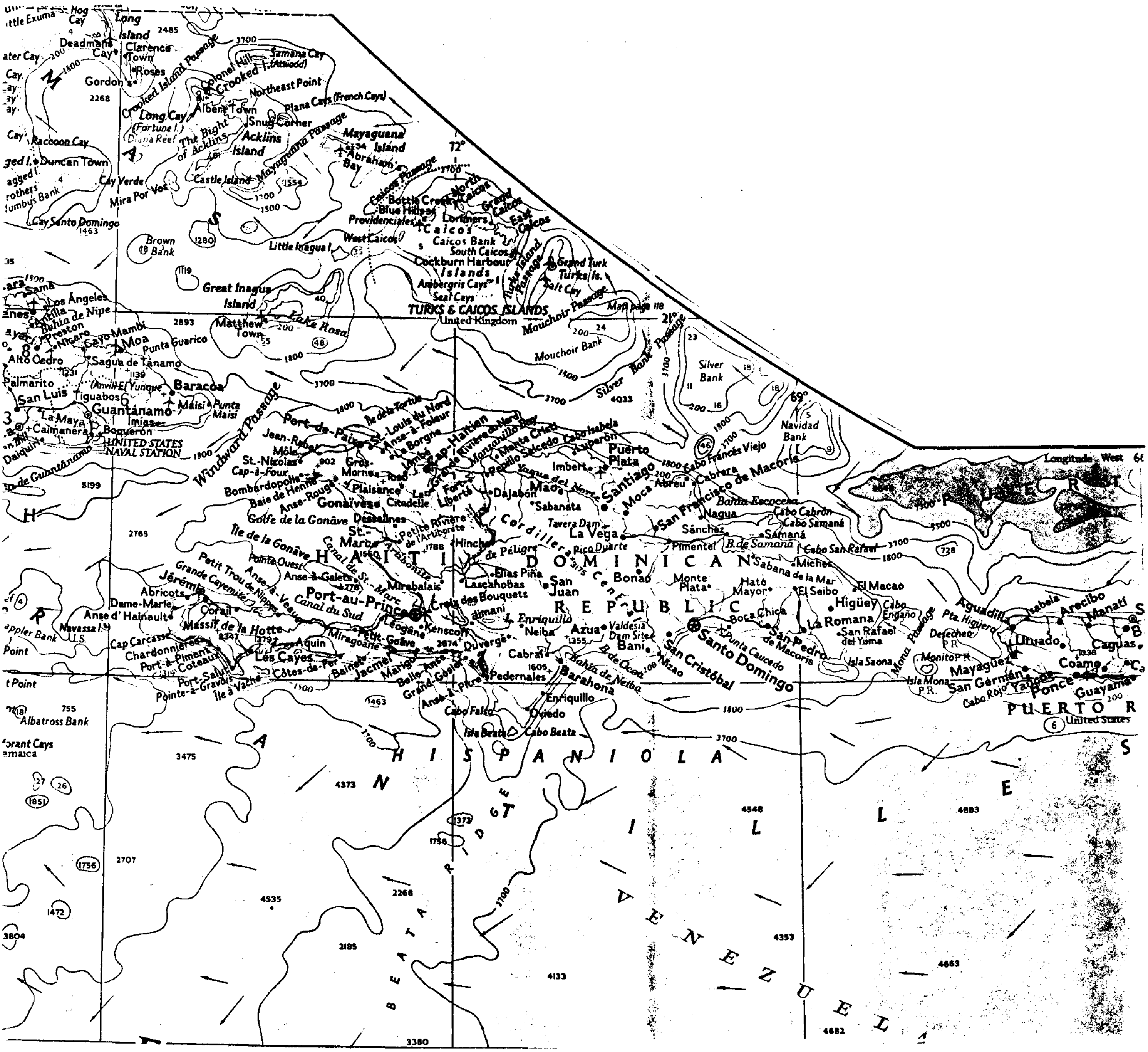
1- Mástil
2- Cuarto delantero
3- Camarote (2)
4- Escotilla
5- Escotilla
6- Bodega (5 a 6 m³)
7- Aislante
8- Escotilla
9- Caseta
10- Motor (40 CV)
11- Tanque Diesel (900 l x 2)
12- Cuarto de máquina
13- Escotilla
14- Cuarto trasero
15- Camarote (2)
16- Timón



Appendix I Figure 18. Geographical distribution of the Dominican Republic artisinal fishing fleet (from Fisheries Development, Ltd., 1980). YOLAS = small boats; BOTES = boats; BARCOS = craft; CAYUCO = small boats; 2356 = Total number of vessels.



Appendix I Figure 19. Hispaniola (Haiti and Dominican Republic) and adjacent waters.



Appendix I Table 7. Food found in stomachs of seven species of tuna from the Atlantic Ocean (from Dragovich, 1967).

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	*Katsuwonus pelamis*	*Thunnus albacares*	*Thunnus atlanticus*	*Thunnus thynnus*	*Thunnus obesus*	*Thunnus alalunga*
FISHES							
Abalistes stellaris (Bloch and Schneider)	--	--	--	--	--	--	X
Ablennes hians (Valenciennes)	X	X	--	--	--	--	--
Acanthurus sp.	--	X	X	X	--	--	X
Acanthurus chirurgus (Bloch)	X	X	--	X	--	--	--
Acanthurus coeruleus Bloch and Schneider	--	X	X	--	--	--	--
Acanthurus hepatus (Linnaeus)	X	--	--	--	--	--	--
Acanthurus monroviae Steindachner	--	--	X	--	--	--	X
Alepisaurus sp.	--	--	X	X	--	--	X
Alepisaurus ferox Lowe	--	--	X	--	--	X	X
Allaneta harringtonensis (Goode)	X	--	--	--	--	--	--
Alutera sp.	--	--	X	--	--	--	--
Alutera monoceros (Linnaeus)	--	--	X	--	--	--	--
Alutera scripta (Osbeck)	--	--	X	--	--	--	--
Alutera heudelotii Hollard	--	--	X	--	--	--	--
Ammodytes sp.	X	--	--	--	--	--	--
Anchoa cubana (Poey)	X	--	--	--	--	--	--
Anchoa sp.	X	--	--	--	--	--	--
Anchoviella sp.	--	--	--	X	--	--	--
Anchoviella guineensis (Rossignol and Blache)	--	X	X	--	--	--	--
Anoplogaster cornutus (Cuvier and Valenciennes)	--	--	--	X	--	--	--
Anotopterus pharao Zugmayer	--	--	--	--	--	--	X
Antennarius sp.	--	--	X	--	--	--	--
Anthias sacer Lowe	X	--	--	--	X	--	X
Antigonia sp.	--	--	X	--	--	--	X
Antigonia combatia Berry and Rathjen	--	--	--	X	--	--	--
Aphanopus sp.	--	X	--	--	--	--	X
Argentina sp.	--	--	--	--	--	--	X
Argyropelecus sp.	--	--	--	--	--	--	X
Argyropelecus aculeatus Cuvier and Valenciennes	--	--	--	X	--	--	--
Argyropelecus olfersi (Cuvier)	--	--	--	--	--	--	X
Ariomma ledanoisi (Belloc)	--	--	--	--	--	--	X
Arnoglossus sp.	--	--	X	--	--	--	--
Arnoglossus imperialis Rafinesque	--	--	--	--	--	--	X
Atherinidae	X	X	--	--	--	--	--
Atherinomorus stipes (Müller and Troschel)	--	X	X	--	--	--	--
Aulopus sp.	X	--	--	--	--	--	--
Auxis sp.	--	--	X	--	--	--	--
Auxis thazard (Lacépède)	X	--	X	--	--	--	X
Avocettina infans (Günther)	--	--	--	X	--	--	--
Balistidae	X	X	X	X	--	--	X

Appendix I Table 7. Food found in stomachs of seven species of tuna from the Atlantic Ocean (from Dragovich, 1967) (continued).

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	*Katsuwonus pelamis*	*Thunnus albacares*	*Thunnus atlanticus*	*Thunnus thynnus*	*Thunnus obesus*	*Thunnus alalunga*
FISHES							
Balistes sp.	--	--	X	--	--	--	--
Balistes forcipatus Gmelin	--	--	X	--	--	--	X
Bathylagus microcephalus Norman	--	--	--	--	X	--	X
Barathronus parfaiti Vaillant	--	--	--	--	--	--	X
Belonidae	--	--	X	--	--	--	--
Belone belone (Linnaeus)	--	--	--	--	--	--	X
Benthodesmus atlanticus Goode and Bean	--	--	--	X	--	--	--
Berycoidea	--	--	X	--	--	--	--
Blennius ocellaris Linnaeus	--	--	--	--	--	--	X
Boops vulgaris Bowdich	--	--	--	--	--	--	X
Bothidae	--	--	--	--	--	--	X
Box boops Vinciguerra	X	--	--	--	--	--	--
Brama sp.	--	--	--	--	X	--	--
Brama rayi (Bloch)	--	--	X	X	X	X	X
Bramidae	--	X	X	X	--	X	X
Brevoortia tyrannus (Latrobe)	--	--	--	X	--	--	--
Brotulidae	--	X	X	--	--	--	--
Cantherines pullus (Ranzani)	--	X	X	--	--	--	--
Canthidermis sufflamen (Mitchill)	--	--	X	X	--	--	--
Canthigaster rostratus (Bloch)	--	--	X	--	--	--	X
Capros aper (Linnaeus)	--	--	--	--	--	--	X
Carangidae	X	X	X	X	--	--	--
Caranx sp.	X	--	X	X	--	--	--
Caranx bartholomaei Cuvier	--	--	X	--	--	--	--
Caranx crysos (Mitchill)	X	X	X	--	--	--	--
Caranx hippos (Linnaeus)	--	--	--	X	--	--	X
Caranx latus Agassiz	X	X	X	--	--	--	--
Caranx rhonchus Geoffroy St.-Hilaire	--	--	--	--	--	--	X
Caranx ruber (Bloch)	--	X	X	--	--	--	--
Caranx trachurus Cuvier	--	--	--	--	--	--	X
Centropholoides falcatus (Barnard)	--	--	X	--	X	X	X
Ceratioidei	--	--	--	--	--	--	X
Ceratoscopelus townsendi (Eigenmann and Eigenmann)	--	--	--	--	--	--	X
Chaetodontidae	--	--	--	--	--	--	X
Chaetodon marleyi Regan	--	--	--	--	--	--	X
Chaetodon sedentarius Poey	--	--	--	X	--	--	--
Chaetodon striatus Linnaeus	--	--	--	X	--	--	--
Champsodon sp.	--	--	--	--	--	--	X
Chauliodus sloani Schneider	--	--	--	--	--	--	X
Chiasmodontidae	--	--	X	X	--	--	X
Chlorophthalmus agassizi Bonaparte	--	--	--	--	--	--	X
Chlorophthalmus atlanticus Poll	--	--	X	--	--	--	--
Chloroscombrus sp.	--	--	X	--	--	--	--
Clinidae	--	X	--	--	--	--	--
Clupea finta Cuvier	--	--	--	--	X	--	--

Appendix I Table 7. Food found in stomachs of seven species of tuna from the Atlantic Ocean (from Dragovich, 1967) (continued).

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	*Katsuwonus pelamis*	*Thunnus albacares*	*Thunnus atlanticus*	*Thunnus thynnus*	*Thunnus obesus*	*Thunnus alalunga*
FISHES							
Clupea sprattus Poggi	--	--	--	X	--	--	--
Clupeidae	X	--	--	--	--	--	--
Collybus sp.	--	--	--	--	--	--	X
Conger conger (Linnaeus)	--	--	--	--	--	--	X
Conger vulgaris (leptocephala) Günther	--	--	--	--	--	--	X
Congermuranea impressa (Poey)	X	--	--	--	--	--	--
Coryphaena hippurus Linnaeus	X	--	X	--	--	--	X
Cubiceps gracilis (Lowe)	--	--	X	--	--	--	X
Cyclichthys orbicularis Kaup	--	--	X	--	--	--	--
Cypselurus sp.	X	--	X	--	--	--	--
Cypselurus furcatus (Mitchill)	--	--	--	--	--	--	X
Cypselurus heterurus (Rafinesque)	--	X	--	--	--	--	--
Cypselurus lineatus (Valenciennes)	--	--	--	--	--	--	X
Dactyloptena orientalis (Cuvier)	--	--	--	--	--	--	X
Dactylopteridae	--	--	X	--	--	--	X
Dactylopterus volitans (Linnaeus)	--	X	X	X	--	--	--
Decapterus macarellus (Cuvier)	--	--	X	X	--	--	--
Decapterus punctatus (Agassiz)	X	X	X	X	--	--	X
Decapterus ronchus (Geoffroy St.-Hilaire)	X	--	--	--	--	--	--
Diagramma mediterraneum (Guichenot)	--	--	--	--	--	--	X
Diaphus sp.	--	--	--	--	X	X	X
Diaphus effulgens (Goode and Bean)	--	--	--	X	--	--	X
Diaphus gemellarii (Cocco)	--	--	--	--	--	--	X
Diaphus lütkeni (Brauer)	--	--	--	--	--	--	X
Diaphus rafinesquii (Cocco)	--	--	--	X	--	--	--
Diaphus theta Eigenmann and Eigenmann	--	--	--	--	--	--	X
Diodon sp.	--	X	X	X	--	--	--
Diodon holacanthus Linnaeus	--	X	X	--	--	--	--
Diodon hystrix Linnaeus	--	--	--	--	X	--	--
Diplodus sargus (Linnaeus)	--	--	--	--	--	--	X
Diretmus argenteus Johnson	--	--	--	--	X	--	--
Engraulidae	X	--	--	--	--	--	--
Engraulis sp.	X	--	X	--	--	--	--
Engraulis encrasicholus (Linnaeus)	X	--	--	--	X	--	X
Engraulis hepsetus Linnaeus	--	X	--	--	--	--	--
Engraulis japonicus (Hottuyn)	--	--	X	--	X	X	--
Entelurus aequoreus Linnaeus	--	--	--	--	--	--	X
Epinnula orientalis Gilchrist and Von Bonde	--	--	--	X	--	--	--
Etrumeus teres (De Kay)	X	X	--	X	X	--	--
Eucinostomus pseudogula Poey	--	X	X	--	--	--	--
Euthynnus alletteratus (Rafinesque)	X	--	X	--	--	--	X
Exocoetidae	X	X	X	--	--	--	X
Exocoetus sp.	X	--	--	--	--	--	--
Exonautes rubescens (Rafinesque)	--	--	--	X	--	--	--

Appendix I Table 7. **Food found in stomachs of seven species of tuna from the Atlantic Ocean (from Dragovich, 1967) (continued).**

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	Katsuwonus pelamis	Thunnus albacares	Thunnus atlanticus	Thunnus thynnus	Thunnus obesus	Thunnus alalunga
FISHES							
Fistularia serrata Cuvier	--	--	--	X	--	--	--
Fistularia tabacaria Linnaeus	X	--	--	X	--	--	--
Fistularia villosa Klunzinger	--	--	X	--	--	--	--
Fodiator acutus (Valenciennes)	X	--	X	--	--	--	--
Gadidae	X	--	--	--	--	--	--
Galeoides polydactylus (Vahl)	X	--	--	--	--	--	--
Gempylidae	--	X	X	X	--	--	X
Gempylus serpens Cuvier	--	X	X	--	--	--	X
Gephyroberyx darwini (Johnson)	--	X	--	--	--	--	--
Gerridae	--	X	--	--	--	--	--
Gerres cinereus (Walbaum)	--	X	--	--	--	--	--
Gonorynchus gonorynchus (Linnaeus)	--	--	X	--	--	--	--
Gonostoma sp.	--	--	X	--	--	--	--
Gonostomatidae	--	--	X	--	--	--	--
Haemulon flavolineatum (Desmarest)	X	--	--	--	--	--	--
Halieutea fitzsimonsi (Gilchrist and Thompson)	--	--	--	--	--	--	X
Harengula sp.	--	--	--	--	X	--	--
Helicolenus dactylopterus (De la Roche)	--	--	--	--	--	--	X
Helicolenus maculatus Cuvier	--	--	--	--	X	X	X
Helicolenus porcus (Linnaeus)	X	--	--	--	X	--	X
Hemipteronotus sp.	--	--	--	X	--	--	--
Hemipteronotus noracula (Linnaeus)	X	--	--	--	--	--	--
Hemiramphidae	X	X	X	--	--	--	--
Hemiramphus sp.	X	X	--	X	--	--	--
Hemiramphus balao LeSueur	--	X	--	--	--	--	--
Heterosomata larvae	--	--	--	X	--	--	X
Hippocampus sp.	X	--	X	--	X	--	--
Hippocampus brevirostris Valenciennes	--	--	--	--	X	--	--
Hippocampus erectus Perry	--	--	--	X	--	--	--
Holocentridae	--	X	--	X	--	--	--
Holocentrus Gronow	--	X	X	--	--	--	--
Holocentrus ascensionis (Osbeck)	X	X	X	X	--	--	--
Holocentrus rufus (Walbaum)	X	X	X	--	--	--	--
Holocentrus vexillarius (Poey)	X	--	--	X	--	--	--
Hyporhamphus sp.	X	X	--	--	--	--	X
Hyporhamphus unifasciatus (Ranzani)	--	--	X	--	--	--	--
Jenkinsia sp.	X	--	--	X	--	--	--
Katsuwonus pelamis (Linnaeus)	X	X	--	X	--	--	X
Lactophrys sp.	--	--	--	X	--	--	--
Lagocephalus sp.	--	--	--	--	--	--	X
Lagocephalus laevigatus (Linnaeus)	--	--	X	--	--	--	--
Lampadena chavesii Collett	--	--	--	--	X	X	--
Lampanyctodes hectoris Günther	--	--	X	--	X	X	X
Lampanyctus sp.	--	--	--	--	--	X	X

Appendix I Table 7. Food found in stomachs of seven species of tuna from the Atlantic Ocean (from Dragovich, 1967) (continued).

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	*Katsuwonus pelamis*	*Thunnus albacares*	*Thunnus atlanticus*	*Thunnus thynnus*	*Thunnus obesus*	*Thunnus alalunga*
FISHES							
Lampanyctus alatus (postlarva) Goode and Bean --now *Lampanyctus pusillus* (Johnson)	--	--	--	--	--	--	X
Lampanyctus crocodilus (Risso)	--	--	--	--	--	--	X
Lampanyctus intricarius Taaning	--	--	--	--	--	--	X
Lampanyctus maderensis (Lowe)	--	--	--	--	--	--	X
Lampanyctus margaritiferus (Goode and Bean)	--	--	--	--	--	--	X
Lamputa umgazi Smith	--	--	--	--	--	--	X
Laptostomais sp.	--	X	--	--	--	--	--
Lepidopus sp.	--	--	X	--	--	--	X
Lepidopus caudatus (Euphrasen)	--	--	X	--	X	X	X
Lepidotrigla sp.	--	--	X	--	--	--	--
Leptocephalus (Anguilliformes-larvae)	X	--	X	X	--	--	--
Lestidium sp.	--	--	X	--	--	X	X
Lichia glauca (Linnaeus) (Probably: *Trachinotus glauca* (Linnaeus))	--	--	--	--	--	--	X
Liosaccus cutaneus (Günther)	--	--	--	--	--	--	X
Lophiidae	--	--	--	--	--	--	X
Maurolicus sp.	--	--	--	X	--	--	X
Maurolicus muelleri (Gmelin)	--	--	X	--	X	--	X
Melanostomiatidae	--	--	--	X	--	--	--
Merluccius bilinearis (Mitchill)	--	--	--	--	X	--	--
Merluccius capensis Gastlenau	--	--	X	--	X	X	X
Merluccius merluccius (Linnaeus)	--	--	--	--	--	--	X
Micropteryx chrysurus (Linnaeus) (*Chloroscombrus chrysurus*)	--	--	--	--	--	--	X
Molidae	--	--	X	X	--	--	X
Monacanthus sp.	--	--	--	X	--	--	--
Monacanthus ciliatus (Mitchill)	X	--	X	X	--	--	--
Monacanthus hispidus (Linnaeus)	--	--	X	X	--	--	--
Monacanthus tuckeri Bean	--	--	--	X	--	--	--
Mullidae	--	--	--	X	--	--	X
Mulloidichthys martinicus (Cuvier)	X	--	--	--	--	--	--
Mullus barbatus Linnaeus	--	--	--	--	--	--	X
Myctophidae	--	--	--	--	X	--	X
Myctophum coccoi (Cocco)	--	--	X	--	X	X	X
Myctophum sp.	X	--	X	--	--	--	X
Myctophum humboldti (Risso)	--	--	X	--	X	X	X
Myctophum hygomii (Lütken)	--	--	--	X	--	--	--
Myctophum punctatum Rafinesque	--	--	--	--	--	--	X
Myctophum tisso (Cocco)	--	--	--	--	--	--	X
Naucrates ductor (Linnaeus)	--	--	X	--	--	--	X

Appendix I Table 7. Food found in stomachs of seven species of tuna from the Atlantic Ocean (from Dragovich, 1967) (continued).

FOOD ITEM	*Euthynnus alletteratus*	*Katsuwonus pelamis*	*Thunnus albacares*	*Thunnus atlanticus*	*Thunnus thynnus*	*Thunnus obesus*	*Thunnus alalunga*
FISHES							
Nemichthys scolopaceus Richardson	--	--	--	--	--	--	X
Nesiarchus nasutus Johnson	--	--	--	X	--	--	--
Nesiarchus sp.	--	--	X	--	--	--	--
Notolepis rissoi kroyers (Lütken)	--	--	--	--	--	--	X
Ogcocephalidae	--	--	--	X	--	--	--
Oligoplites saurus (Bloch and Schneider)	--	X	--	--	--	--	--
Omosudis lowii Günther	--	--	--	X	--	--	X
Onos mediterraneus (Linnaeus)	--	--	--	--	--	--	X
Onos vulgaris Yarrel	--	--	--	--	--	--	X
Ophidiidae	--	--	--	X	--	--	--
Ophidion barbatum Linnaeus	--	--	X	--	--	--	--
Ophidion vassali Risso	X	--	--	--	X	--	X
Oreosoma atlanticum Cuvier and Valenciennes	--	--	X	--	X	X	X
Ostracion sp.	--	--	X	--	--	--	X
Ostracion tuberculatus Linnaeus	--	--	X	--	--	--	--
Oxyporhamphus sp.	--	--	X	--	--	--	--
Oxyporhamphus micropterus similis Bruun	--	X	X	--	--	--	--
Otophidium omostigmum (Jordan and Gilbert)	X	--	--	--	--	--	--
Pagellus sp.	X	--	--	--	--	--	--
Paralepis sp.	X	--	X	X	X	--	X
Paralepis coregonoides Risso	--	--	--	--	--	--	X
Paralepis coregonoides borealis Reinhardt	--	--	--	--	--	--	X
Paralepis pseudosphyraenoides Ege	--	--	--	--	--	--	X
Paralepis speciosus Bellotti	X	--	--	--	X	--	X
Paralepis sphyraenoides Risso	--	--	--	--	--	--	X
Paranthias furcifer (Valenciennes)	--	--	--	X	--	--	--
Peprilus alepidotus (Linnaeus)	X	--	--	--	--	--	--
Photichthys argenteus Hutton	--	--	--	--	--	--	X
Plagyodus alepisaurus Lowe	--	--	--	--	--	--	X
Planctanthias praeopercularis Fowler	--	--	--	--	--	--	X
Pleuronectoidea	X	--	--	--	--	--	--
Polydactylus virginicus (Linnaeus)	--	X	--	X	--	--	--
Polyipnus spinosus Günther	--	--	X	--	X	X	X
Pomadasys sp.	X	--	--	--	--	--	--
Priacanthidae	--	X	--	--	--	--	--
Priacanthus sp.	--	--	X	--	--	--	X
Priacanthus cruentatus (Lacépède)	--	--	X	--	--	--	--
Priacanthus hamrur Forskal	--	--	--	--	--	--	X
Prionotus sp.	X	--	--	--	--	--	--
Pristopomatides sp.	--	--	X	--	--	--	--
Prognichthys gibbifrons (Valenciennes)	--	X	--	--	--	--	--

Column headings above span "SPECIES OF TUNA".

Appendix I Table 7. Food found in stomachs of seven species of tuna from the Atlantic Ocean (from Dragovich, 1967) (continued).

FOOD ITEM	SPECIES OF TUNA: Euthynnus alletteratus	Katsuwonus pelamis	Thunnus albacares	Thunnus atlanticus	Thunnus thynnus	Thunnus obesus	Thunnus alalunga
FISHES							
Psenes sp.	--	--	X	--	--	--	X
Psenes cyanophrys Cuvier	--	--	X	--	--	--	--
Pseudopentaceros richardsoni (Smith)	--	--	--	--	--	--	X
Pseudopriacanthus altus (Gill)	X	--	X	--	--	--	--
Pseudupeneus maculatus (Bloch)	X	--	--	--	--	--	--
Pseudupeneus prayensis (Cuvier)	--	--	X	--	--	--	--
Pteraclidae	--	--	--	--	--	--	X
Pteraclis sp.	--	--	X	--	--	--	--
Pterycombus goodei (Jordan)	--	X	X	--	--	--	--
Rhomboplites aurorubens (Cuvier)	--	--	--	X	--	--	--
Sardina pilchardus (Walbaum)	--	--	--	--	X	--	--
Sardinella sp.	X	X	X	--	--	--	--
Sardinella anchovia Valenciennes	X	--	X	X	--	--	--
Sardinella aurita Valenciennes	X	--	X	--	X	--	X
Sardinella eba (Cuvier and Valenciennes)	--	--	--	--	--	--	X
Sardinella rouxi Whitehead	--	--	X	--	--	--	--
Sardinops ocellata (Pappe)	--	--	X	--	X	X	X
Sargus sp.	X	--	--	--	--	--	--
Saurida parri Norman	X	--	--	--	--	--	--
Schedophilus enigmaticus Günther	--	--	--	--	--	--	X
Schedophilus medusophagus Cocco	--	--	--	--	--	--	X
Scomber sp.	X	--	--	--	--	--	--
Scomber japonicus Houttuyn	X	X	X	--	X	X	X
Scomberesox saurus (Walbaum)	--	--	X	--	X	X	X
Scomberomorus maculatus (Mitchill)	X	--	--	--	--	--	--
Scombridae	X	--	X	--	--	--	--
Selene vomer (Linnaeus)	--	--	--	X	--	--	--
Selar crumenophthalmus (Bloch)	X	--	X	X	--	--	X
Serranidae	--	X	X	X	--	--	X
Smaris sp.	X	--	--	--	--	--	--
Soleidae	--	--	--	--	--	--	X
Sparisoma flavescens (Bloch and Schneider)	X	--	--	--	--	--	--
Sphaeroides sp.	--	--	--	X	--	--	--
Sphaeroides spengleri (Bloch)	--	--	X	--	--	--	--
Sphyraena sp.	X	--	X	--	--	--	X
Sphyraena barracuda (Walbaum)	--	X	--	--	--	--	--
Spondyliosoma cantharus (Linnaeus)	--	--	--	--	--	--	X
Sternoptyx diaphana Herman	--	X	--	--	--	--	X
Stomiatidae	--	--	--	--	--	--	X
Strongylura sp.	--	--	--	X	--	--	--
Strongylura marina (Walbaum)	--	--	X	--	X	--	--
Strongylura timueu (Walbaum)	X	--	--	--	--	--	--
Sudis sp.	--	--	--	--	--	--	X
Synagrops microlepis Norman	--	--	X	--	--	--	X
Syngnathidae	--	X	X	--	--	--	--

Appendix I Table 7. Food found in stomachs of seven species of tuna from the Atlantic Ocean (from Dragovich, 1967) (continued).

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	*Katsuwonus pelamis*	*Thunnus albacares*	*Thunnus atlanticus*	*Thunnus thynnus*	*Thunnus obesus*	*Thunnus alalunga*
FISHES							
Syngnathus sp.	--	--	X	X	X	--	--
Syngnathus dunckeri Metzelaar	--	--	--	X	--	--	--
Syngnathus springeri Herald	X	--	--	--	--	--	--
Synodontidae	X	--	X	--	--	--	--
Synodus sp.	--	X	X	--	--	--	--
Synodus synodus (Linnaeus)	--	--	--	--	--	--	X
Taractes sp.	--	--	X	--	--	--	X
Tetragonurus atlanticus Lowe	--	--	--	--	--	--	X
Tetragonurus cuvieri Risso	--	--	--	--	--	--	X
Tetraodontidae	--	--	X	X	--	--	X
Therapon sp.	--	--	--	--	--	--	X
Thunnus atlanticus (Lesson)	--	X	--	--	--	--	--
Thyrsites atun (Euphrasen)	--	X	--	--	--	--	X
Trachurus sp.	--	--	--	--	--	--	X
Trachurus trachurus (Linnaeus)	--	--	X	--	X	--	X
Trachypterus iris (Walbaum)	--	--	--	--	--	--	X
Trachurus trachurus (Linnaeus)	--	--	X	--	X	X	X
Trichiurus sp.	--	X	X	--	--	--	--
Trichiurus lepturus Linnaeus	--	X	--	--	--	--	X
Trigla gurnardus Linnaeus	--	--	--	--	--	--	X
Triglidae (*Trigla* sp.)	--	--	--	--	--	--	X
Tripterodon sp.	--	--	--	--	--	--	X
Tylosurus acus (Lacépède)	X	--	--	--	--	--	--
Tylosurus crocodilus Linnaeus	X	--	--	--	--	--	--
Uranoscopus sp.	--	--	X	--	--	--	--
Valenciennellus tripunctulatus (Esmark)	--	--	X	--	--	--	--
Vomer setapinnis (Mitchill)	--	--	X	--	--	--	X
Vinciguerria sp.	--	--	--	--	--	--	X
Vinciguerria sanzoi Jespersen and Taaning	--	--	--	--	--	--	X
Xanthichthys ringens (Linnaeus)	--	--	X	X	--	--	--
Xiphasia setifer Swainson	--	--	X	--	--	--	--
Yozia bicoarctata (Bleeker)	--	--	X	--	--	--	--
Zeoidei	--	--	--	--	--	--	X
Zeus sp.	--	--	X	--	--	--	--
INVERTEBRATES							
OSTRACODA:							
Conchoecia sp.	--	--	--	--	--	--	X
Ostracoda (not further identified)	--	--	--	X	--	--	--
CEPEPODA:							
Calanus finmarchicus (Gunner)	--	--	--	--	--	--	X
Copepoda (not further identified)	X	X	--	--	--	--	--
Penella exocoeti (Holten)	--	--	X	--	--	--	--
CIRRIPEDIA:							
Lepas anatifera Linnaeus	--	--	--	--	--	--	X

Appendix I Table 7. Food found in stomachs of seven species of tuna from the Atlantic Ocean (from Dragovich, 1967) (continued).

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	*Katsuwonus pelamis*	*Thunnus albacares*	*Thunnus atlanticus*	*Thunnus thynnus*	*Thunnus obesus*	*Thunnus alalunga*
INVERTEBRATES							
MYSIDACAEA:							
Gnathophausia ingens (Dohrn)	--	--	--	X	--	--	X
ISOPODA:							
Isopoda (not further identified)	--	X	X	X	--	--	--
Idotea metallica Bosc	--	--	--	--	--	--	X
AMPHIPODA:							
Anchylomera blossevillei H. Milne Edwards	X	--	--	--	X	--	X
Amphipoda (not further identified)	--	X	X	X	--	--	X
Brachyscelus sp.	--	--	X	--	--	--	--
Brachyscelus crusculum Bate	X	--	X	--	X	--	X
Cystisoma sp.	--	--	X	--	X	--	X
Euthemisto sp.	--	--	--	--	--	--	X
Euthemisto bispinosa (Boeck) (Syn. of *Parathemisto guadichaudii* (Guerin))	--	--	--	--	--	--	X
Euprimno macropaus (Guerin) --now *Primno macropa* (Guerin)	--	--	--	X	--	--	--
Gammarus sp.	--	--	--	--	--	--	X
Hyperiidae	--	--	X	--	--	--	--
Hyperioides longipes (Chevreux)	X	--	--	--	X	--	X
Hyperia galba (Montegu)	--	--	--	--	--	--	X
Lanceola sayana Bovallius	--	--	X	--	--	--	--
Oxycephalus sp.	--	--	X	X	--	--	--
Paraproноë crustulum Claus	--	--	X	--	X	X	X
Paraphronima crassipes (Claus)	X	--	--	--	X	--	X
Parathemisto obliva (Kröyer) probably *Parathemisto gracilipes* (Norman)	--	--	--	--	--	--	X
Phronima sp.	--	--	X	X	--	--	--
Phronima atlantica Guérin	X	--	X	--	X	--	X
Phronima sedentaria (Forskal)	X	X	X	X	X	X	X
Phronima stebbingii (Vosseler)	X	--	--	--	X	--	X
Phrosina semilunata Risso	X	--	X	--	X	X	X
Platyscelus armatus (Claus)	--	--	X	--	X	X	X
Platyscelus ovoides (Risso)	X	--	--	--	X	--	X
Platyscelus serratulus Stebbing	--	--	--	--	--	--	X
Streetsia sp.	--	--	X	--	--	--	X
Streetsia challengeri Stebbing	--	--	--	--	--	--	X
Streetsia pronoides (Bovallius)	X	--	--	--	X	--	X
STOMATOPODA:							
Gonodactylus sp.	--	X	--	X	--	--	--
Lysiosquilla sp. (larvae)	--	X	X	X	--	--	--
Stomatopoda (not further identified)	X	X	X	X	--	--	--
Squillidae (various types of larvae)	X	X	X	X	--	--	X
Squilla sp.	--	--	X	X	--	--	--

Appendix I Table 7. Food found in stomachs of seven species of tuna from the Atlantic Ocean (from Dragovich, 1967) (continued).

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	*Katsuwonus pelamis*	*Thunnus albacares*	*Thunnus atlanticus*	*Thunnus thynnus*	*Thunnus obesus*	*Thunnus alalunga*
INVERTEBRATES							
EUPHAUSIACEA:							
Euphausiacea (not further identified)	--	X	X	X	X	--	X
Euphausia sp.	--	--	X	--	--	--	--
Euphausia lucens Hansen	--	--	X	-	X	X	X
Meganyctiphanes norvegica (M. Sars)	--	--	--	--	--	--	X
Nematoscelis megalops G. O. Sars	--	--	--	--	--	--	X
Nematoscelis sp.	X	--	--	--	X	--	X
Nyctiphanes sp.	--	X	--	--	--	--	--
Nyctiphanes capensis Hansen	--	--	X	--	--	--	--
Nyctiphanes couchii (Bell)	--	--	X	--	--	--	--
Stylocheiron abbreviatum G.O. Sars	--	--	--	--	--	--	X
Thysanoessa sp.	X	--	--	--	X	--	X
Thysanopoda	X	--	--	--	X	--	X
DECAPODA-CRUSTACEA:							
Decapoda (not further identified)	X	X	X	X	--	--	--
PENAEIDAE:							
Aristaeomorpha foliacea (Risso)	--	--	--	--	--	--	X
Cerataspis sp. (larvae)	--	--	X	--	--	--	--
Cerataspis monstrosa Gray	--	--	X	X	--	--	--
Funchalia villosa (Bouvier)	--	--	--	X	--	--	--
Mysis stages	X	--	--	--	--	--	--
Funchalia woodwardi Johnson	--	--	X	--	X	X	X
Gennadas (*Amalopenaeus*) *elegans* S. I. Smith	--	--	--	--	--	--	X
Parapenaeus longirostris (Lucas)	X	--	X	--	--	--	--
Penaeus duorarum Burkenroad	X	--	--	--	--	--	--
Penaeidae (not further identified)	X	--	--	--	--	--	X
SERGESTIDAE:							
Sergestes sp.	--	--	--	--	--	--	X
Sergestes arcticus Kröyer	--	--	--	--	--	--	X
Sergestes gloriosus Stebbing	--	--	--	--	--	--	X
Sergestes phorcus Faxon	--	--	--	--	--	--	X
Sergestes robustus Smith	--	--	--	--	--	--	X
Sergestes splendens Sund	--	--	--	--	X	--	--
CARIDEA:							
Acanthephyra sp.	--	--	X	--	--	--	X
Acanthephyra multispina Coutiere Syn. of *A. pelagica* (Risso)	--	--	--	--	--	--	X
Alpheidae (Diaphorus-larvae)	--	--	--	--	--	--	X
Alpheus ruber (larvae *Anebocaris*) H. Milne Edwards	--	--	--	--	--	--	X
Brachycarpus biunguiculatus (Lucas)	X	--	--	--	X	--	X
Enoplometopus dentatus Miers	--	--	--	--	--	--	X
Glyphocrangon sp.	--	--	--	--	--	--	X
Heterocarpus ensifer A. Milne Edwards	--	--	X	--	--	--	--
Hippolytidae	--	--	X	--	--	--	--

Appendix I Table 7. Food found in stomachs of seven species of tuna from the Atlantic Ocean (from Dragovich, 1967) (continued).

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	Katsuwonus pelamis	Thunnus albacares	Thunnus atlanticus	Thunnus thynnus	Thunnus obesus	Thunnus alalunga
INVERTEBRATES							
Icotopus amphissimus Coutière	X	--	--	--	X	--	X
Leptochela sp.	--	X	--	X	--	--	--
Palaemonidae	--	X	--	--	--	--	--
Palaemonella sp.	--	--	X	X	--	--	--
Parapasiphae sulcatifrons Smith	--	--	--	--	--	--	X
Pasiphae sp. (?)	--	--	--	--	--	--	X
Systellaspis debilis A. Milne Edwards	--	--	--	--	--	--	X
MACRURA-REPTANTIA:							
Axius stirhynchus Leach	--	--	--	--	--	--	X
Hippa cubensis (Saussure)	--	--	--	X	--	--	--
Jasus lalandii (A. Milne Edwards)	--	--	X	--	X	X	X
Jasus parkeri Stebbing - Syn. of Projasus parkeri (Stebbing)	--	--	--	--	--	--	X
Nephrops andamanica (?) Wood-Mason	--	--	--	--	--	--	X
Palinuridae	--	X	--	--	--	--	--
Palinurus sp.	--	X	--	--	--	--	X
Palinurus regius Brito Capello	--	--	--	X	--	--	X
Palinurus vulgaris (Phyllosoma) Latreille	X	--	--	--	X	--	X
Panulirus sp.	--	--	--	X	--	--	--
Phyllosoma	--	--	X	--	--	--	--
Scyllarides sp. (nisto stage)	--	--	--	--	--	--	X
Scyllarus arctus (Linnaeus)	X	--	--	--	X	--	X
Paguridae (Glaucothöe)	--	X	X	X	--	--	--
Pagurus sp.	--	--	X	--	--	--	--
Stenopus hispidus (Olivier)	--	--	--	X	--	--	--
BRACHYURA:							
Brachyrhyncha	--	X	--	--	--	--	--
Brachyrhyncha-megalopa	--	--	X	X	X	X	X
Megalopa (Portunidae and Dromiidae)	--	--	X	--	--	--	--
Megalopa	--	X	X	X	X	X	X
Oxyrhyncha	--	X	--	X	--	--	--
Plagusia chabrus (Linnaeus)	--	--	X	--	--	--	X
Portunas sp.	--	--	--	--	X	--	--
Zoea	--	X	X	--	--	--	X
OCTOPODA:							
Allopsus mollis Verrill	--	--	--	X	--	--	--
Argonauta nodosa Solander	--	--	X	--	X	X	X
Argonauta sp.	--	--	X	--	X	X	X
Bathypolypus sponsalis P. and H. Fischer	--	--	X	--	--	--	--
Bolliattaenella (Japetella) diaphana (Hoyle)	--	--	--	--	--	--	X
Eledone cirrhosa (Lamarck)	--	--	--	--	--	--	X
Eledone moschata (Lamarck)	--	--	--	--	X	--	--
Nautilus sp.	--	X	--	--	--	--	--
Octopidae	--	X	--	X	--	--	--

Appendix I Table 7. Food found in stomachs of seven species of tuna from the Atlantic Ocean (from Dragovich, 1967) (continued).

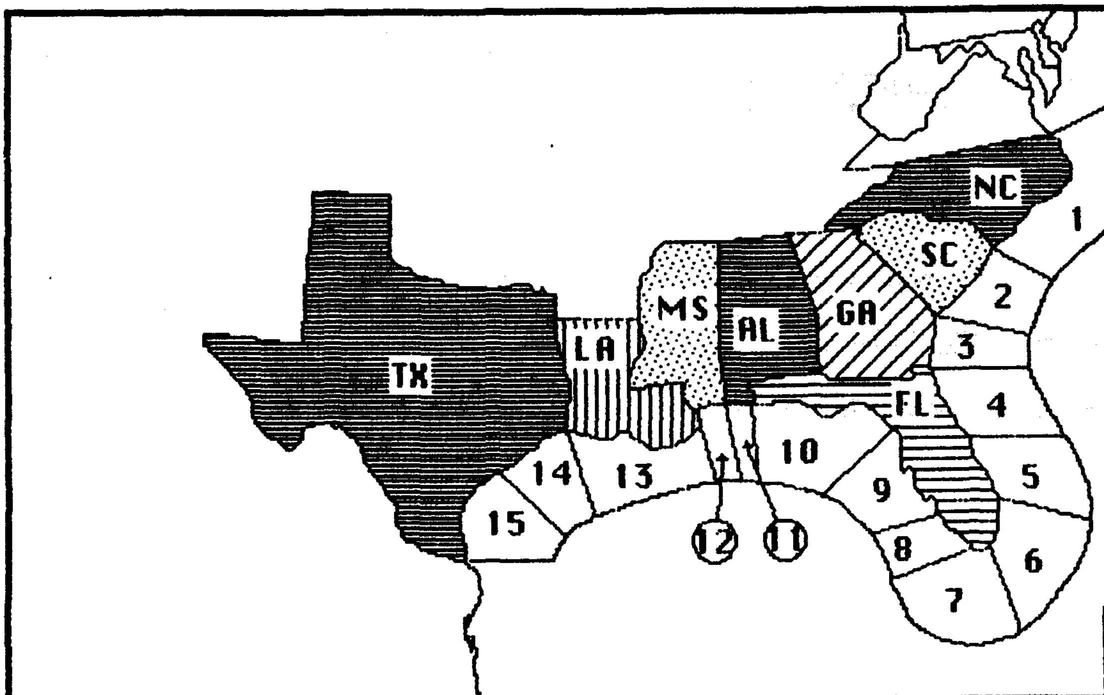
FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	*Katsuwonus pelamis*	*Thunnus albacares*	*Thunnus atlanticus*	*Thunnus thynnus*	*Thunnus obesus*	*Thunnus alalunga*
INVERTEBRATES							
Octopus sp.	--	X	--	X	X	--	--
Octopus burryi Voss	--	X	--	X	--	--	--
Octopus vulgaris Lamarck	--	--	X	--	--	--	X
Octopus defilippi Verany	--	--	X	--	--	--	--
Ocythoe tuberculata Rafinesque	--	--	--	--	--	--	X
Todarodes sagittatus (Lamarck)	--	--	X	--	--	--	--
Tremoctopus violaceus Delle Chiaja	--	--	--	--	--	--	X
Vitreledonella sp. (?)	--	--	--	--	--	--	X
TEUTHOIDEA:							
Abralia gilchristi Robson	--	--	X	--	X	X	X
Abralia veranyi (Ruppell)	--	X	X	--	--	--	--
Allotheuthis africana Adam	--	--	X	--	--	--	--
Brachioteuthis (*Tracheloteuthis*) *riisei* (Streenstrup)	--	--	--	--	--	--	X
Calliteuthis reversa (Verrill)	--	--	--	--	--	--	X
Chiroteuthis veranyi (Ferussac)	--	--	--	--	--	--	X
Chranchia scabra Leach	--	--	X	--	X	X	X
Ctenopteryx siculus Verany	--	--	--	--	--	--	X
Desmoteuthis hyperborea (Steenstrup)	--	--	--	--	--	--	X
Doryteuthis sp.	X	--	--	--	--	--	--
Doryteuthis plei (Blainville)	--	--	X	--	--	--	--
Galiteuthis armata Joubin	--	--	--	--	--	--	X
Gonatus fabricii (Lichtenstein)	--	--	--	--	--	--	X
Heteroteuthis dispar (Ruppell)	--	--	--	--	--	--	X
Histioteuthis bonelliana (Ferussac)	--	--	--	--	--	--	X
Illex coindeti (Verany)	--	--	--	--	--	--	X
Illex illecebrosus coindetti (Verany)	--	X	X	--	--	--	--
Liocranchia reinhardti (Steenstrup)	--	--	--	--	--	--	X
Loligo sp.	X	--	X	--	X	--	--
Loligo pealei LeSueur	--	X	--	--	--	--	--
Loligo reynaudii d'Orbigny	--	--	X	--	X	X	X
Loligo vulgaris Lamarck	--	--	--	--	X	--	--
Lolliguncula brevis (Blainville)	--	X	--	X	--	--	--
Lolliguncula mercatoris Adam	--	--	X	--	--	--	--
Mastigoteuthis (?) sp.	--	--	--	--	--	--	X
Octopodoteuthis sicula (Ruppell)	--	--	X	--	X	X	--
Ommastrephidae	--	--	--	--	--	--	X
Ommastrephes pteropus Steenstrup	--	X	X	--	--	--	--
Ommastrephes sagittatus (Lamarck)	--	--	--	--	--	--	X
Onychoteuthis banksii (Leach)	--	--	X	--	--	--	X
Onykia appellofii Pfeffer	--	--	X	--	--	--	--
Phasmatotenthion richardi (Joubin)	--	--	--	--	--	--	X

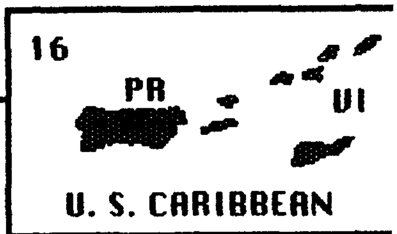
Appendix I Table 7. Food found in stomachs of seven species of tuna from the Atlantic Ocean (from Dragovich, 1967) (continued).

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	Katsuwonus pelamis	Thunnus albacares	Thunnus atlanticus	Thunnus thynnus	Thunnus obesus	Thunnus alalunga
INVERTEBRATES							
Sepia sp.	X	--	X	--	--	--	--
Sepietta oweniana d'Orbigny	--	--	--	--	--	--	X
Spirula spirula (Linnaeus)	--	--	X	--	X	X	X
Teuthoidea	X	X	X	X	X	--	--
Taoniinae	--	--	--	--	--	--	X
Taonidium pfefferi Russell	--	--	--	--	--	--	X
Teuthowenia (Heliocranchia) pfefferi (Massy)	--	--	--	--	--	--	X
Todaropsis eblanae (Ball)	--	--	X	--	--	--	X
GASTROPODA:							
Gastropoda (not further identified)	--	X	X	X	--	--	X
Janthina sp.	--	--	--	--	--	--	X
Janthina exigua Lamarck	--	--	--	--	--	--	X
HETEROPODA:							
Atlantidae	--	--	--	--	--	--	X
Atlanta sp.	--	--	X	X	--	--	--
Atlanta peronii LeSueur	--	--	--	--	--	--	X
Heteropoda (not further identified)	--	X	--	X	--	--	--
Pterotrachea sp.	--	--	X	--	X	X	X
PTEROPODA:							
Cavolinidae	--	--	X	--	X	--	X
Cavolinia sp.	--	--	X	--	X	X	X
Clio pyramidata Linnaeus	--	--	--	--	--	--	X
Creseis sp.	--	--	--	X	--	--	--
Cuvierina sp.	--	--	X	--	--	--	--
Diacria trispinosa (LeSueur)	--	--	--	--	--	--	X
Limacina sp.	--	--	--	X	--	--	--
Pteropoda (not further identified)	--	X	--	--	--	--	--
MISCELLANEOUS:							
Chelophyes appendiculatta	--	--	--	--	--	--	X
(Eschscholtz)	--	--	--	--	--	--	X
Galetta australis? (LeSueur)							
Naiades cantrainii (Delle Chiaje)	--	--	--	--	--	--	X
Pelagia noctiluca Péron and LeSueur	--	--	--	--	--	--	X
Pyrosoma atlanticum (Péron)	--	--	--	--	--	--	X
Salpidae	--	--	X	--	X	X	X
Salpa (Iasis) zonaria Pallas	--	--	--	--	--	--	X
Torrea candida (Delle Chiaje)	--	--	--	--	--	--	X
Velella velella Linnaeus	--	--	--	--	--	--	X

I. APPENDIX II

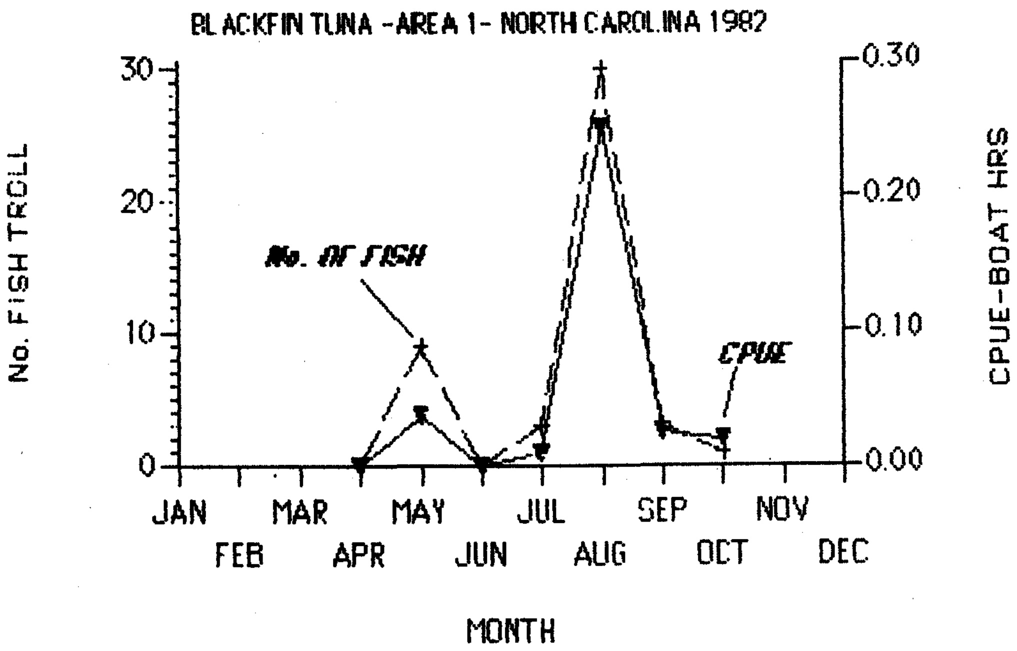
Figures and tables generated by computer programs from unpublished data from several sources: NMFS Panama City Laboratory, NMFS Mississippi Laboratory, Pascagoula, and Metropolitan South Florida Fishing .Tournament



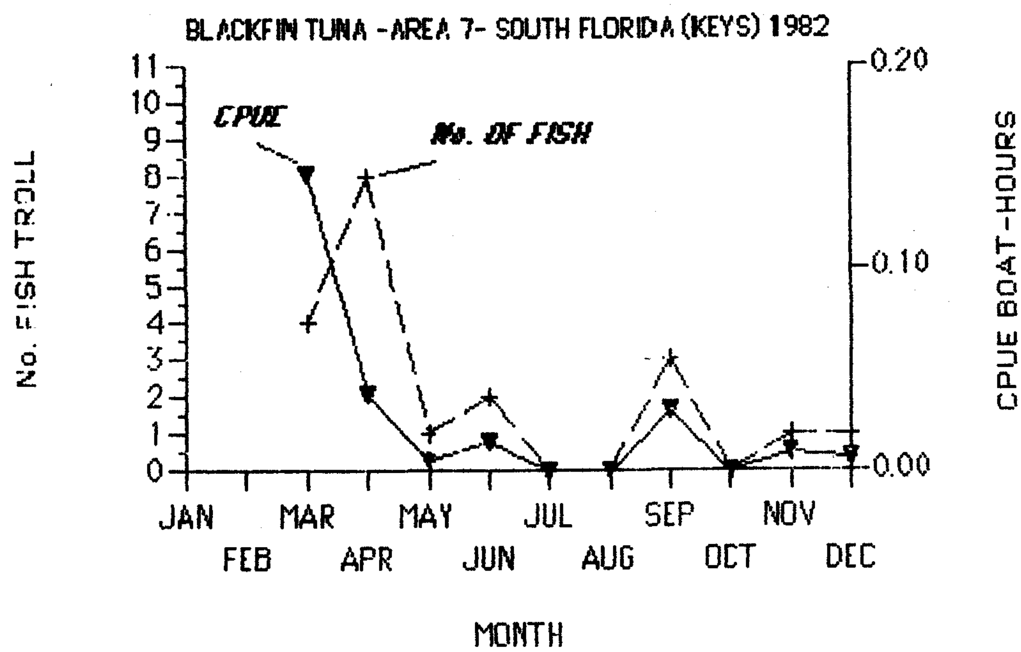


GEOGRAPHIC KEY TO FISHING AREAS IN THE SOUTHEASTERN UNITED STATES FOR FIGURES ON CATCH AND EFFORT DATA FOR BLACKFIN TUNA AND LITTLE TUNNY, FROM SAMPLE SURVEYS OF CHARTERBOAT CAPTAINS, 1982 TO 1985.
(FROM NOAA, NATIONAL MARINE FISHERIES SERVICE, SOUTHEAST FISHERIES CENTER, PANAMA CITY LABORATORY).

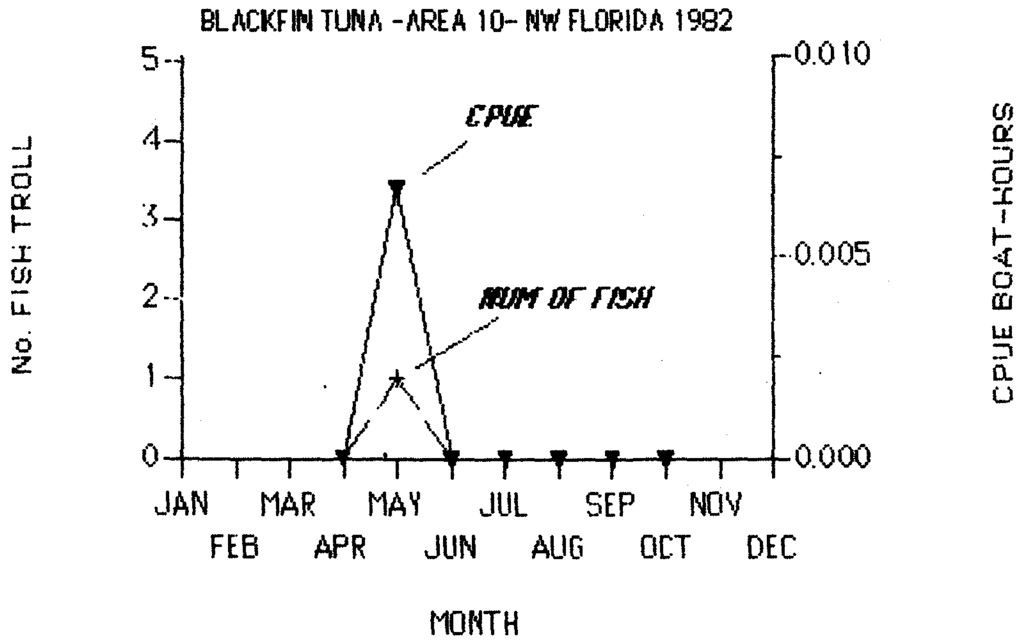
Appendix II. Figure 1.



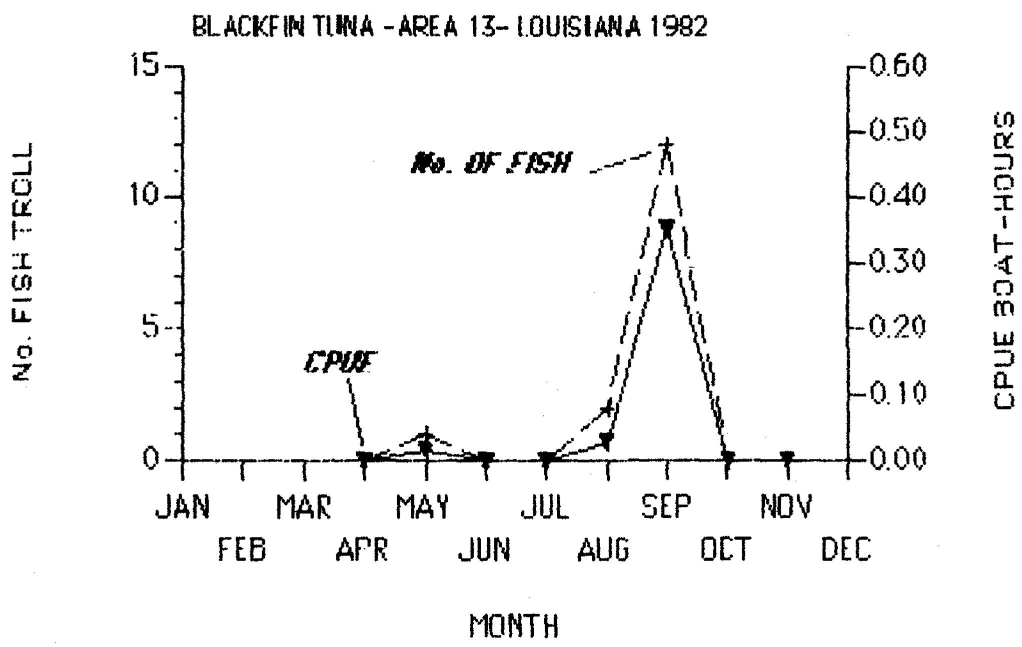
Appendix II. Figure 2.- BLACKFIN TUNA. CATCH AND CPUE FOR NORTH CAROLINA. 1982 CHARTERBOAT DATA.



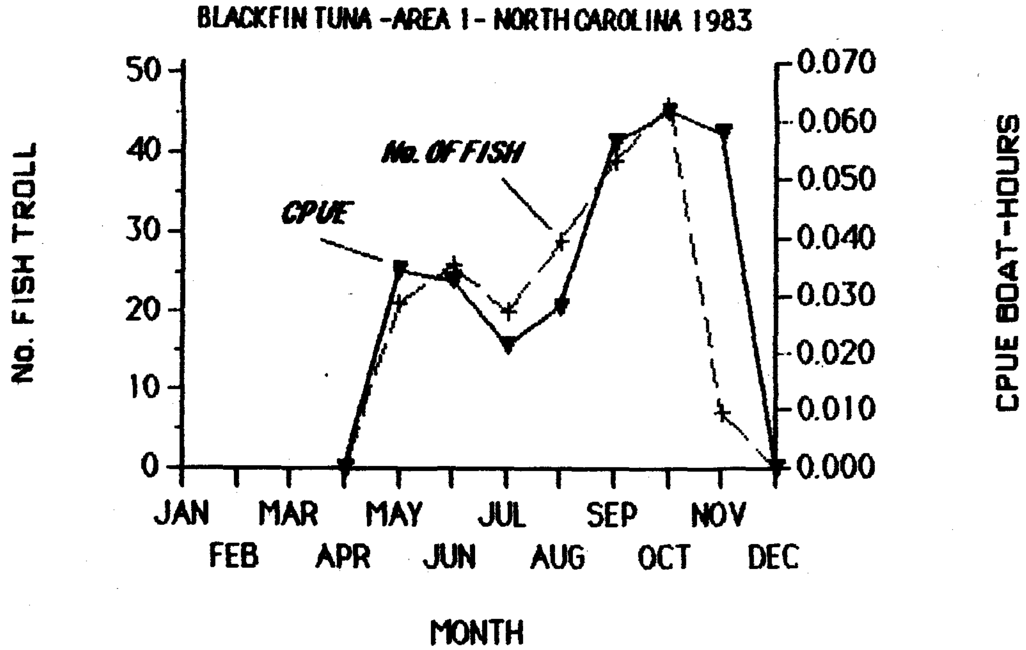
Appendix II. Figure 3.- BLACKFIN TUNA. CATCH AND CPUE FOR THE FLORIDA KEYS. 1982 CHARTERBOAT DATA.



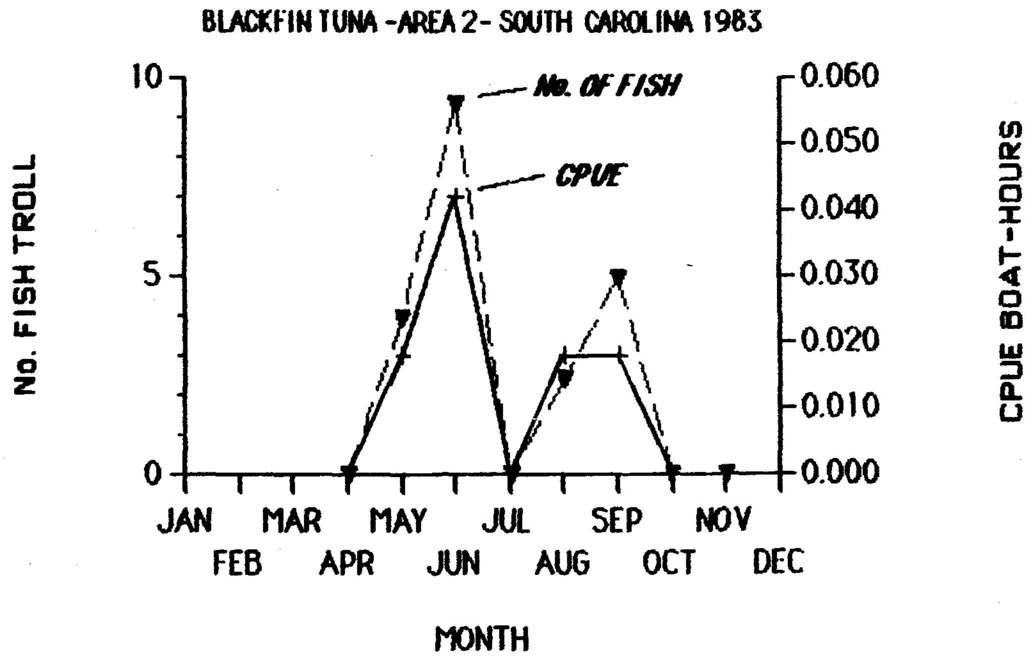
Appendix II. Figure 4.-- BLACKFIN TUNA. CATCH AND CPUE FOR NW FLORIDA. 1982 CHARTERBOAT DATA.



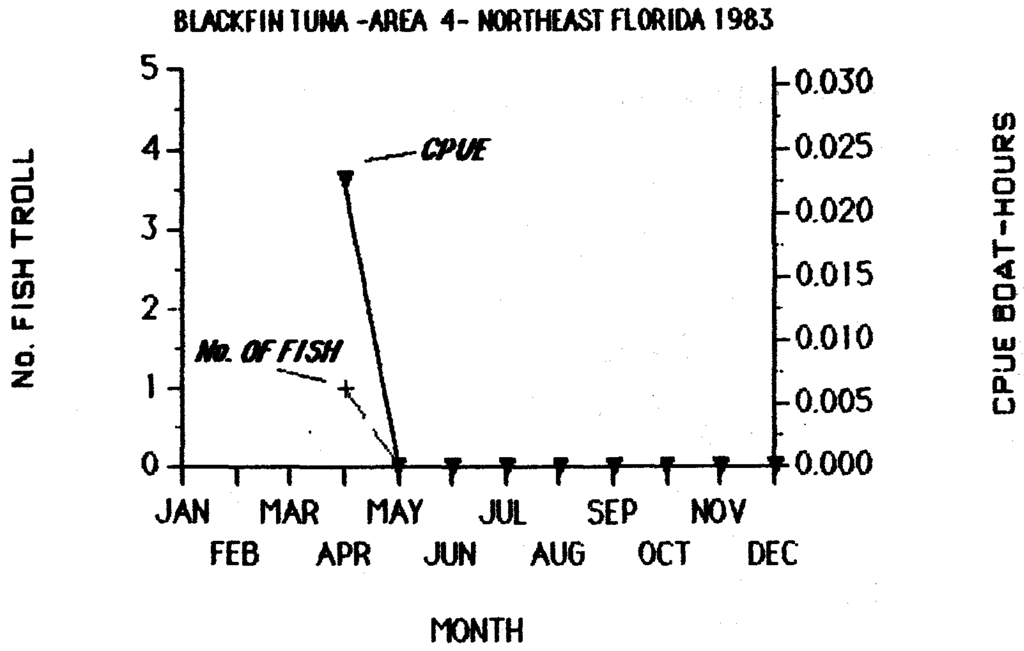
Appendix II. Figure 5.- BLACKFIN TUNA. CATCH AND CPUE FOR LOUSIANA. 1982 CHARTERBOAT DATA.



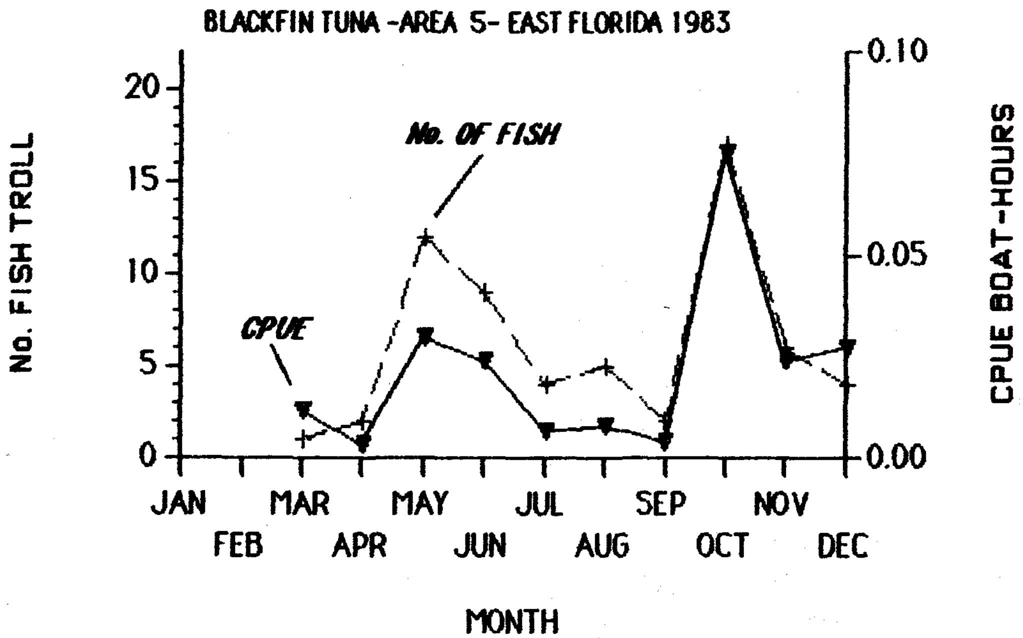
Appendix II.Figure 6.- BLACKFIN TUNA. CATCH AND CPUE FOR NORTH CAROLINA. 1983 CHARTERBOAT DATA.



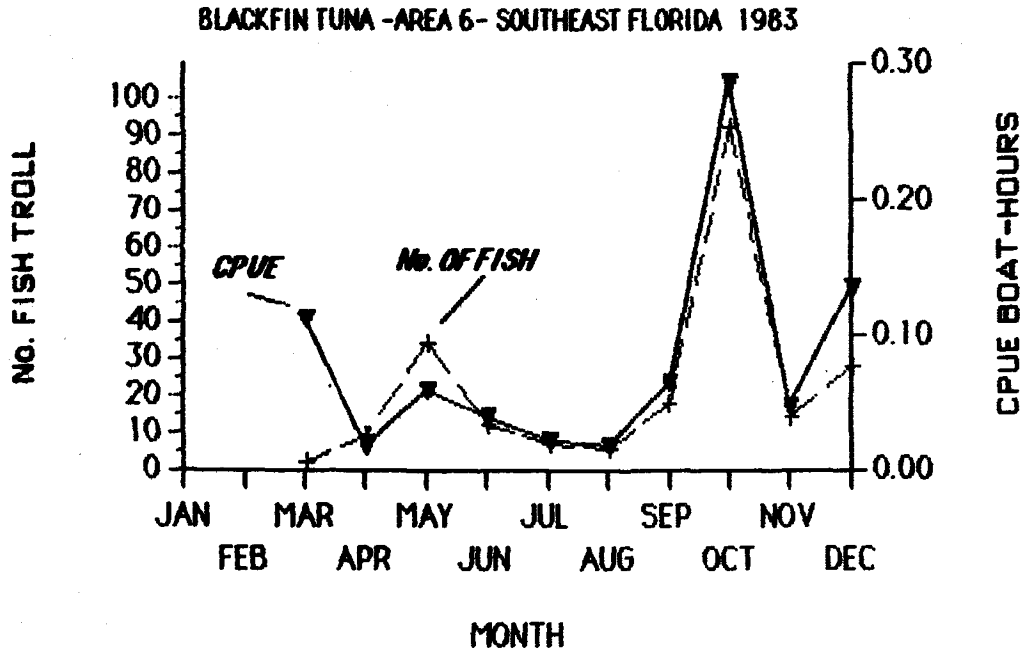
Appendix II. Figure 7.- BLACKFIN TUNA. CATCH AND CPUE FOR SOUTH CAROLINA. 1983 CHARTERBOAT DATA.



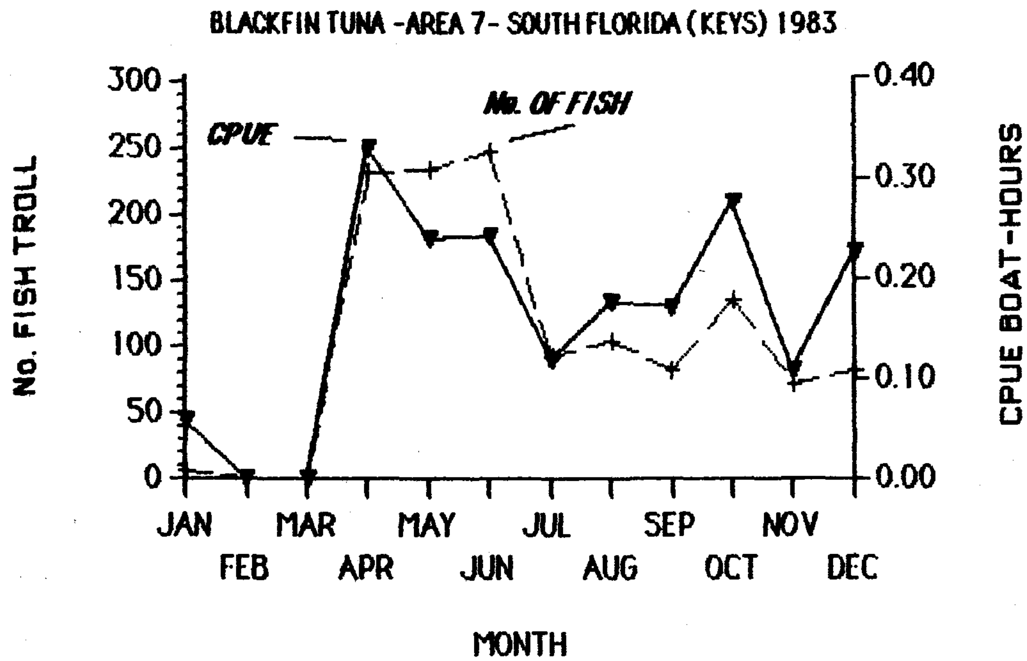
Appendix II. Figure 8.– BLACKFIN TUNA. CATCH AND CPUE FOR NORTHEAST FLORIDA. 1983 CHARTERBOAT DATA.



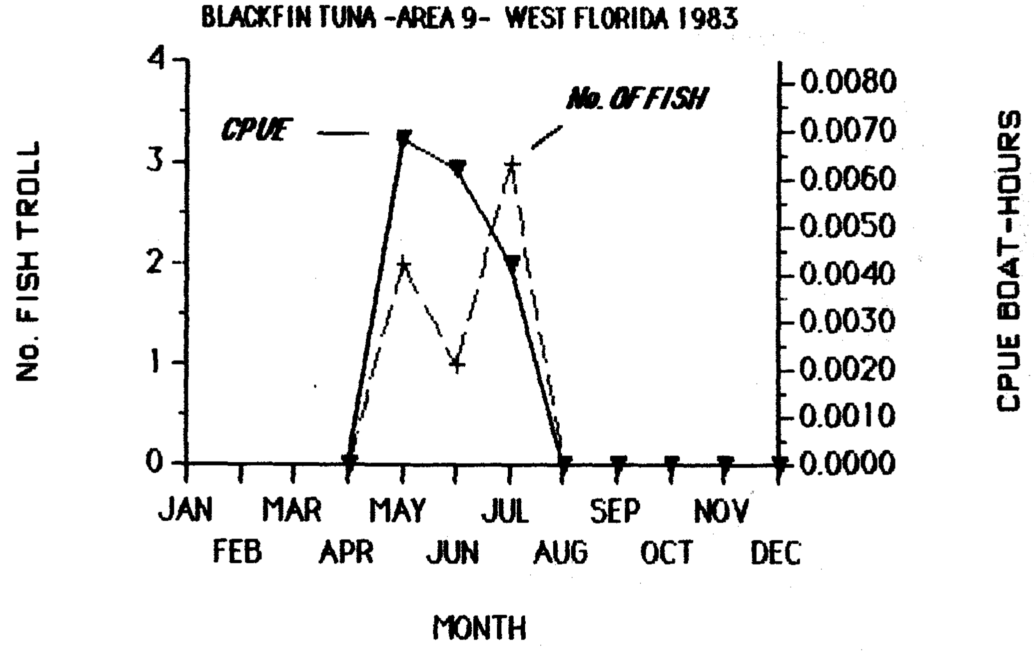
Appendix II. Figure 9.– BLACKFIN TUNA. CATCH AND CPUE FOR EAST FLORIDA. 1983 CHARTERBOAT DATA.



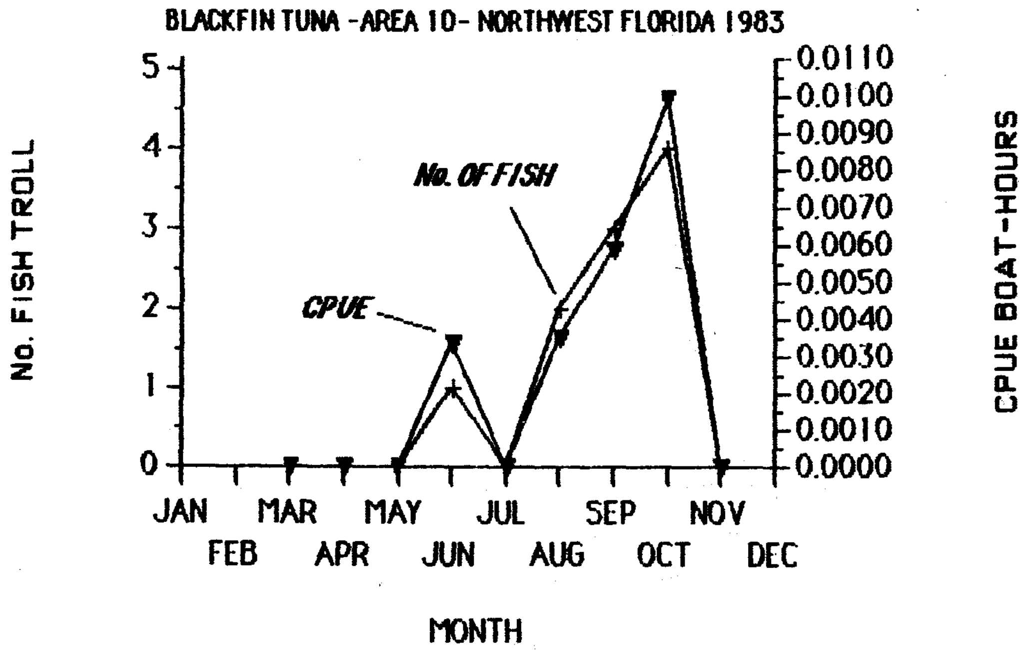
Appendix II. Figure 10.- BLACKFIN TUNA. CATCH AND CPUE FOR SOUTH EAST FLORIDA. 1983 CHARTERBOAT DATA.



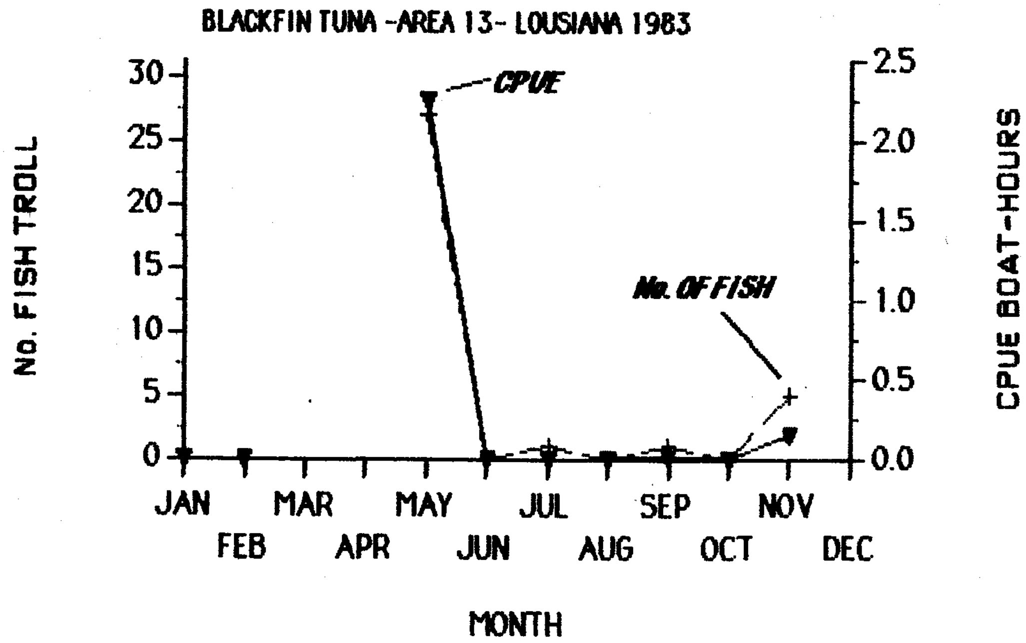
Appendix II. Figure 11.- BLACKFIN TUNA. CATCH AND CPUE FOR SOUTH FLORIDA (KEYS). 1983 CHARTERBOAT DATA.



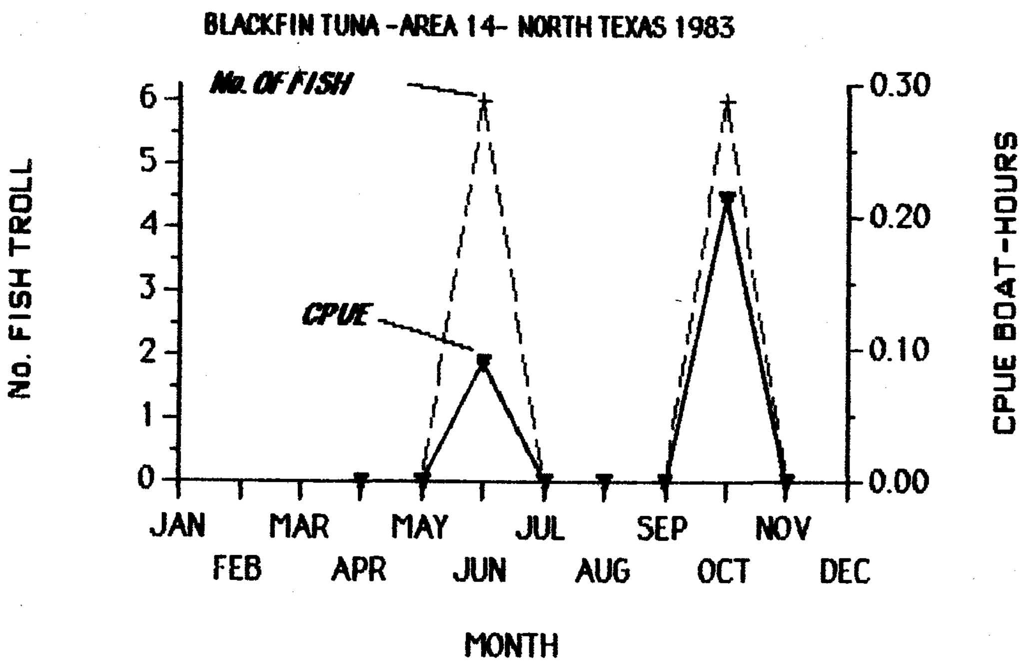
Appendix II.Figure 12.- BLACKFIN TUNA. CATCH AND CPUE FOR WEST FLORIDA. 1983 CHARTERBOAT DATA.



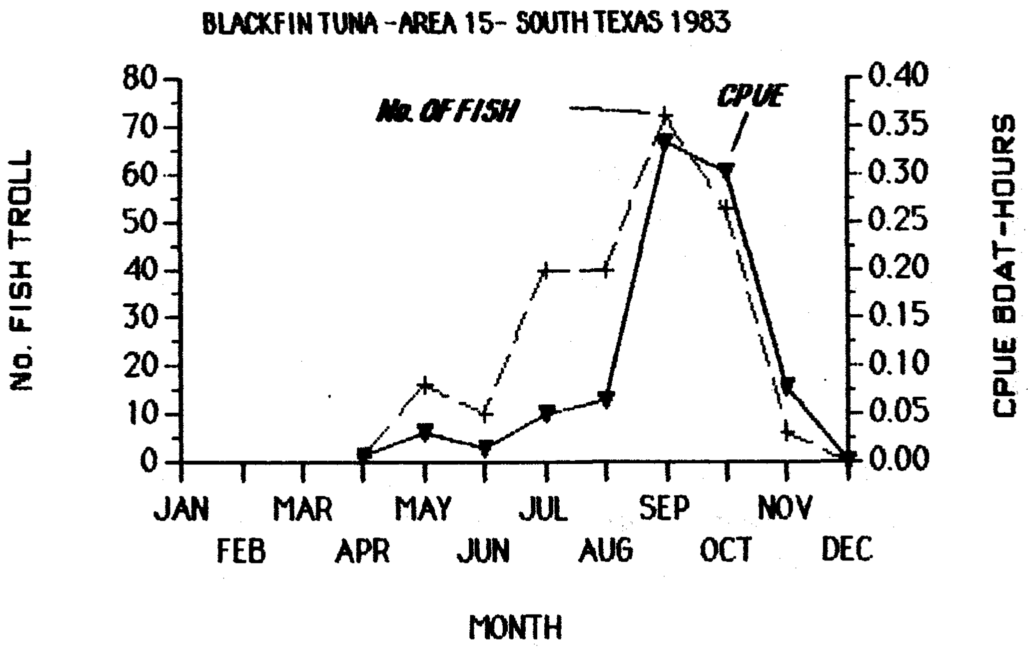
Appendix II. Figure 13. BLACKFIN TUNA. CATCH AND CPUE FOR NORTHWEST FLORIDA. 1983 CHARTERBOAT DATA.



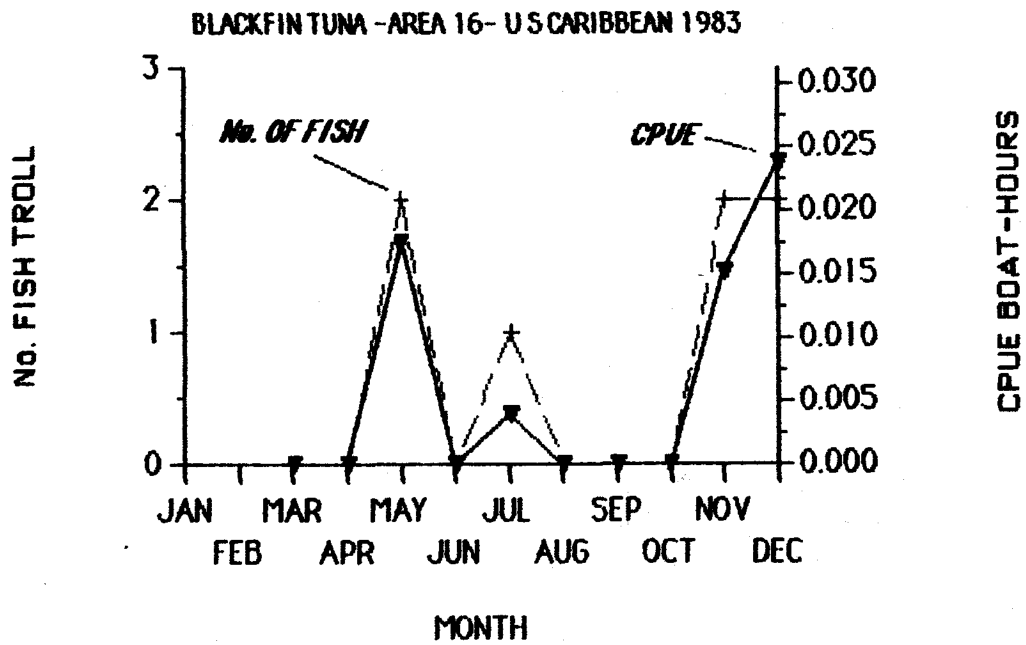
Appendix II. Figure 14.– BLACKFIN TUNA. CATCH AND CPUE FOR LOUSIANA. 1983 CHARTERBOAT DATA.



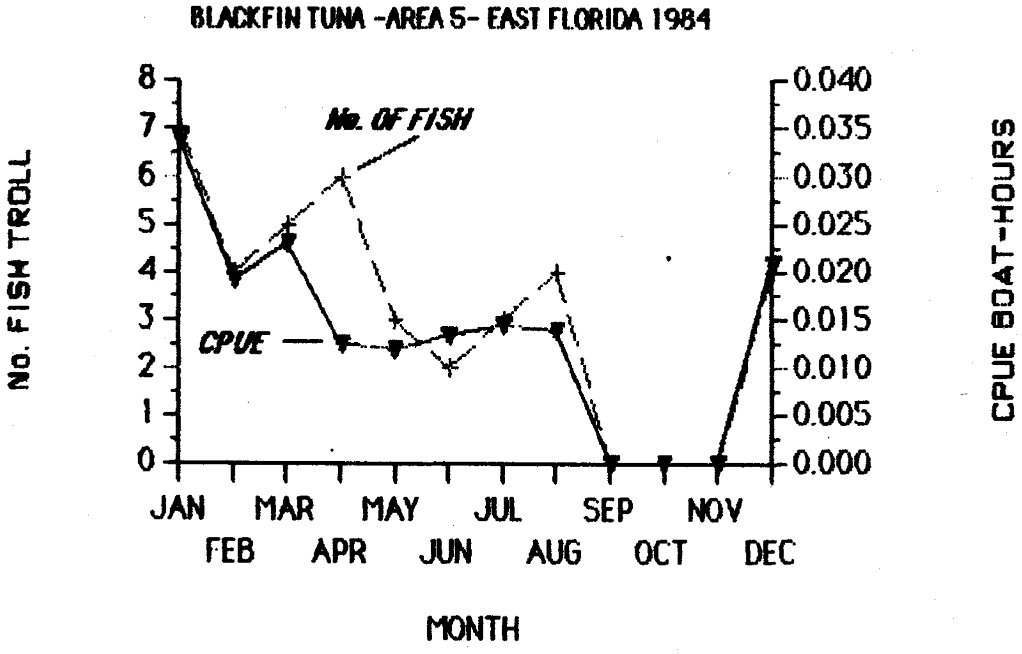
Appendix II. Figure 15.– BLACKFIN TUNA. CATCH AND CPUE FOR NORTH TEXAS. 1983 CHARTERBOAT DATA.



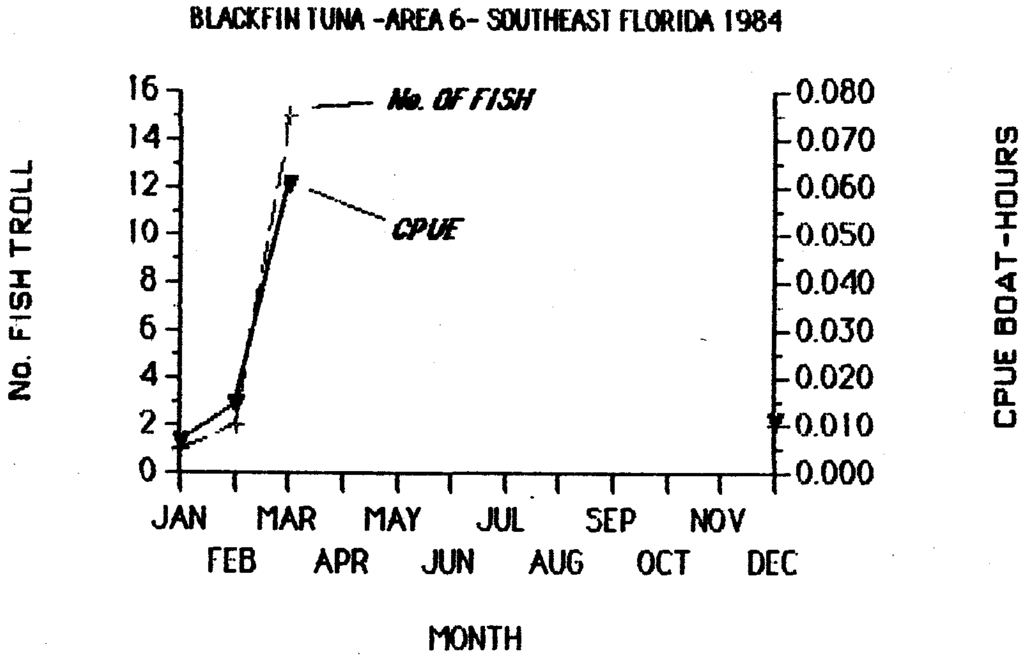
Appendix II. Figure 16.- BLACKFIN TUNA. CATCH AND CPUE FOR SOUTH TEXAS. 1983 CHARTERBOAT DATA.



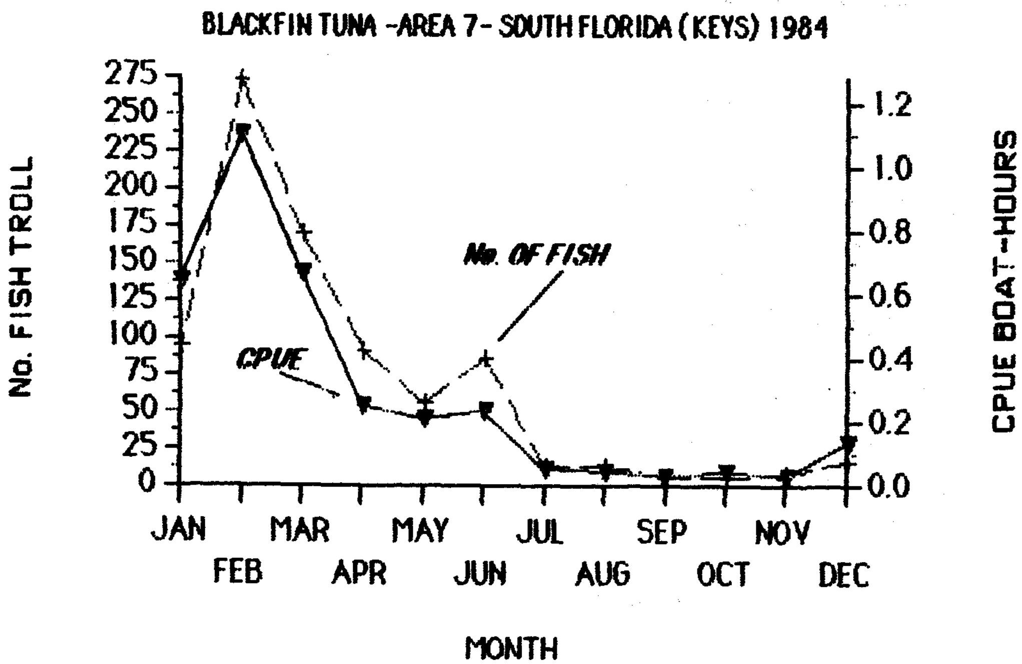
App ndix II. Figure 17.- BLACKFIN TUNA. CATCH AND CPUE FOR THE U. S. CARIBBEAN. 1983 CHARTERBOAT DATA.



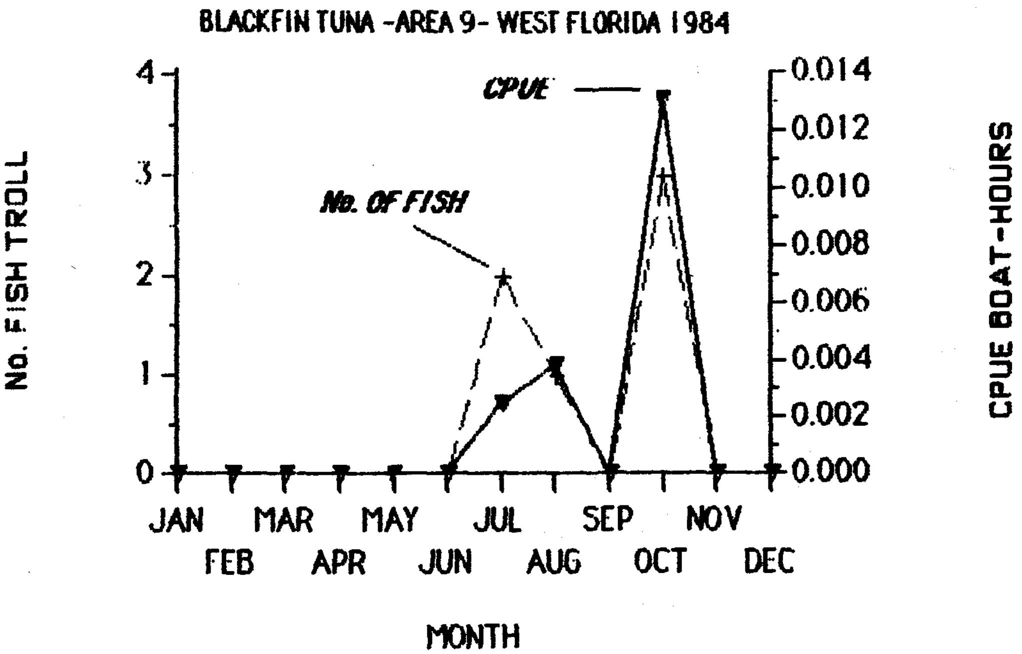
Appendix II. Figure 18.- BLACKFIN TUNA. CATCH AND CPUE FOR EAST FLORIDA. 1984 CHARTERBOAT DATA.



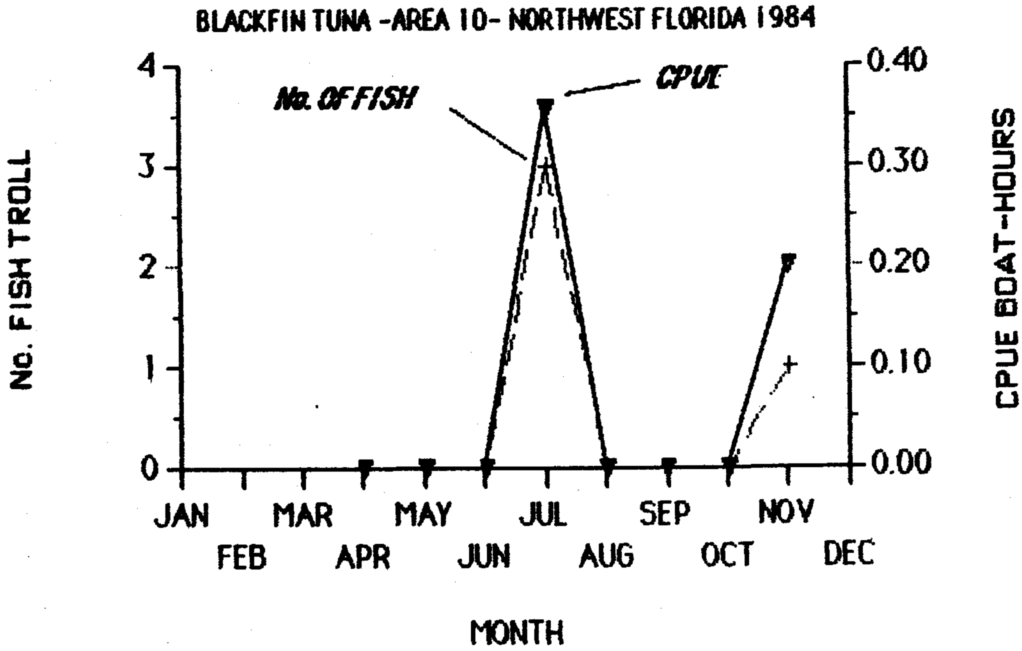
Appendix II. Figure 19.- BLACKFIN TUNA. CATCH AND CPUE FOR SOUTHEAST FLORIDA. 1984 CHARTERBOAT DATA.



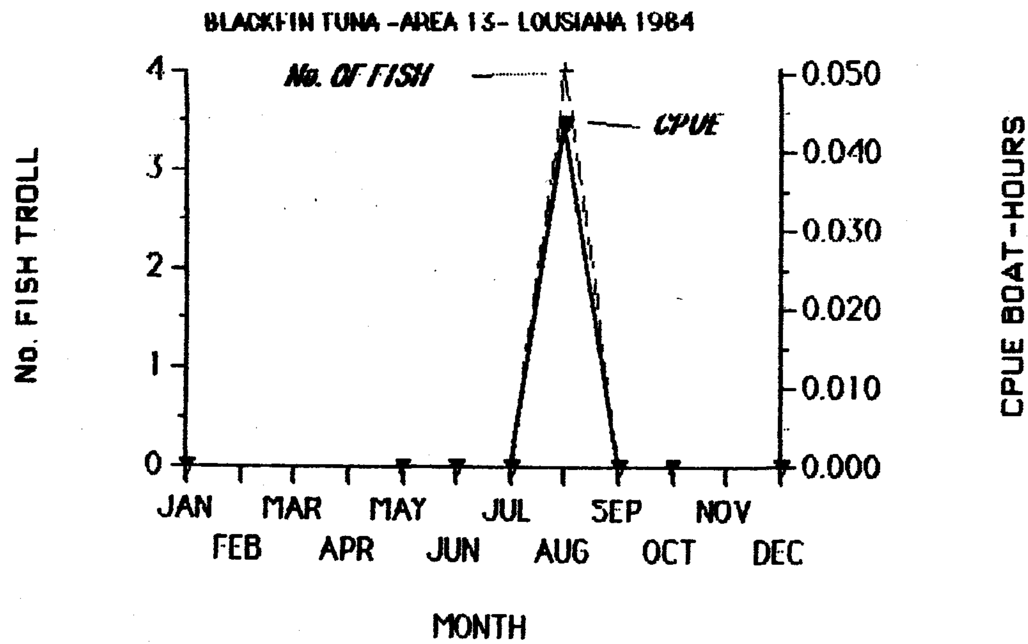
Appendix II. Figure 20.– BLACKFIN TUNA. CATCH AND CPUE FOR SOUTH FLORIDA (KEYS). 1984 CHARTERBOAT DATA.



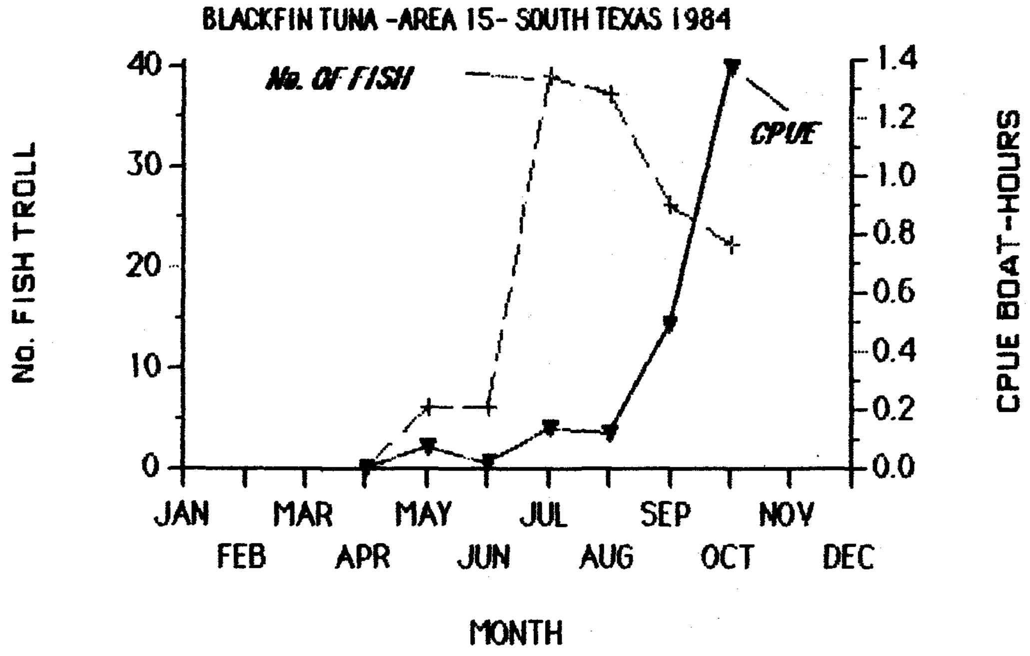
Appendix II. Figure 21.– BLACKFIN TUNA. CATCH AND CPUE FOR WEST FLORIDA. 1984 CHARTERBOAT DATA.



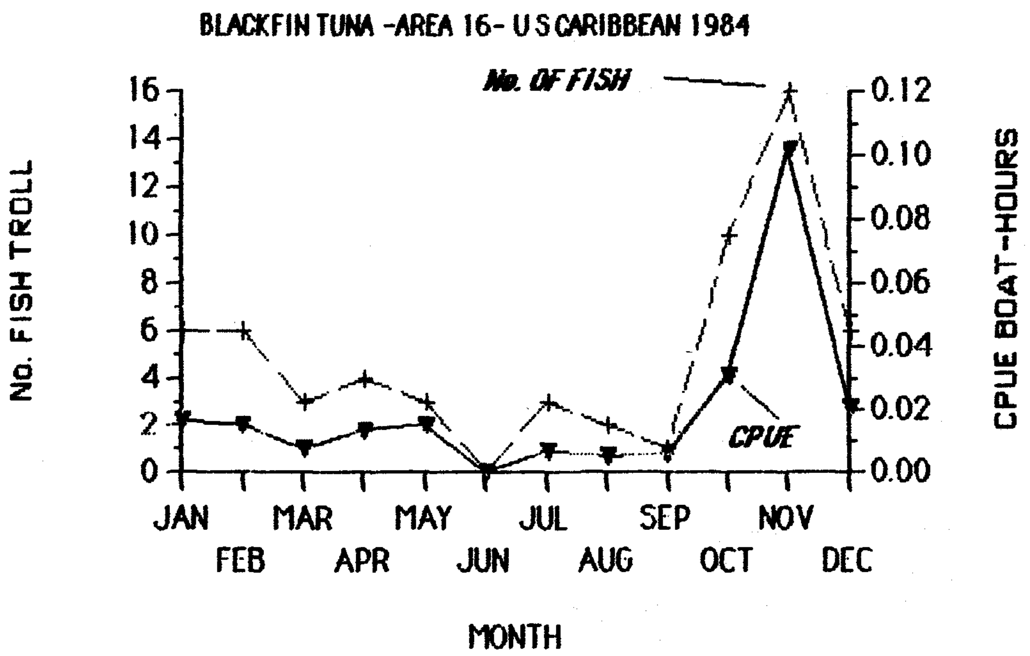
Appendix II. Figure 22.- BLACKFIN TUNA. CATCH AND CPUE FOR NORTHWEST FLORIDA. 1984 CHARTERBOAT DATA.



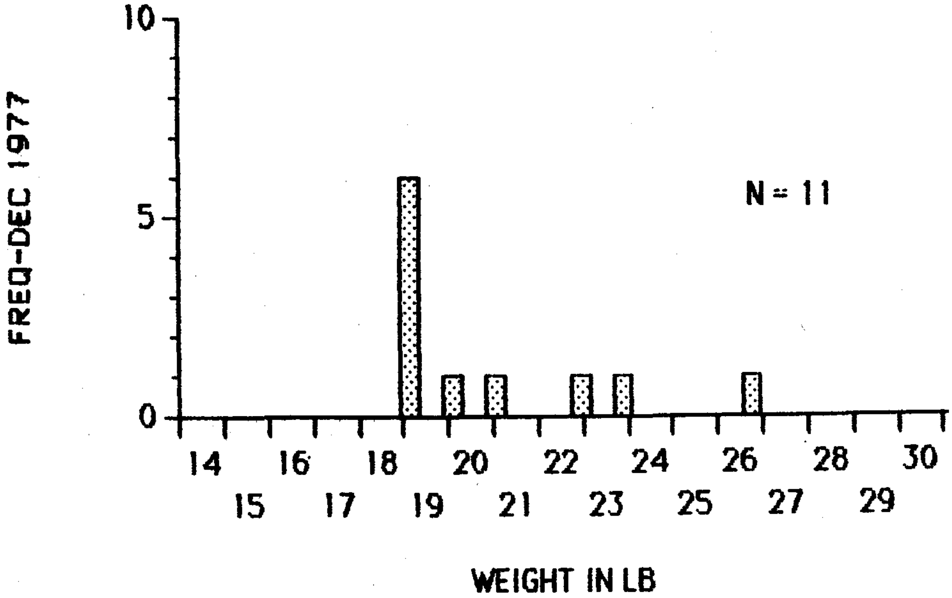
Appendix II. Figur- 23.- BLACKFIN TUNA. CATCH AND CPUE FOR LOUSIANA. 1984 CHARTERBOAT DATA.



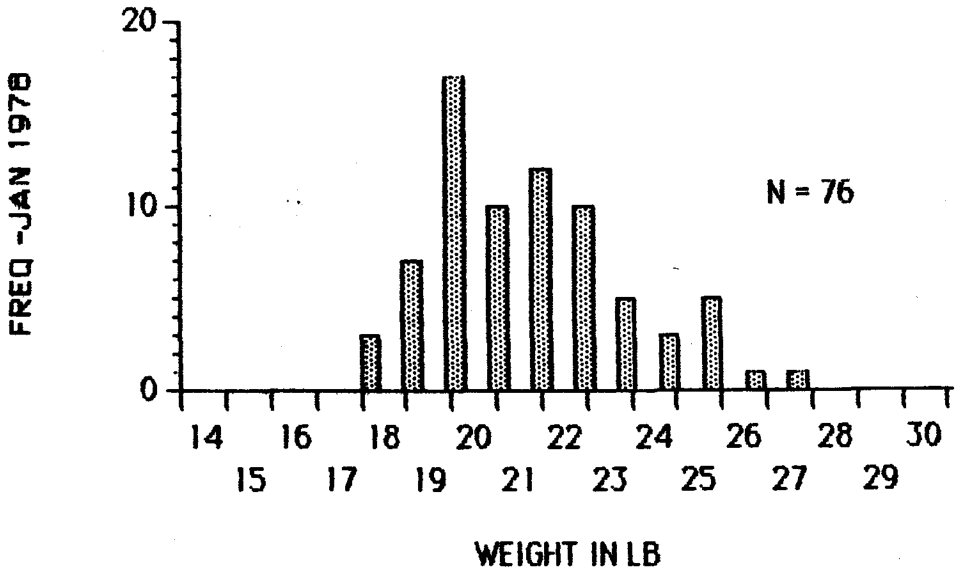
Appendix II. Figure 24.– BLACKFIN TUNA. CATCH AND CPUE FOR SOUTH TEXAS. 1984 CHARTERBOAT DATA.



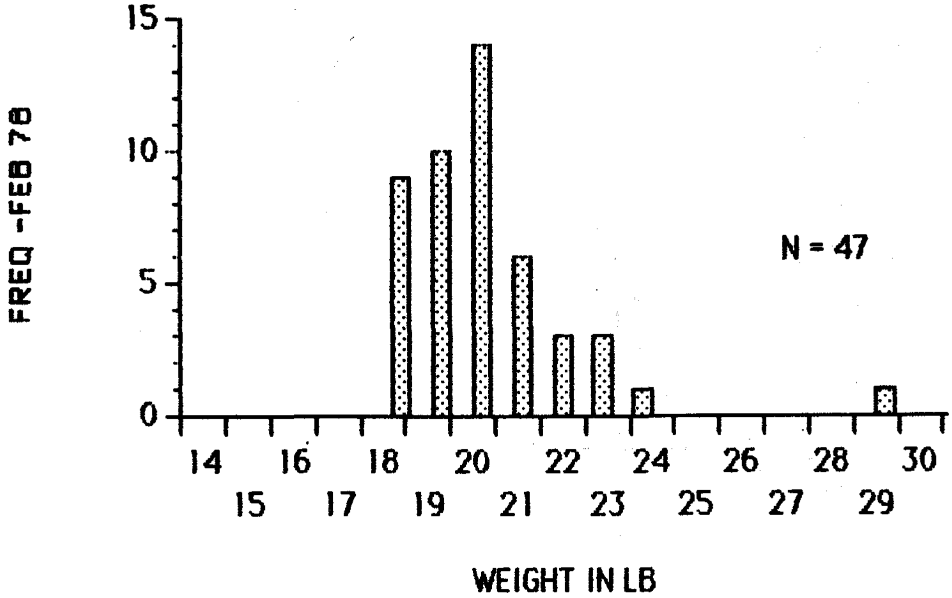
Appendix II. Figure 25.– BLACKFIN TUNA. CATCH AND CPUE FOR THE U. S. CARIBBEAN. 1984 CHARTERBOAT DATA.



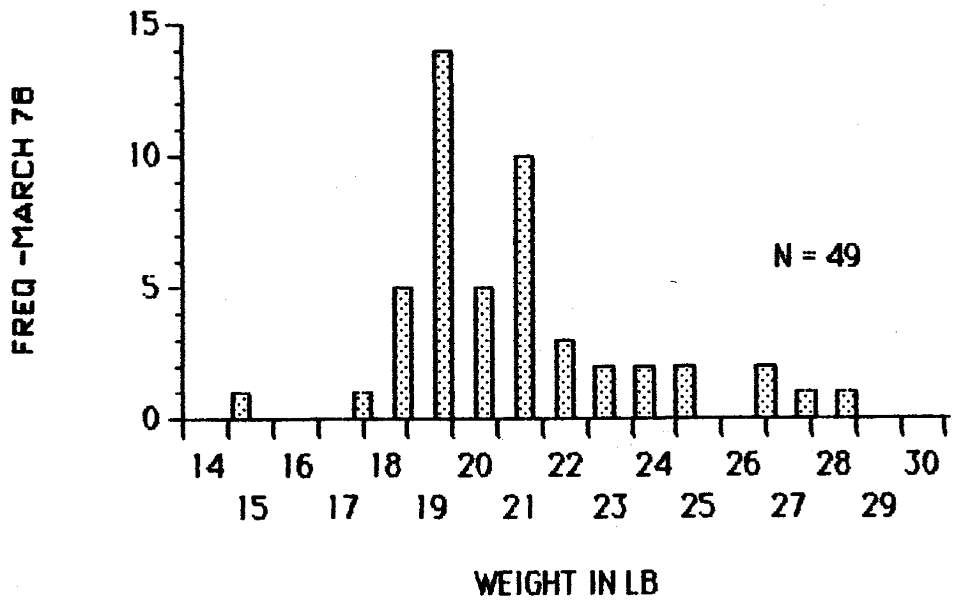
Appendix II. Figure 26.– BLACKFIN TUNA. FREQUENCY DISTRIBUTION OF CATCH BY WEIGHT. METROPOLITAN SOUTH FLORIDA FISHING TOURNAMENT. DECEMBER 1977.



Appendix II. Figure 27.– BLACKFIN TUNA. FREQUENCY DISTRIBUTION OF CATCH BY WEIGHT. METROPOLITAN SOUTH FLORIDA FISHING TOURNAMENT. JANUARY 1978.



Appendix II. Figure 28.- BLACKFIN TUNA. FREQUENCY DISTRIBUTION OF CATCH BY WEIGHT. METROPOLITAN SOUTH FLORIDA FISHING TOURNAMENT. FEBRUARY 1978.



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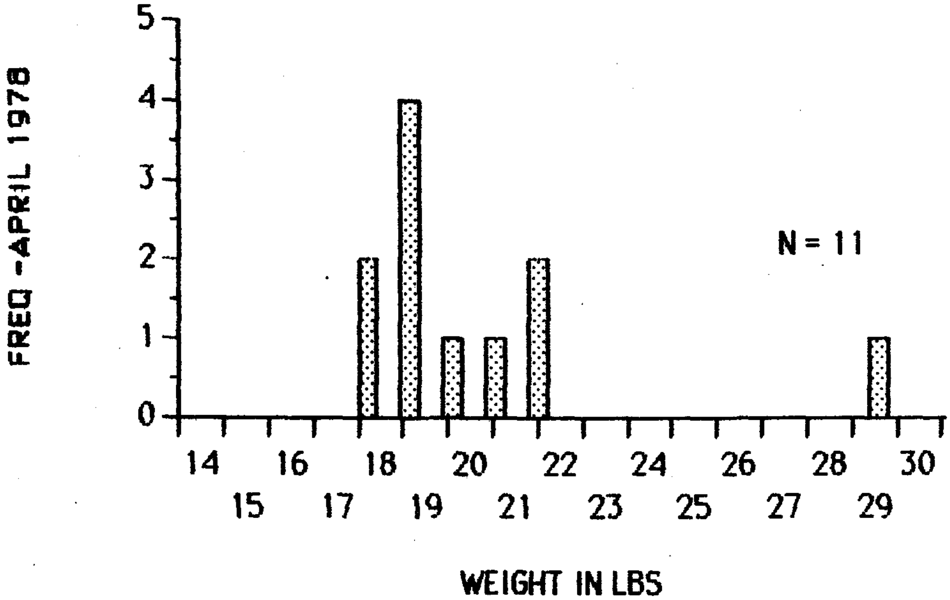
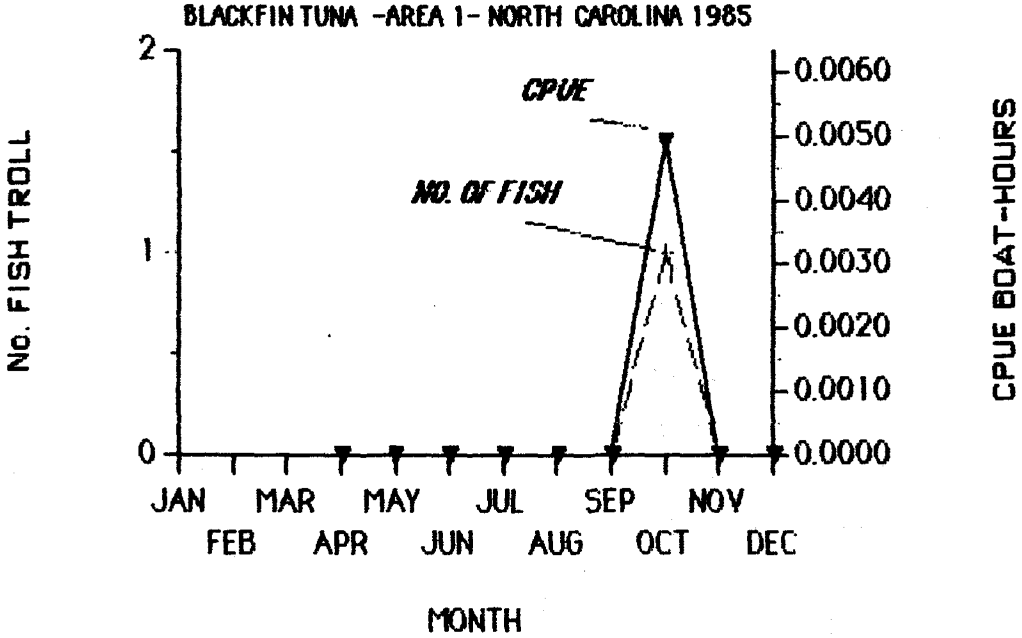
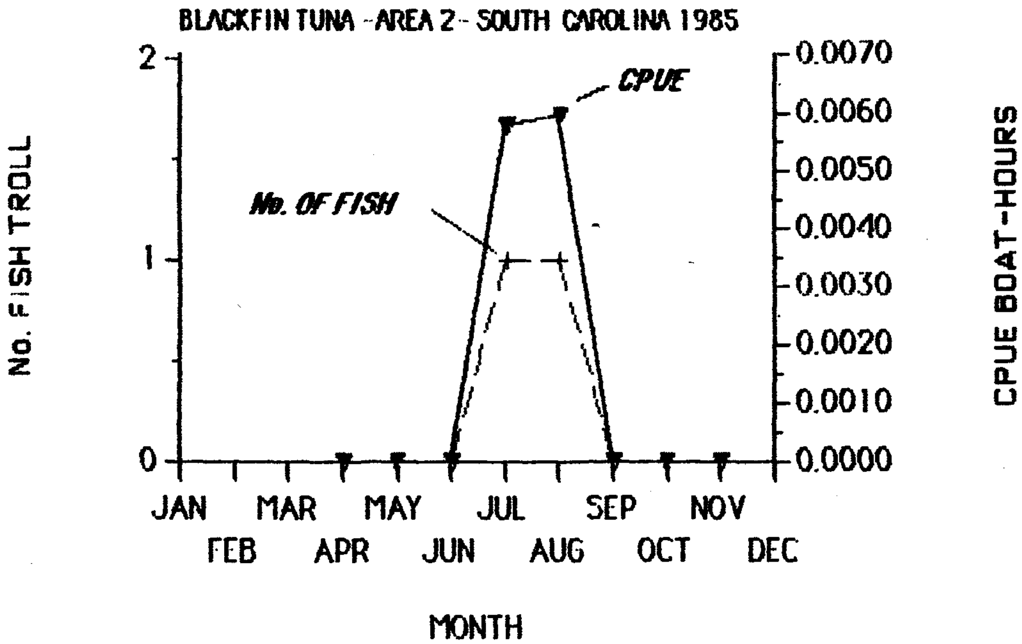


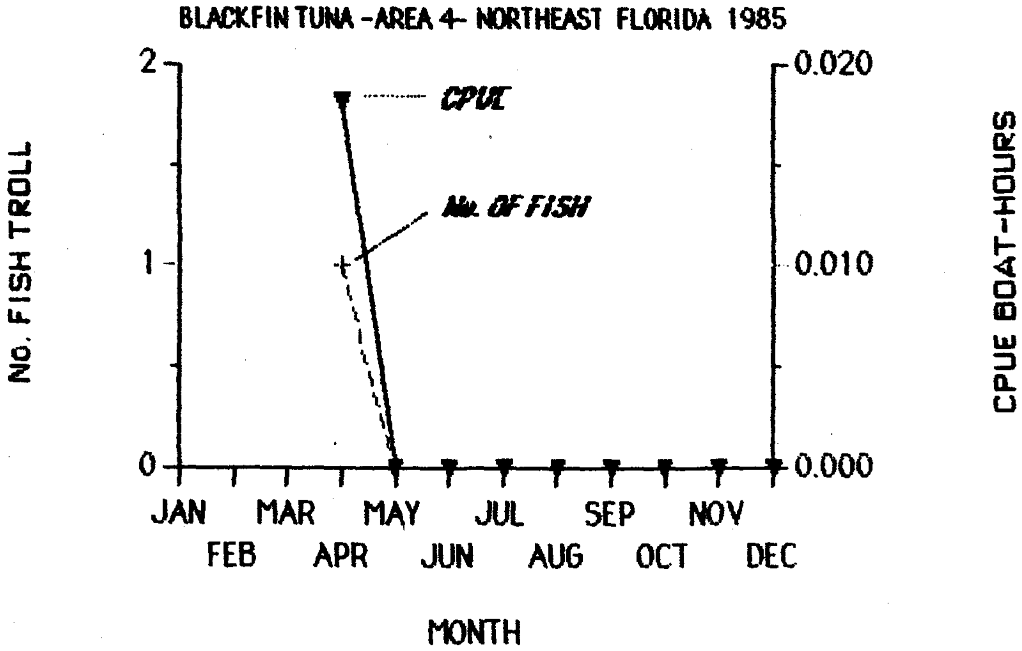
Appendix II. Figure 30.— BLACKFIN TUNA. FREQUENCY DISTRIBUTION OF CATCH BY WEIGHT. METROPOLITAN SOUTH FLORIDA FISHING TOURNAMENT. APRIL 1978.



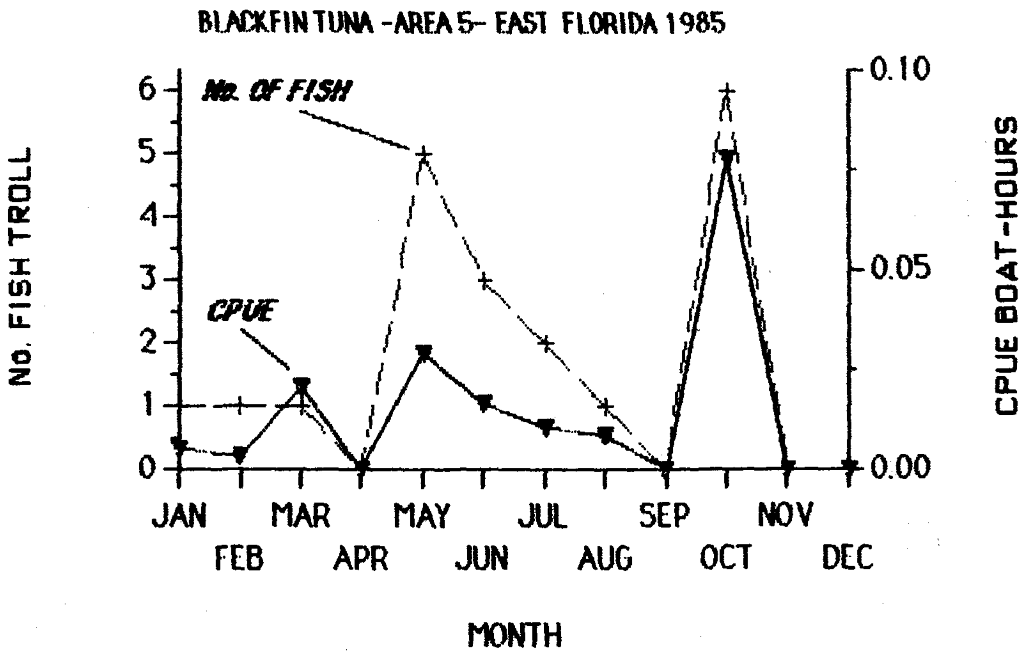
Appendix II. Figure 31.- BLACKFIN TUNA. CATCH AND CPUE FOR NORTH CAROLINA. 1985 CHARTERBOAT DATA.



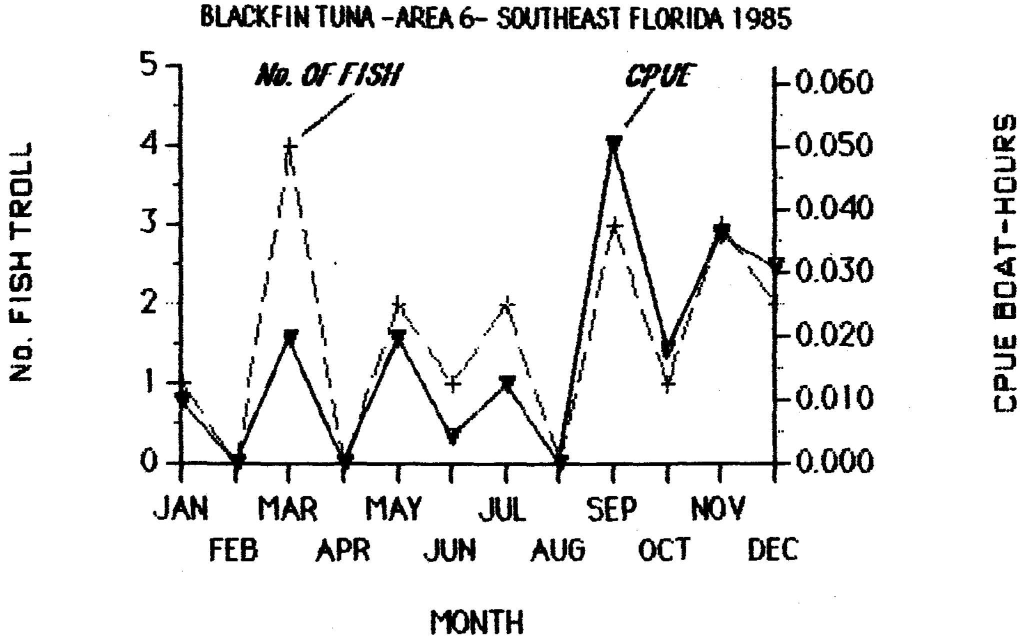
Appendix II. Figure 32.- BLACKFIN TUNA. CATCH AND CPUE FOR SOUTH CAROLINA. 1985 CHARTERBOAT DATA.



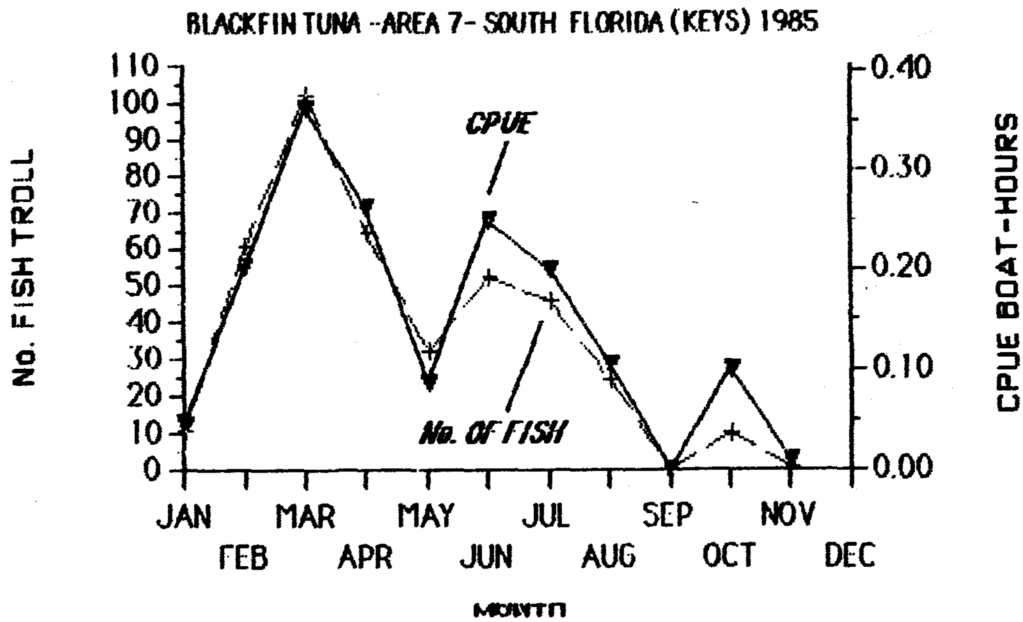
Appendix II. Figure 33.– BLACKFIN TUNA. CATCH AND CPUE FOR NORTHEAST FLORIDA. 1982 CHARTERBOAT DATA.



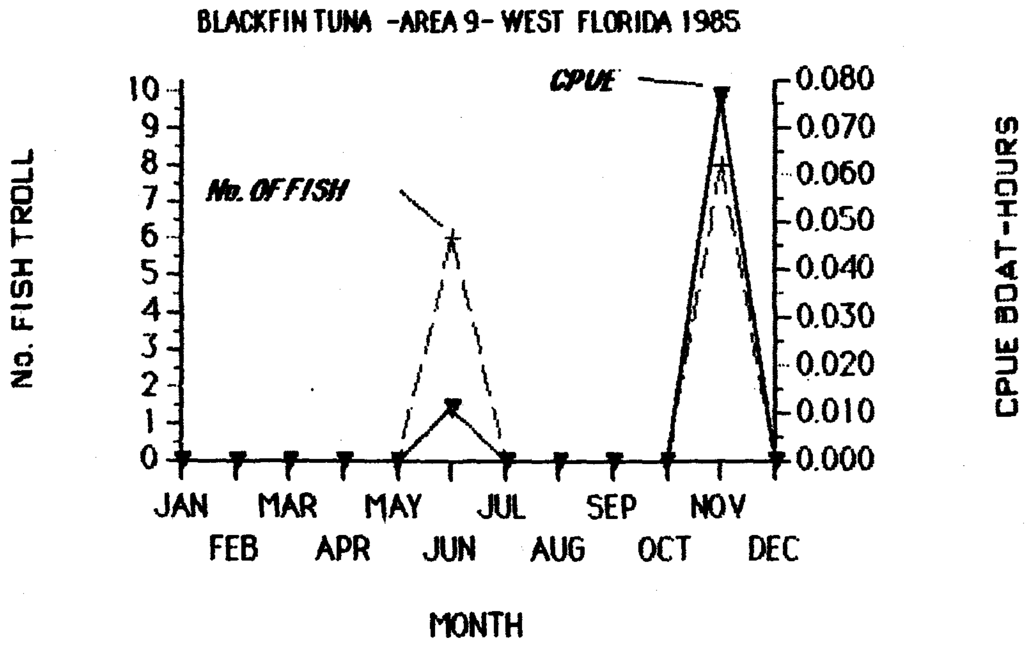
Appendix II. Figure 34.– BLACKFIN TUNA. CATCH AND CPUE FOR EAST FLORIDA. 1985 CHARTERBOAT DATA.



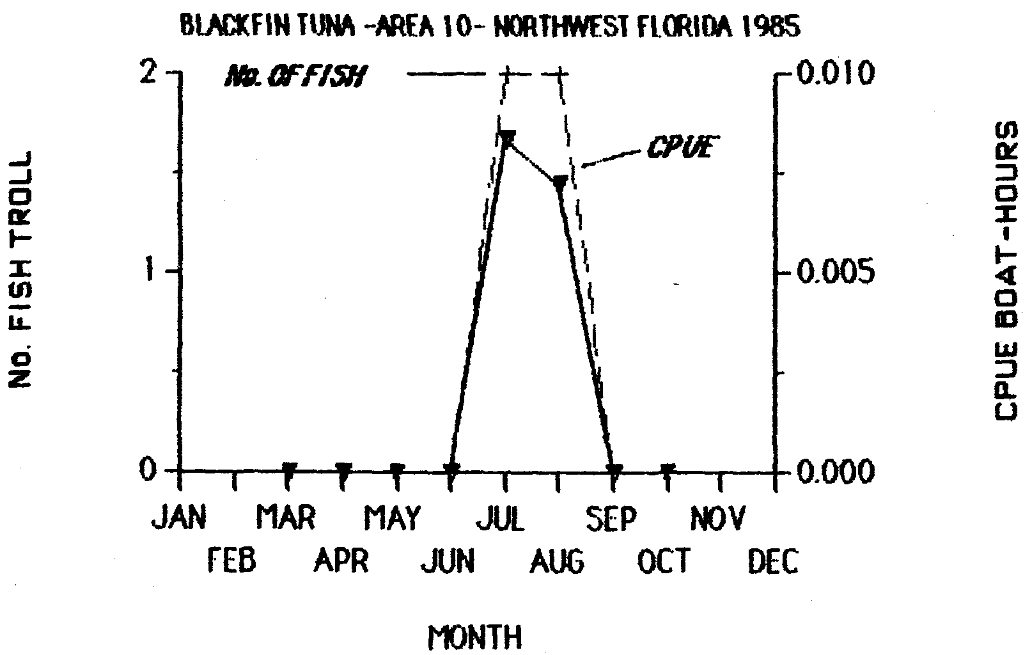
Appendix II. Figure 35.- BLACKFIN TUNA. CATCH AND CPUE FOR SOUTHEAST FLORIDA. 1985 CHARTERBOAT DATA



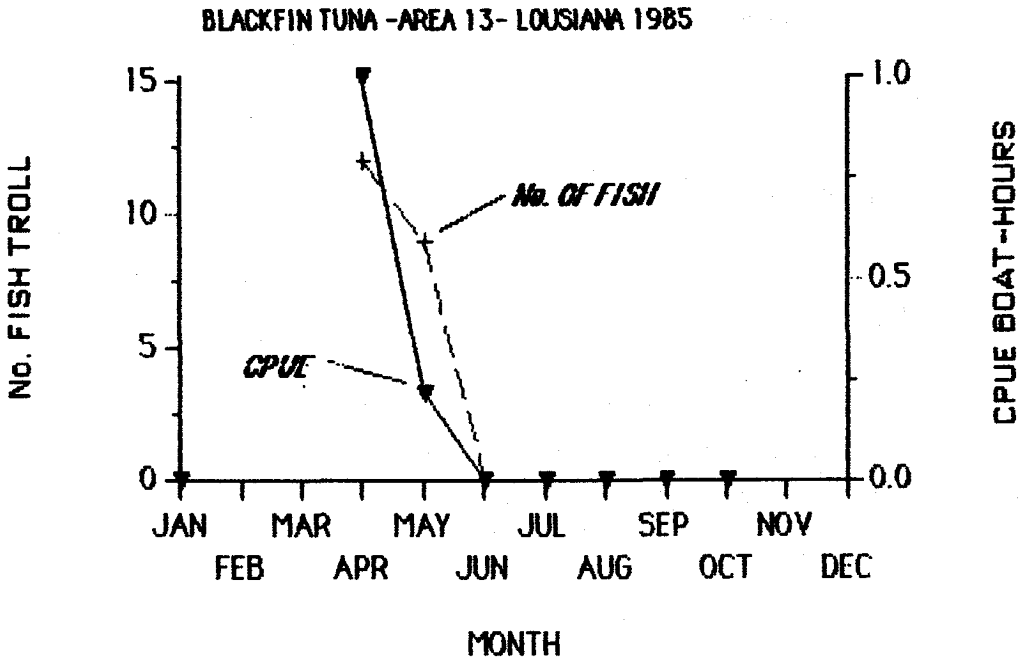
Appendix II. Figur 36.- BLACKFIN TUNA. CATCH AND CPUE FOR SOUTH FLORIDA (KEYS). 1985 CHARTERBOAT DATA.



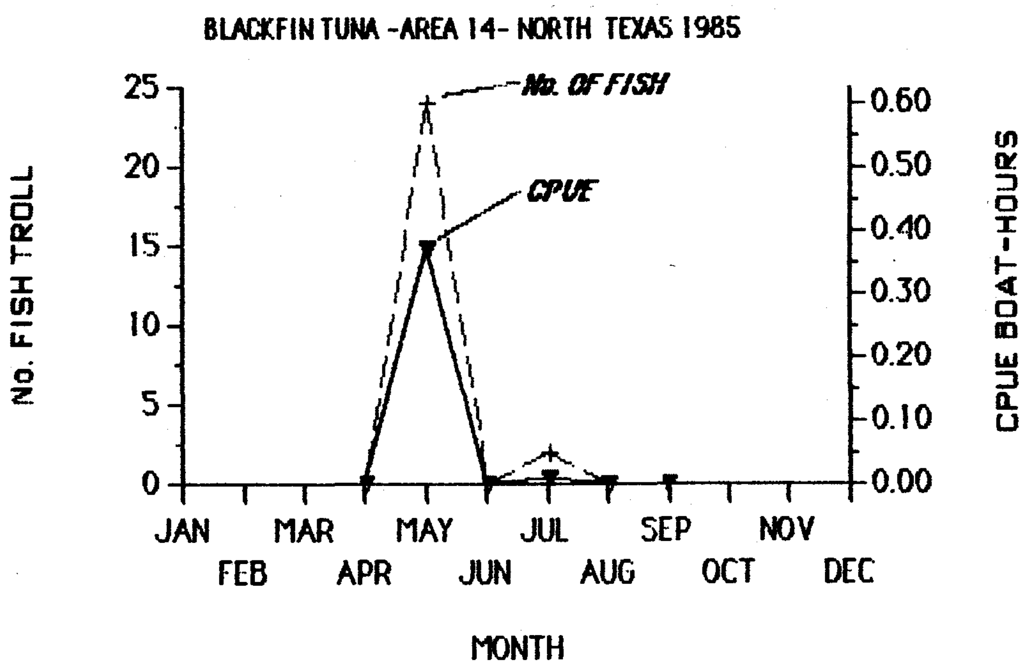
Appendix II. Figure 37.- BLACKFIN TUNA. CATCH AND CPUE FOR WEST FLORIDA. 1985 CHARTERBOAT DATA.



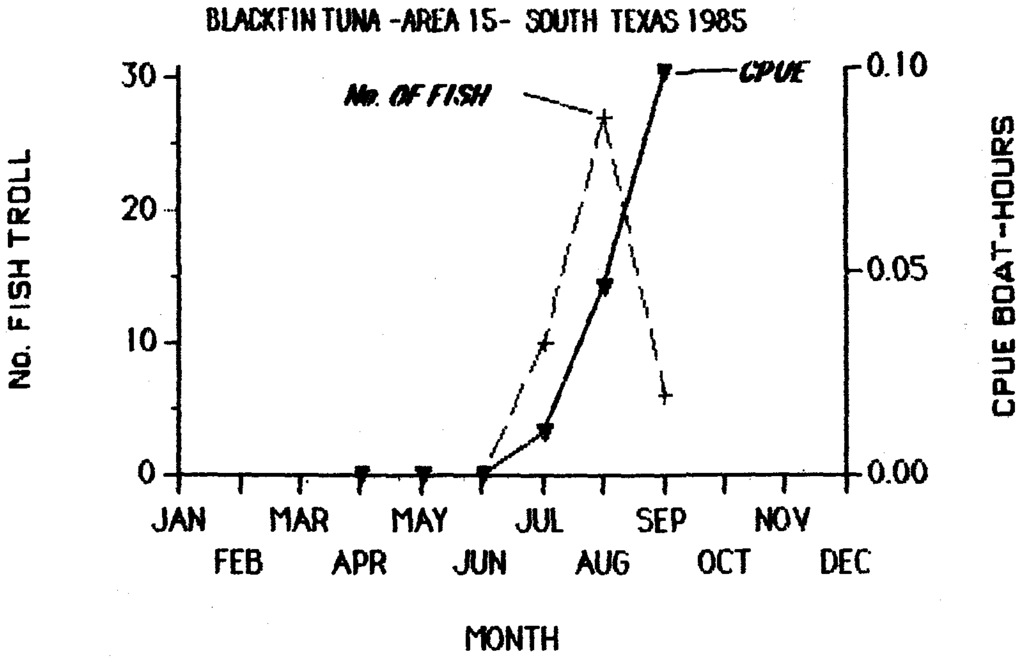
Appendix II. Figure 38.- BLACKFIN TUNA. CATCH AND CPUE FOR NORTHWEST FLORIDA. 1985 CHARTERBOAT DATA.



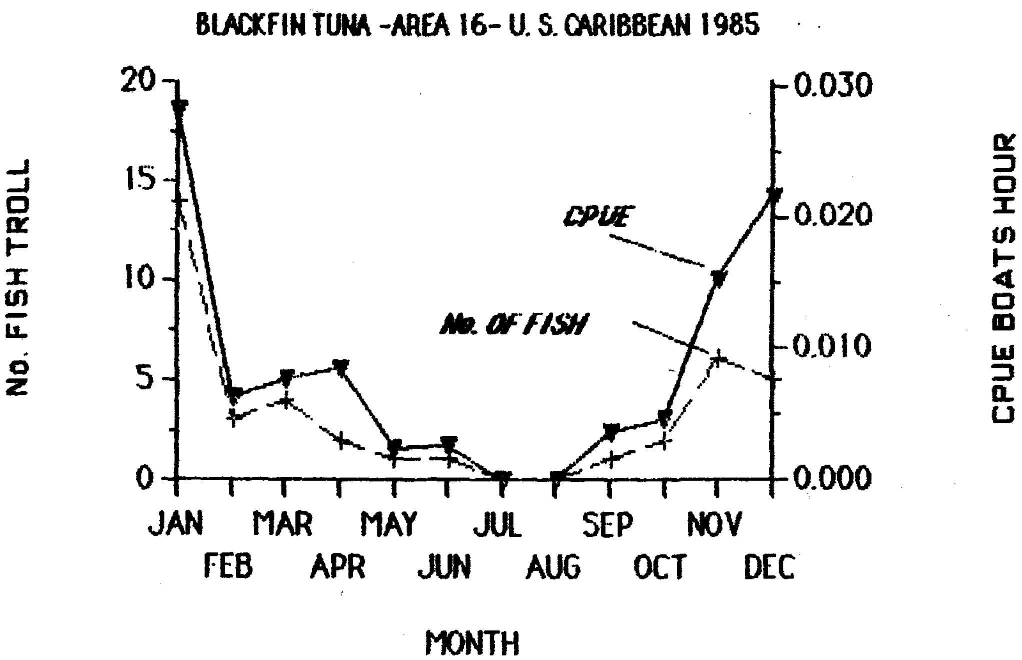
Appendix II. Figure 39.- BLACKFIN TUNA. CATCH AND CPUE FOR LOUSIANA. 1985 CHARTERBOAT DATA.



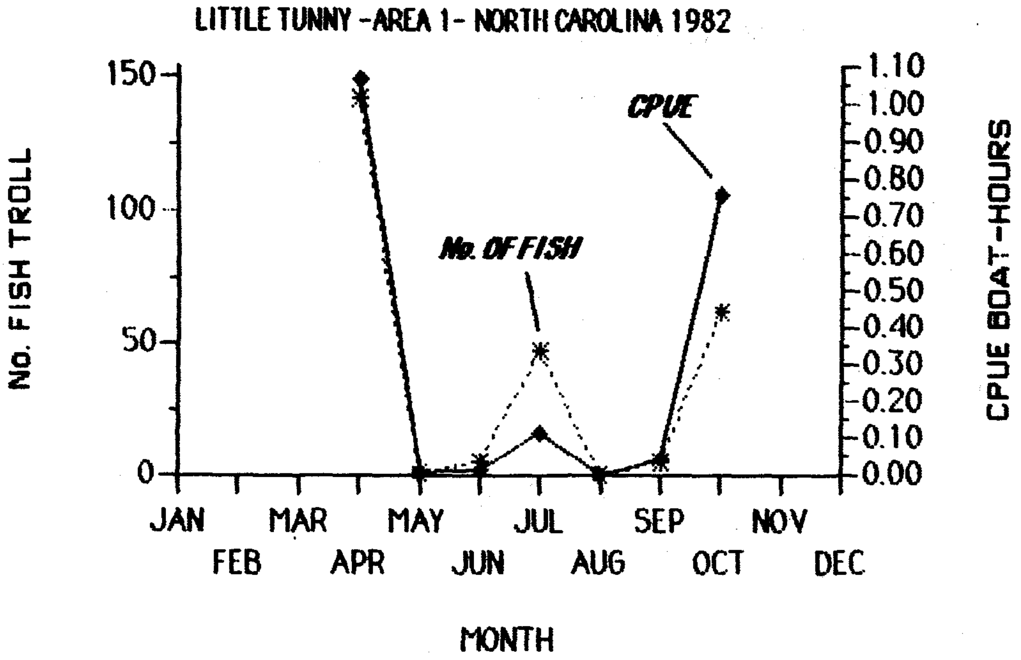
Appendix II. Figure 40.- BLACKFIN TUNA. CATCH AND CPUE FOR NORTH TEXAS. 1985 CHARTERBOAT DATA.



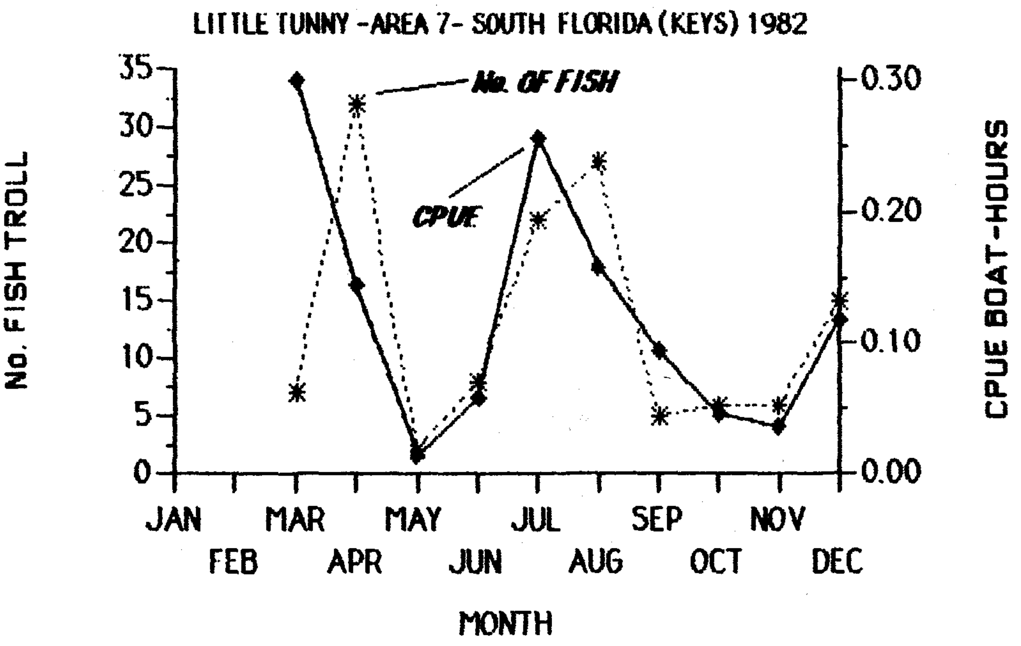
Appendix II. Figure 41.- BLACKFIN TUNA. CATCH AND CPUE FOR SOUTH TEXAS. 1985 CHARTERBOAT DATA.



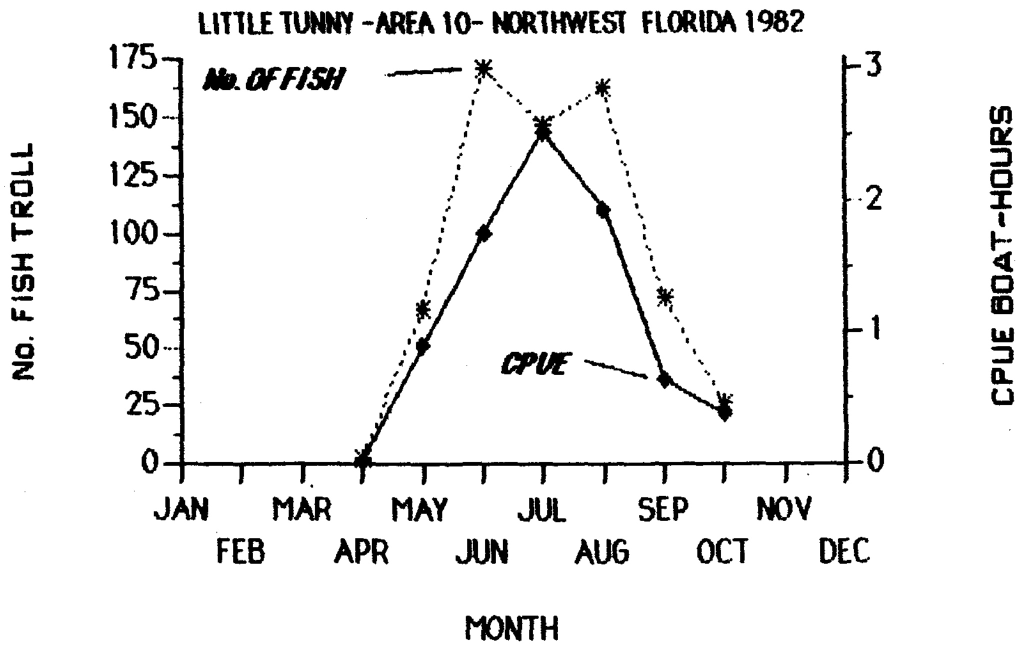
Appendix II. Figure 42.- BLACKFIN TUNA. CATCH AND CPUE FOR THE U. S. CARIBBEAN. 1985 CHARTERBOAT DATA.



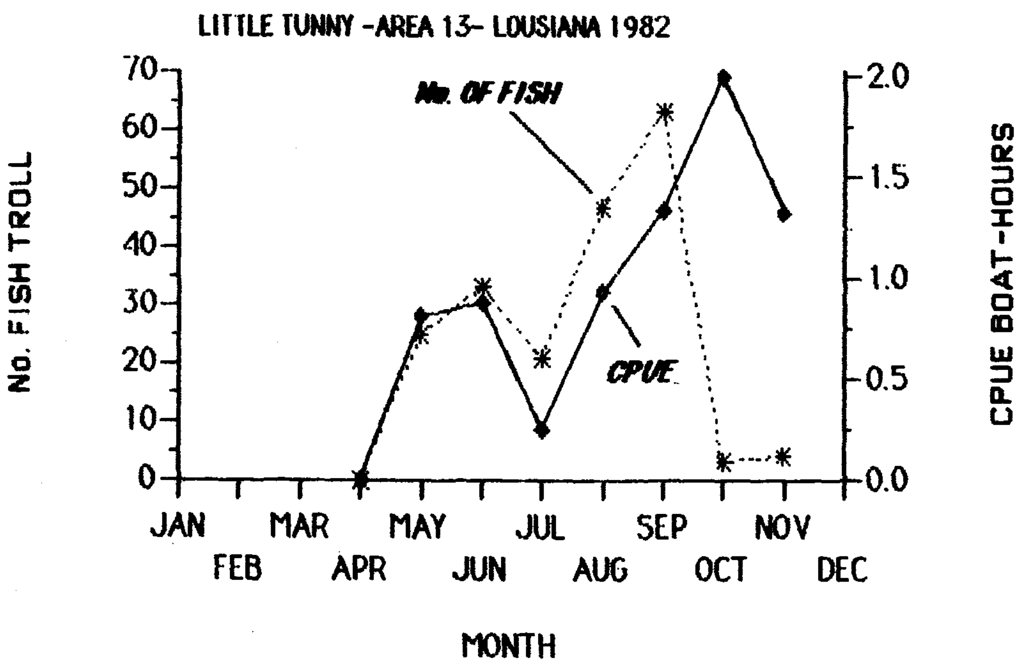
Appendix II. Figure 43.- LITTLE TUNNY. CATCH AND CPUE FOR NORTH CAROLINA. 1982 CHARTERBOAT DATA.



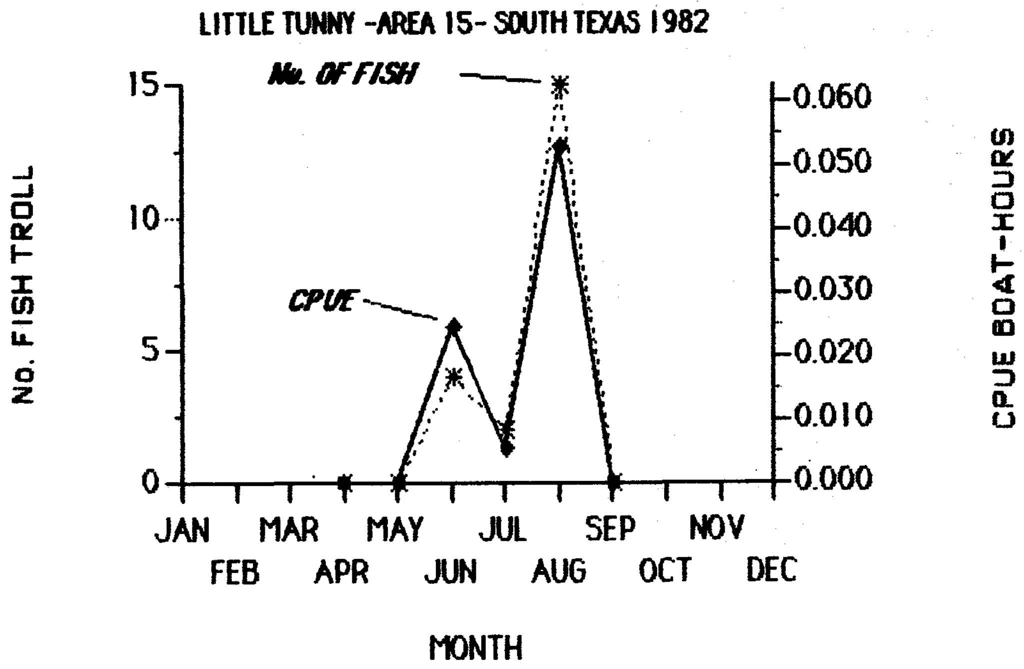
Appendix II. Figure 44.- LITTLE TUNNY. CATCH AND CPUE FOR SOUTH FLORIDA (KEYS). 1982 CHARTERBOAT DATA.



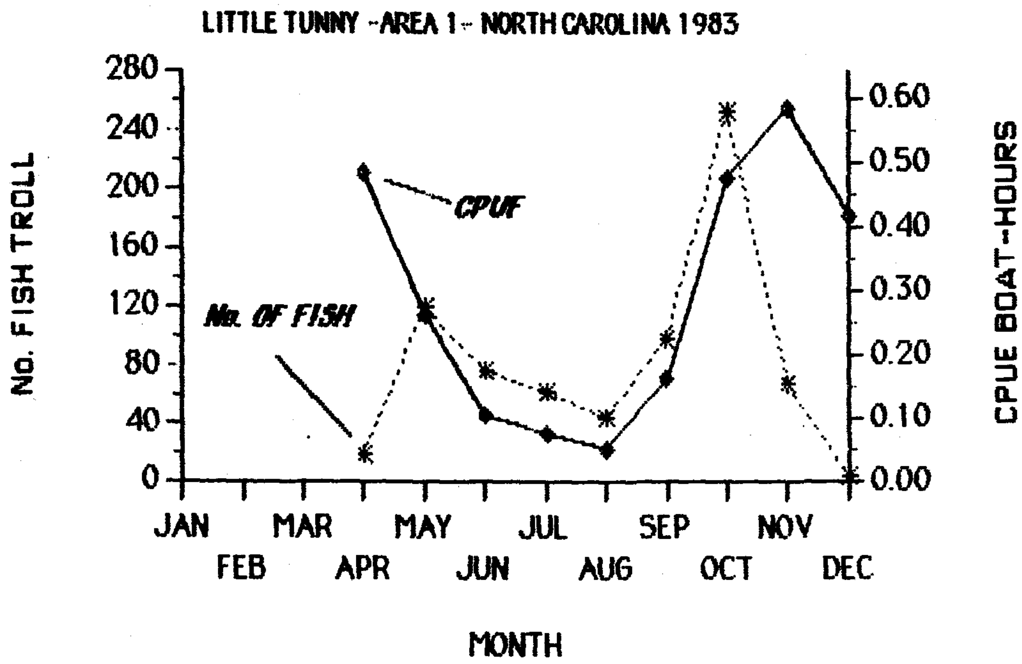
Appendix II. Figure 45.- LITTLE TUNNY. CATCH AND CPUE FOR NORTHWEST FLORIDA. 1982 CHARTERBOAT DATA.



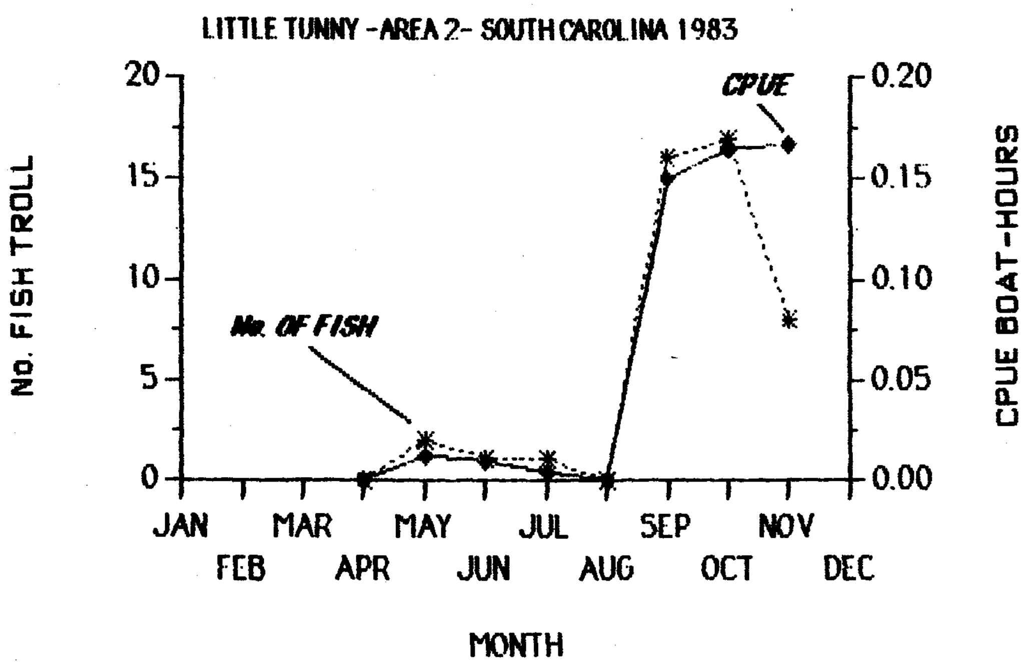
Appendix II. Figure 46.- LITTLE TUNNY. CATCH AND CPUE FOR LOUSIANA. 1982 CHARTERBOAT DATA.



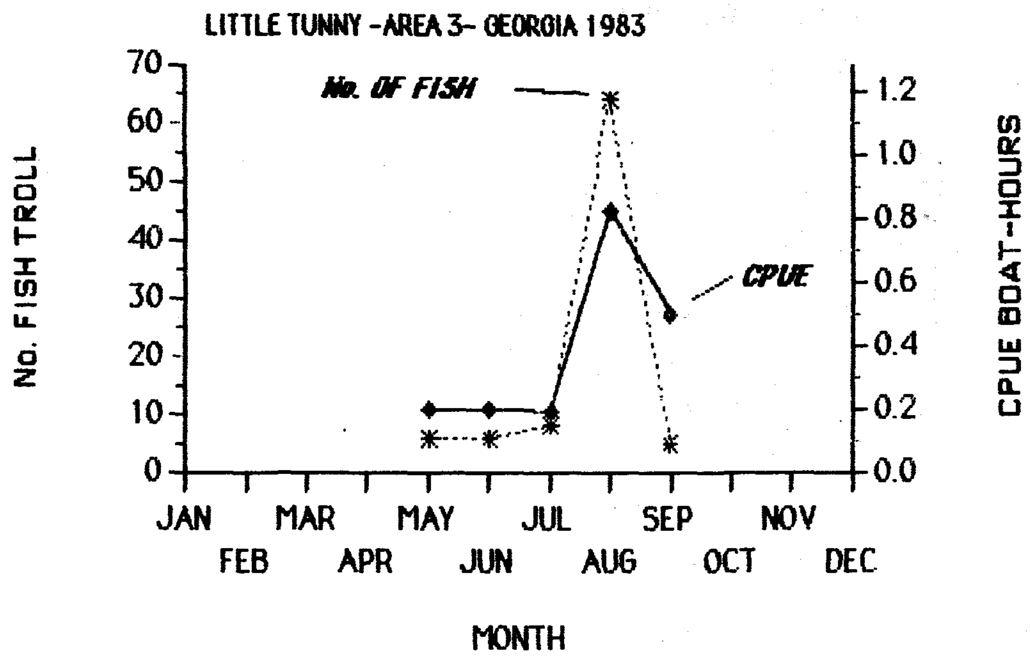
Appendix II. Figure 47.-- LITTLE TUNNY. CATCH AND CPUE FOR SOUTH TEXAS.
1982 CHARTERBOAT DATA.



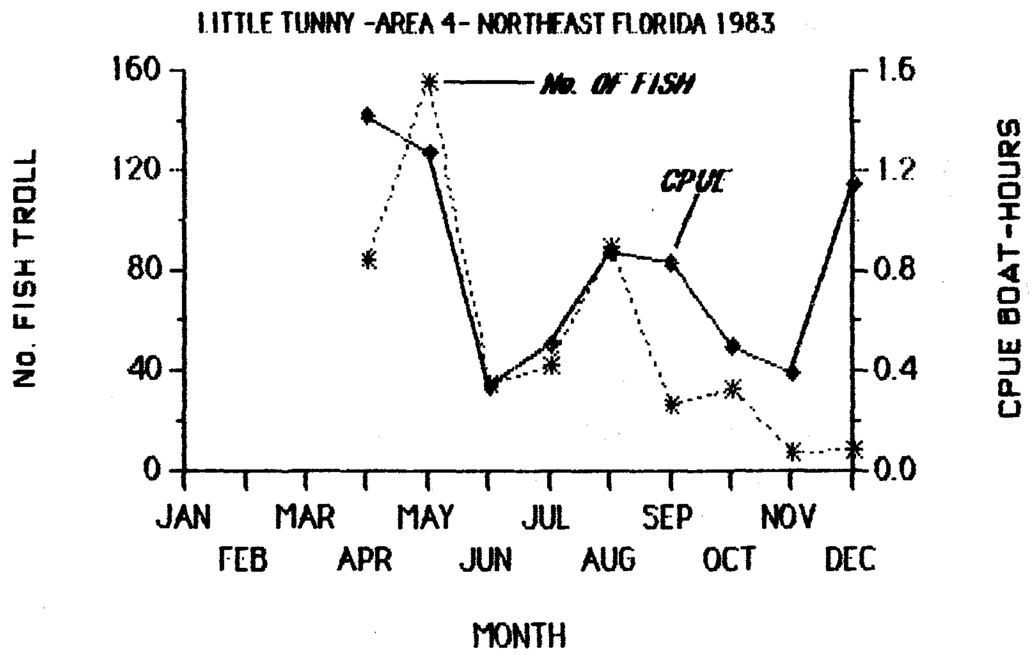
Appendix II. Figure 48.- LITTLE TUNNY. CATCH AND CPUE FOR NORTH CAROLINA. 1983 CHARTERBOAT DATA.



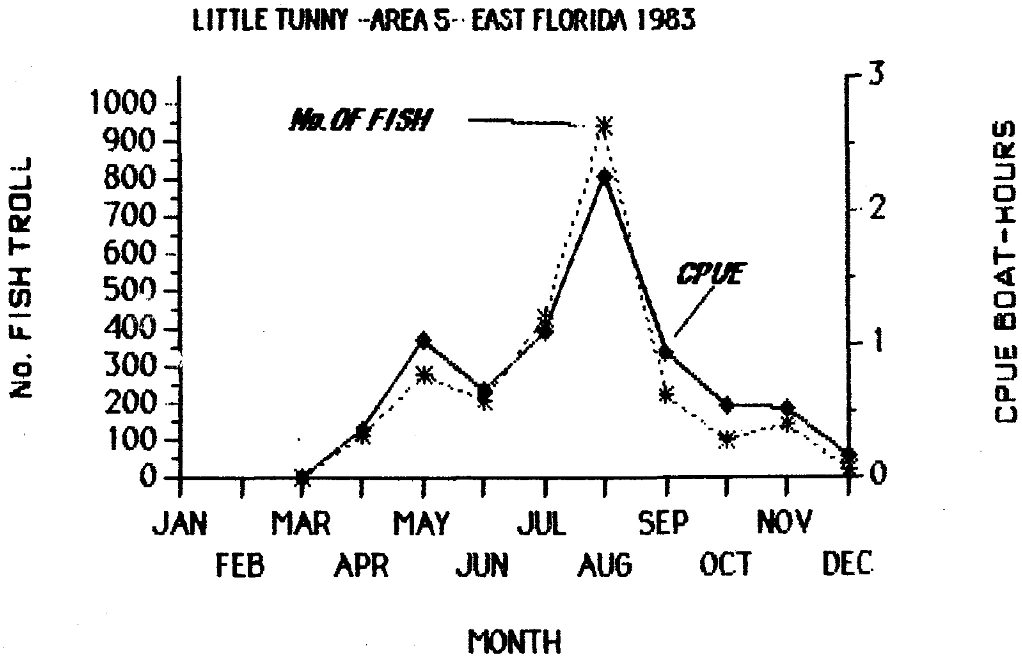
Appendix II. Figure 49.- LITTLE TUNNY. CATCH AND CPUE FOR SOUTH CAROLINA. 1983 CHARTERBOAT DATA.



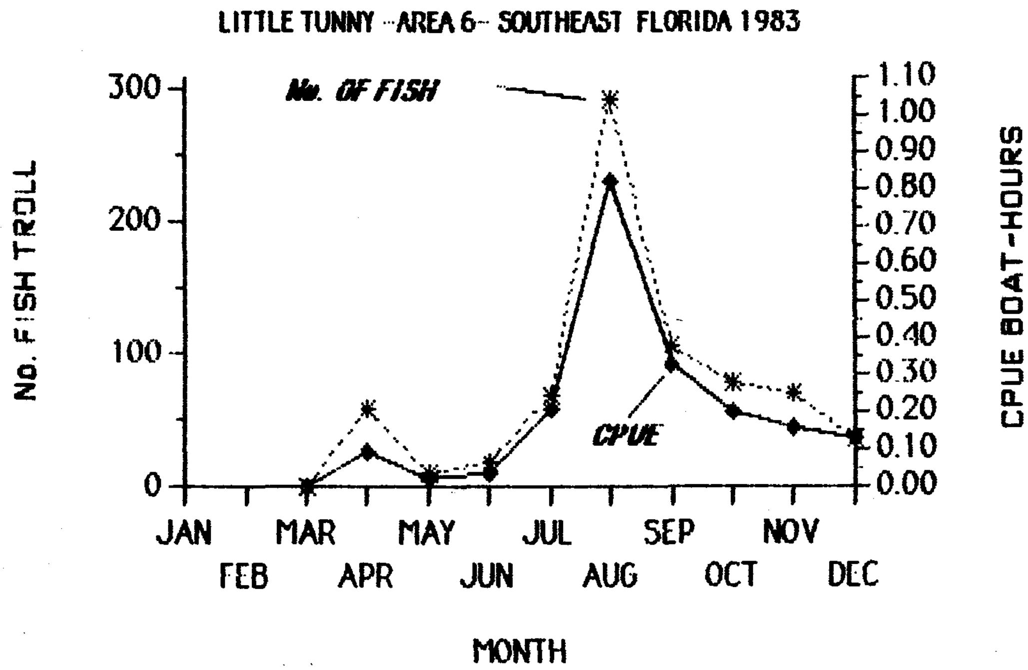
Appendix II. Figure 50.– LITTLE TUNNY. CATCH AND CPUE FOR GEORGIA. 1983 CHARTERBOAT DATA.



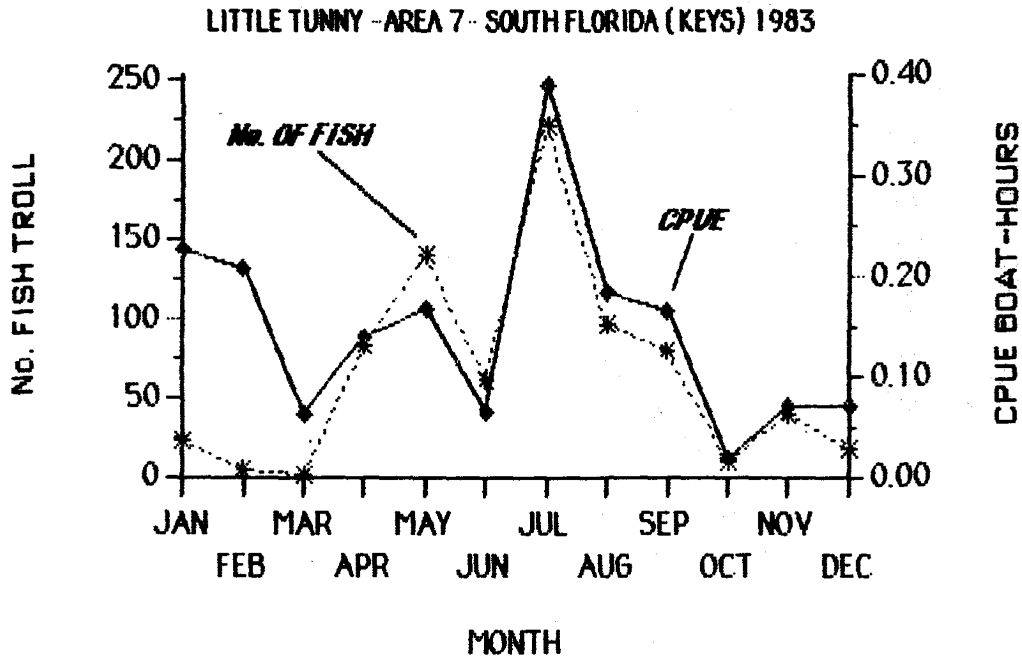
Appendix II. Figure 51.– LITTLE TUNNY. CATCH AND CPUE FOR NORTHEAST FLORIDA. 1983 CHARTERBOAT DATA.



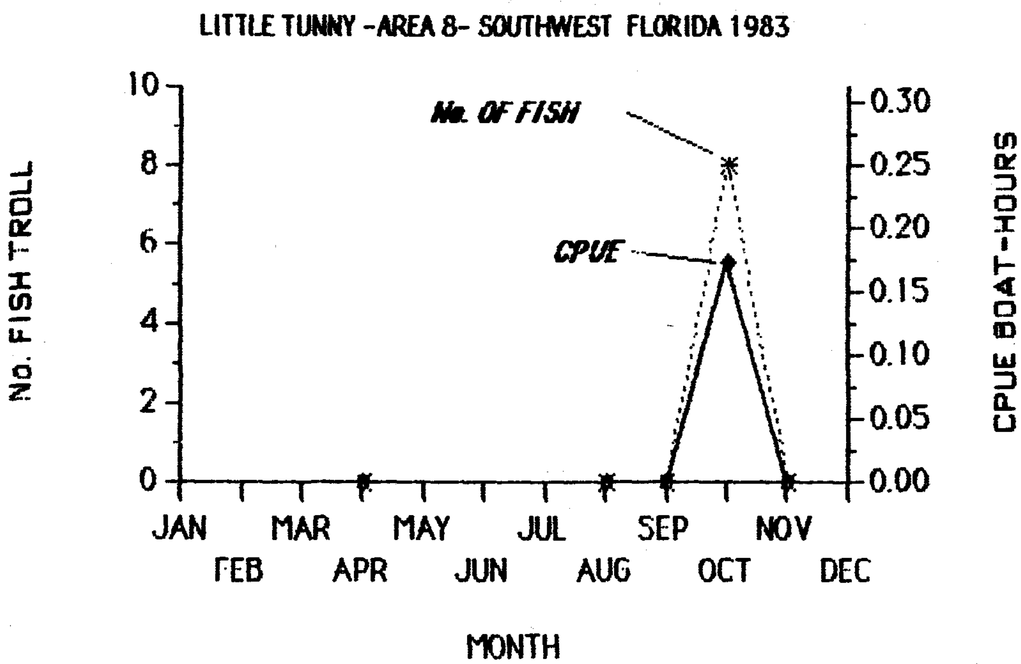
Appendix II. Figure 52.- LITTLE TUNNY. CATCH AND CPUE FOR EAST FLORIDA. 1983 CHARTERBOAT DATA.



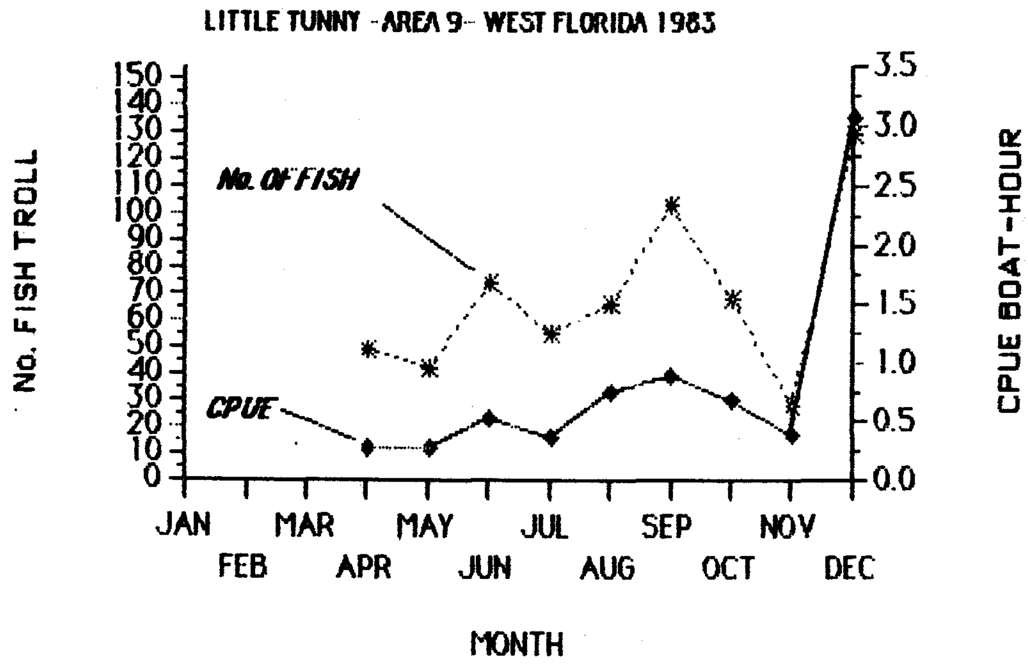
Appendix II. Figur– 53.- LITTLE TUNNY. CATCH AND CPUE FOR SOUTHEAST FLORIDA. 1983 CHARTERBOAT DATA.



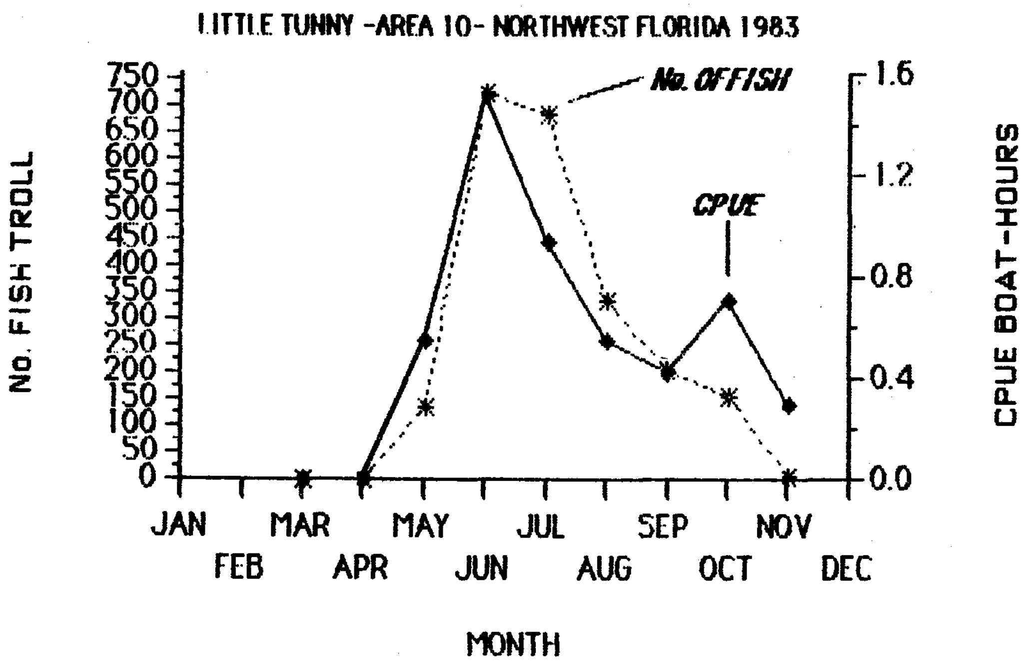
Appendix II. Figure 54.- LITTLE TUNNY. CATCH AND CPUE FOR SOUTH FLORIDA (KEYS). 1983 CHARTERBOAT DATA.



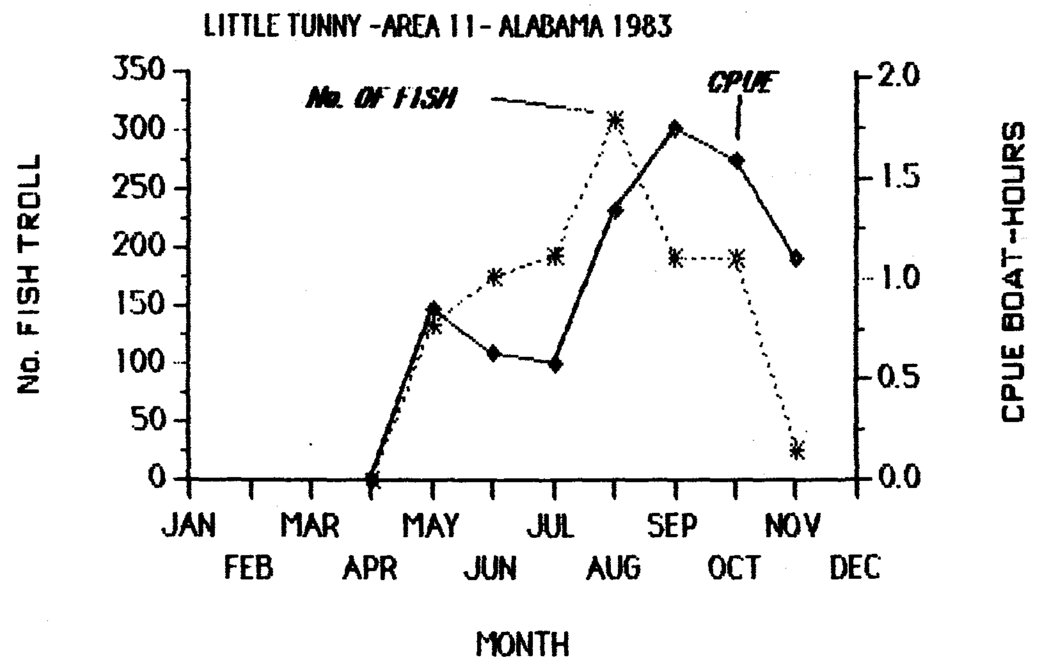
Appendix II. Figure 55.- LITTLE TUNNY. CATCH AND CPUE FOR SOUTHWEST FLORIDA. 1983 CHARTERBOAT DATA.



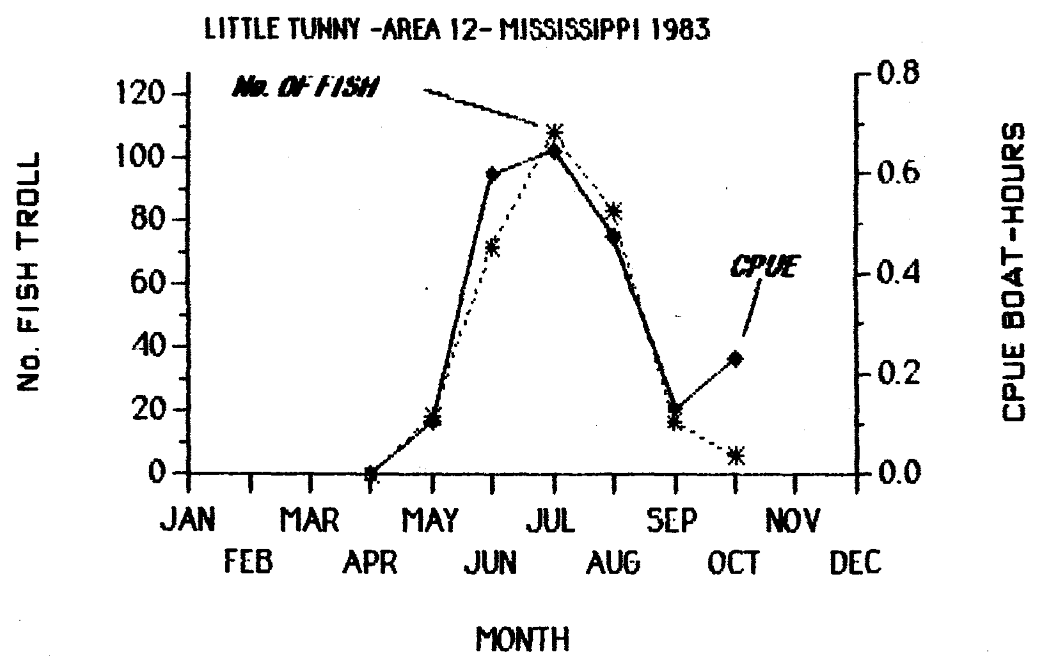
Appendix II. Figure 56.– LITTLE TUNNY. CATCH AND CPUE FOR WEST FLORIDA. 1983 CHARTERBOAT DATA.



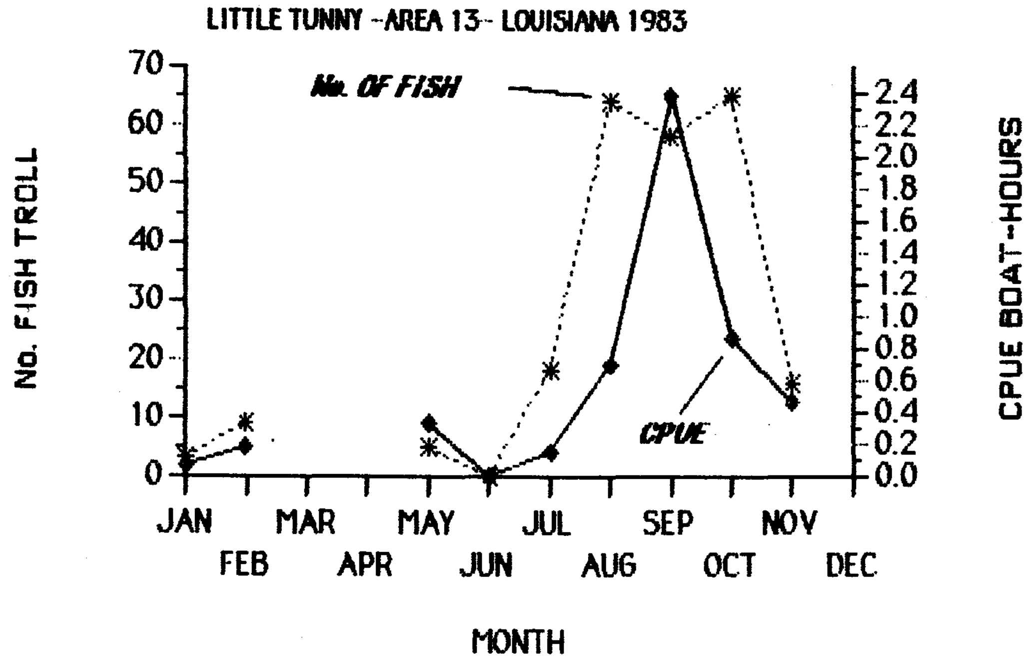
Appendix II. Figure 57.– LITTLE TUNNY. CATCH AND CPUE FOR NORTHWEST FLORIDA. 1983 CHARTERBOAT DATA.



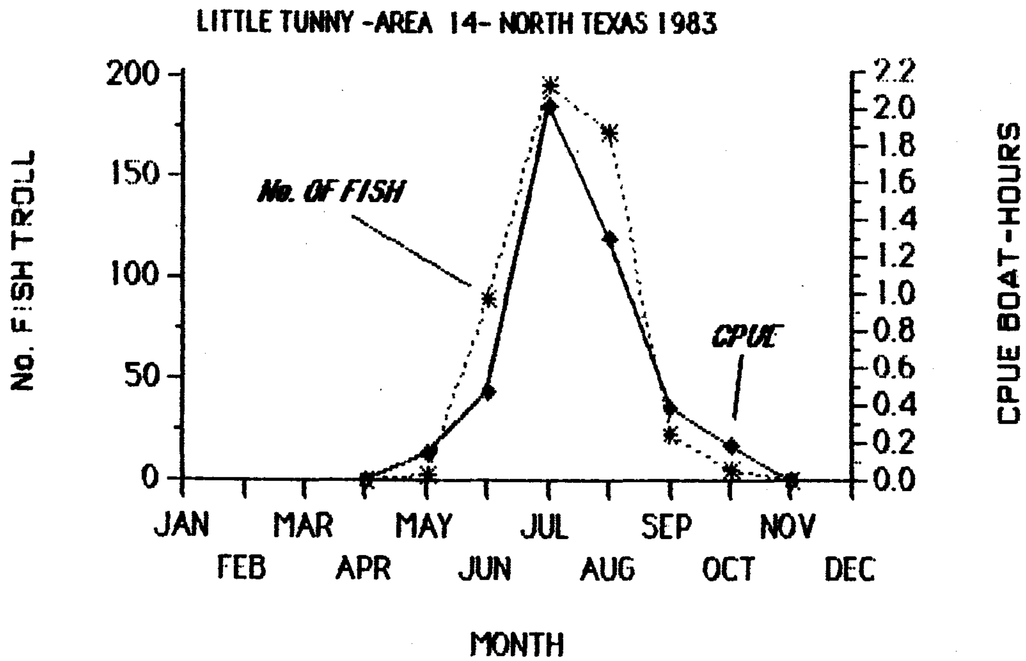
Appendix II. Figure 58.- LITTLE TUNNY. CATCH AND CPUE FOR ALABAMA.
1983 CHARTERBOAT DATA.



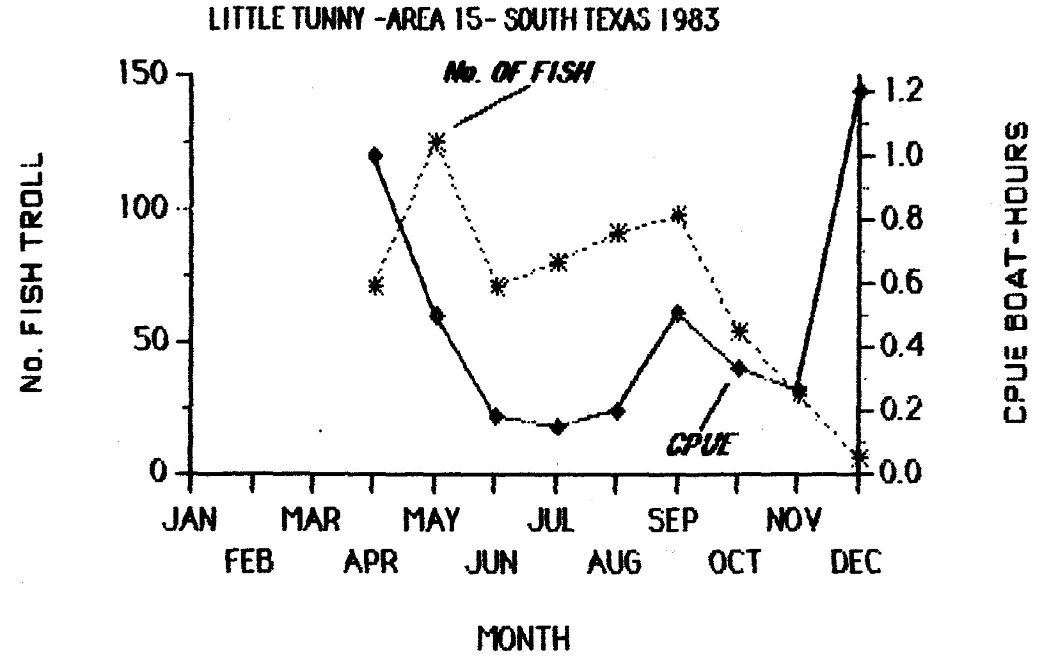
Appendix II. Figure 59.- LITTLE TUNNY. CATCH AND CPUE FOR MISSISSIPPI.
1983 CHARTERBOAT DATA.



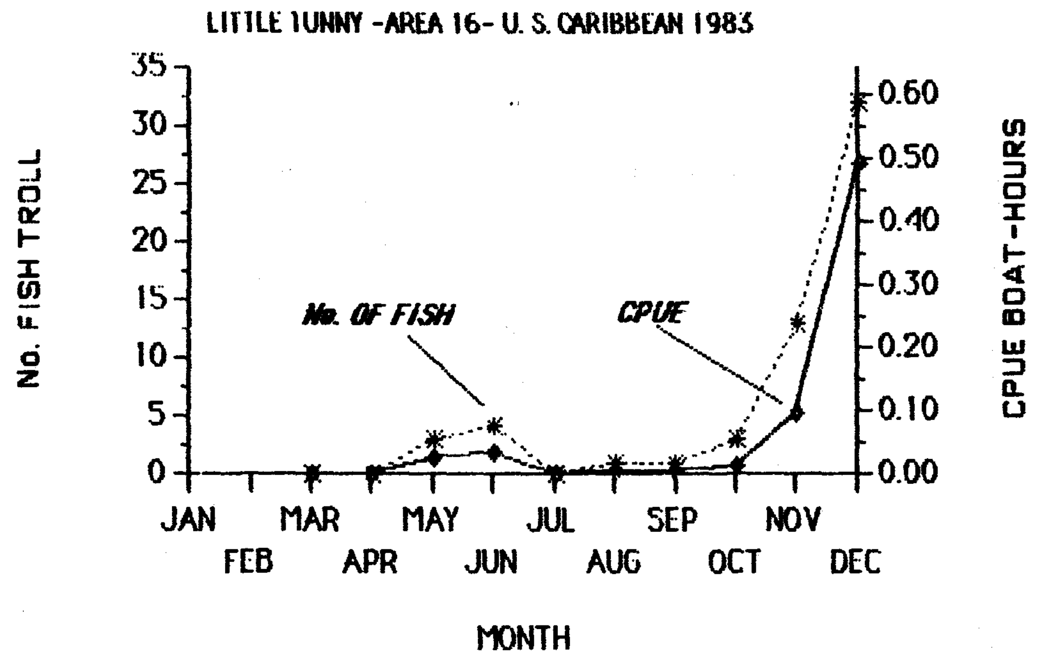
Appendix II. Figure 60.- LITTLE TUNNY. CATCH AND CPUE FOR LOUSIANA. 1983 CHARTERBOAT DATA.



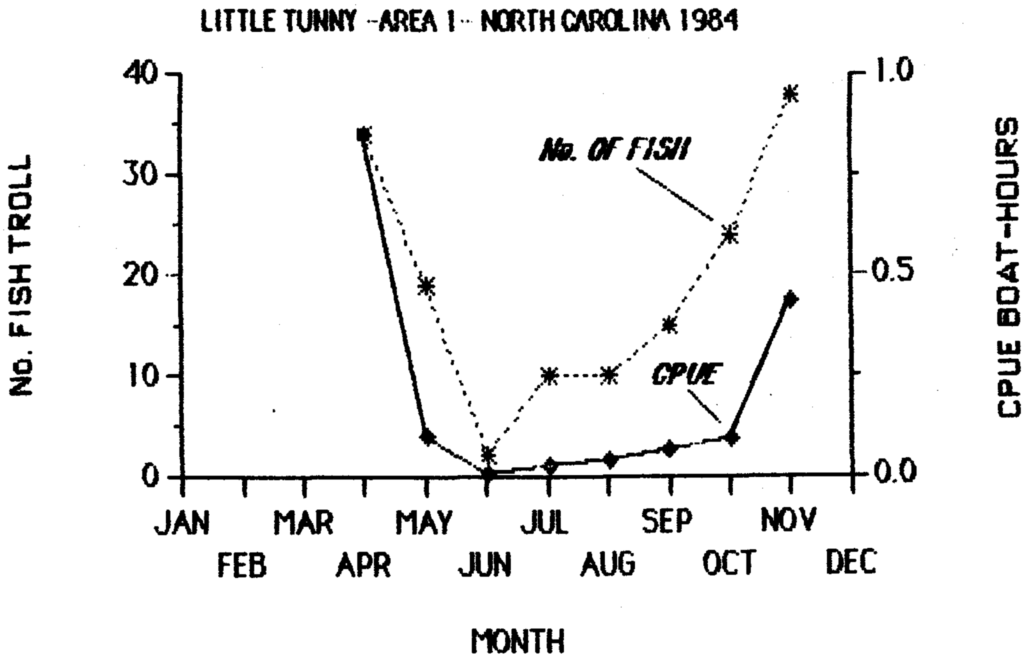
App ndix II. Figure 61.- LITTLE TUNNY. CATCH AND CPUE FOR NORTH TEXAS. 1983 CHARTERBOAT DATA.



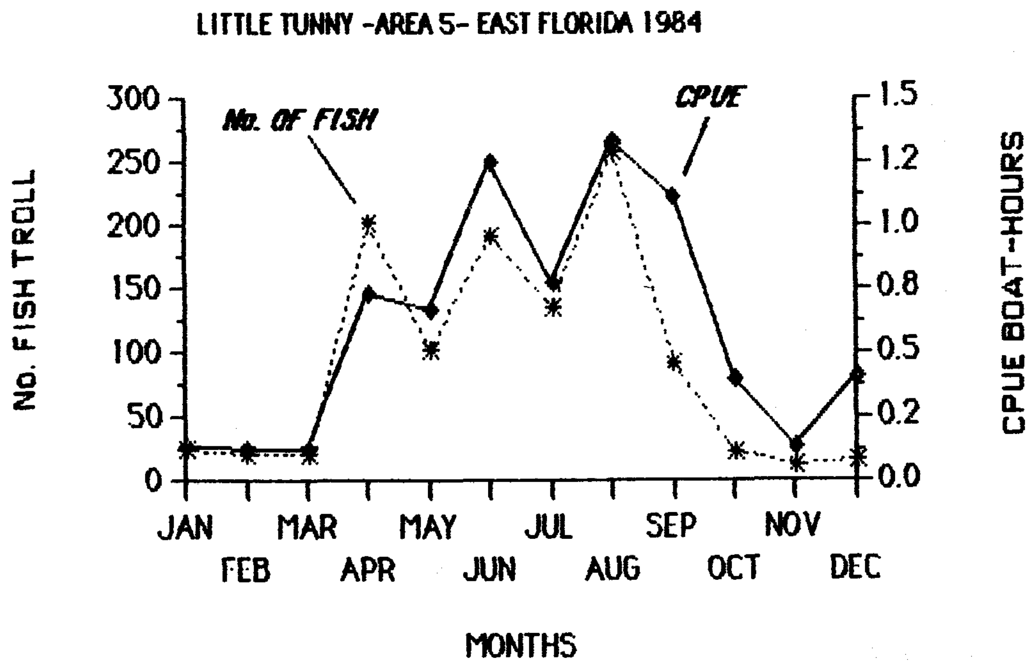
Appendix II. Figure 62.- LITTLE TUNNY. CATCH AND CPUE FOR SOUTH TEXAS. 1983 CHARTERBOAT DATA.



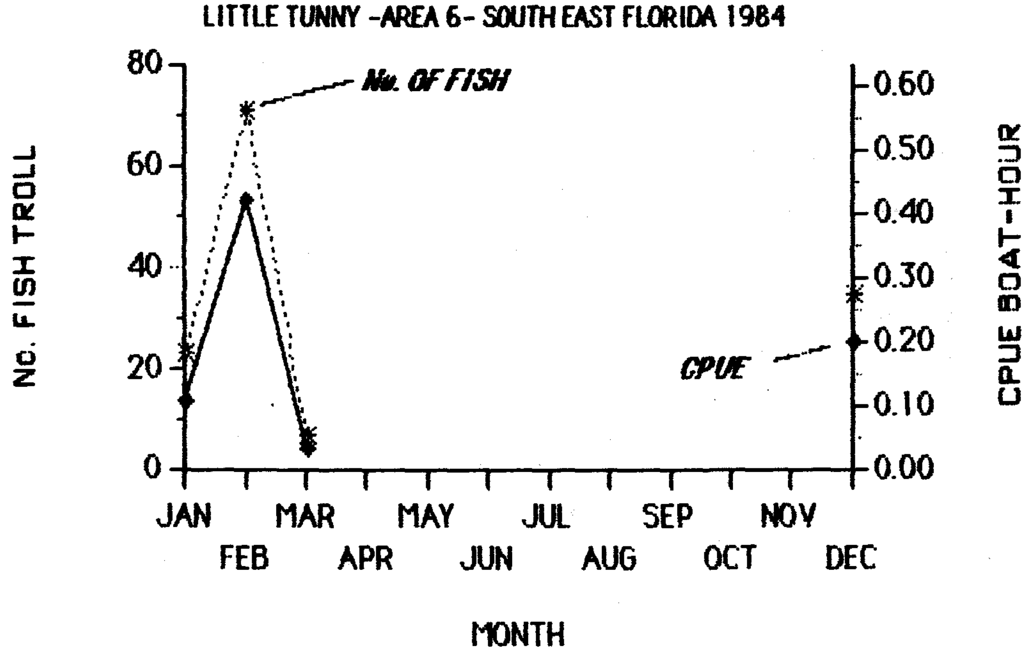
Appendix II. Figure 63.- LITTLE TUNNY. CATCH AND CPUE FOR THE U. S. CARIBBEAN. 1983 CHARTERBOAT DATA.



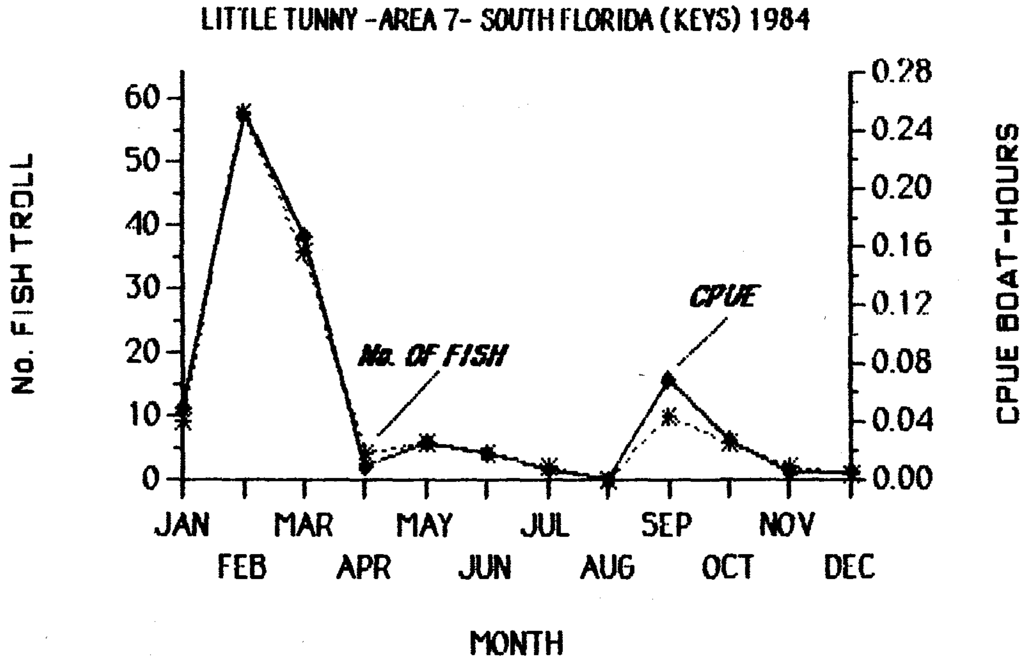
Appendix II. Figure 64.- LITTLE TUNNY. CATCH AND CPUE FOR NORTH CAROLINA. 1984 CHARTERBOAT DATA.



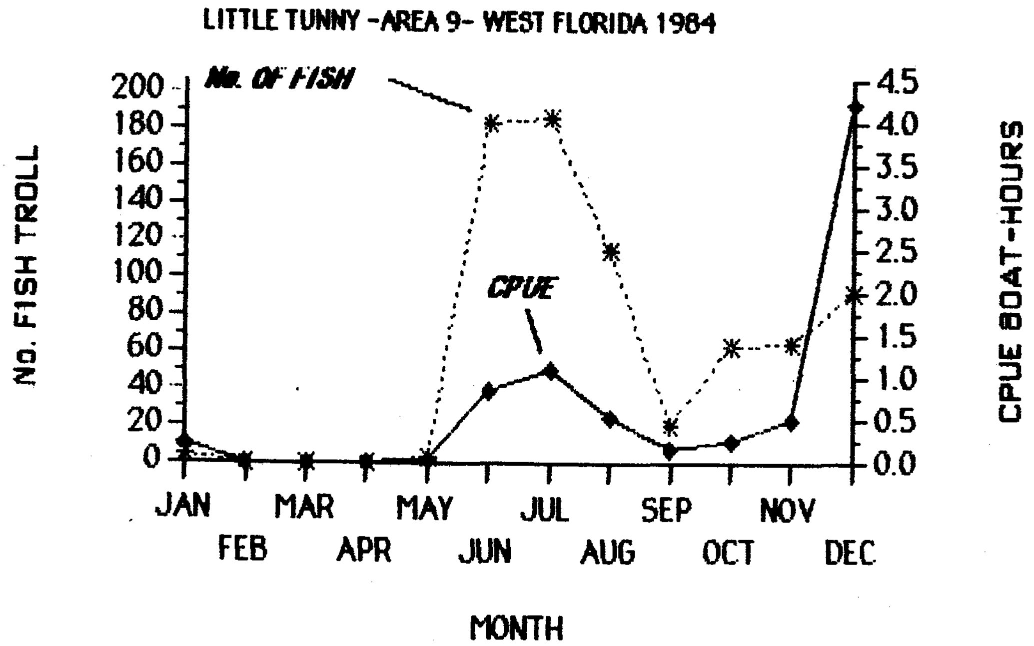
Appendix II. Figure 65.- LITTLE TUNNY. CATCH AND CPUE FOR EAST FLORIDA. 1984 CHARTERBOAT DATA.



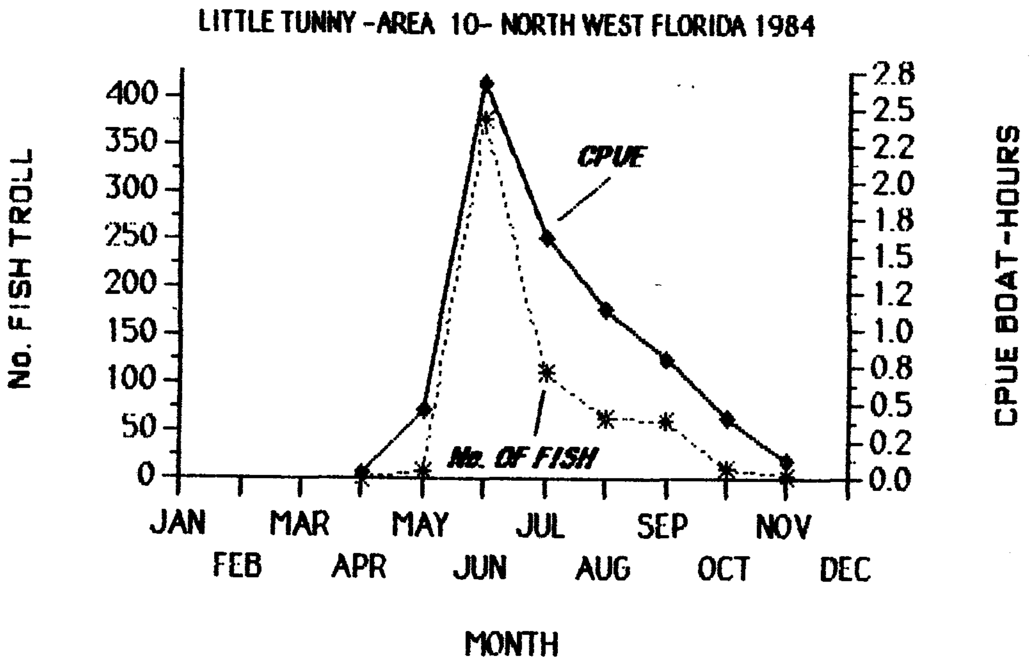
Appendix II. Figure 66.- LITTLE TUNNY. CATCH AND CPUE FOR SOUTHEAST FLORIDA. 1984 CHARTERBOAT DATA.



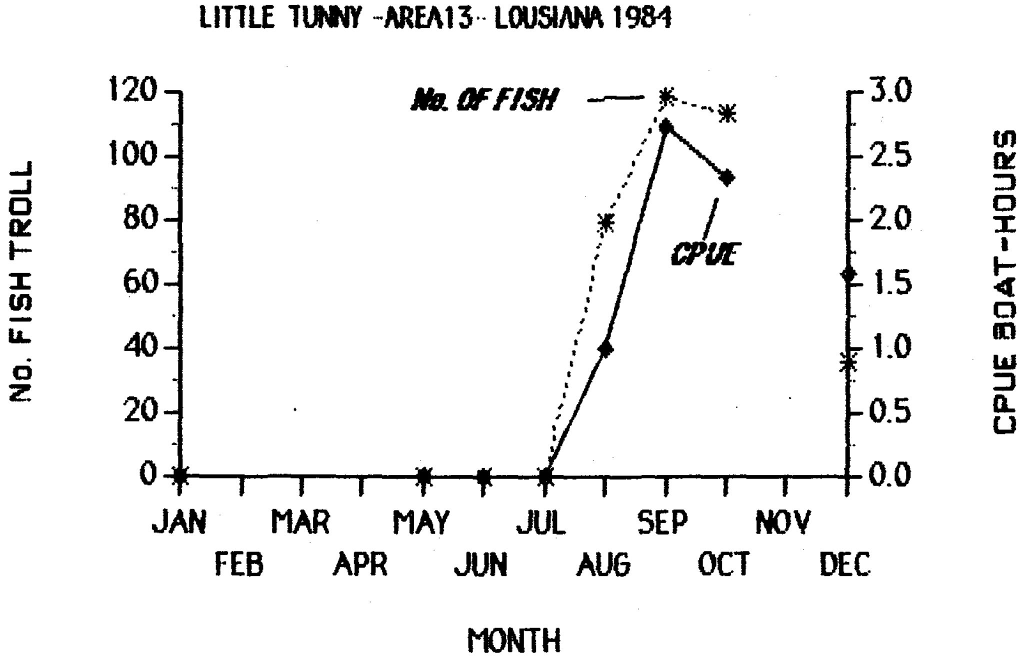
Appendix II. Figure 67.- LITTLE TUNNY. CATCH AND CPUE FOR SOUTH FLORIDA (KEYS). 1984 CHARTERBOAT DATA.



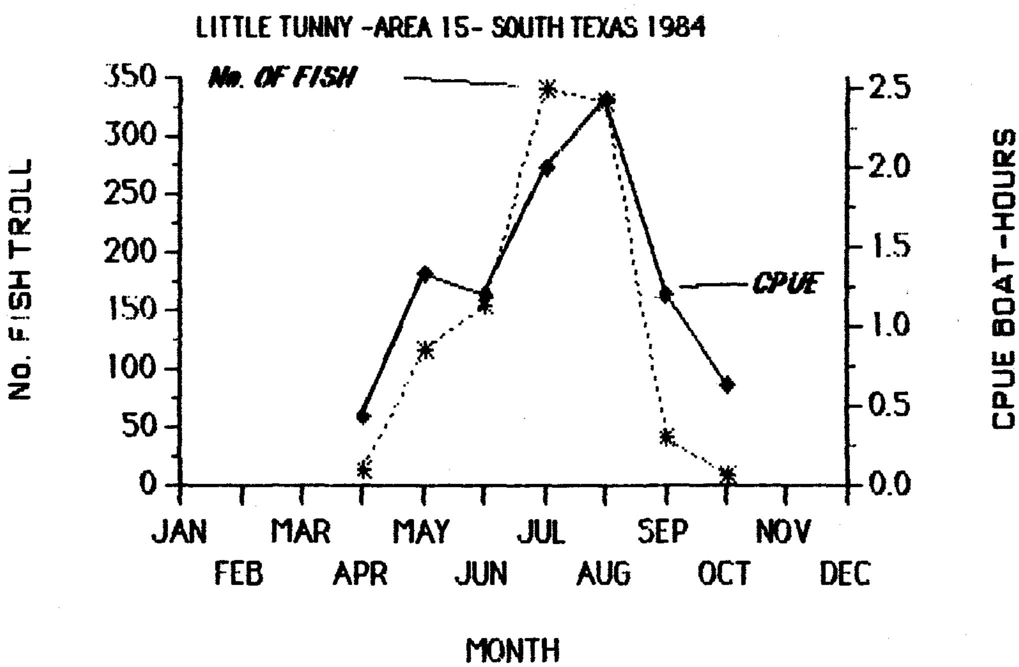
Appendix II. Figure 68.- LITTLE TUNNY. CATCH AND CPUE FOR WEST FLORIDA. 1984 CHARTERBOAT DATA.



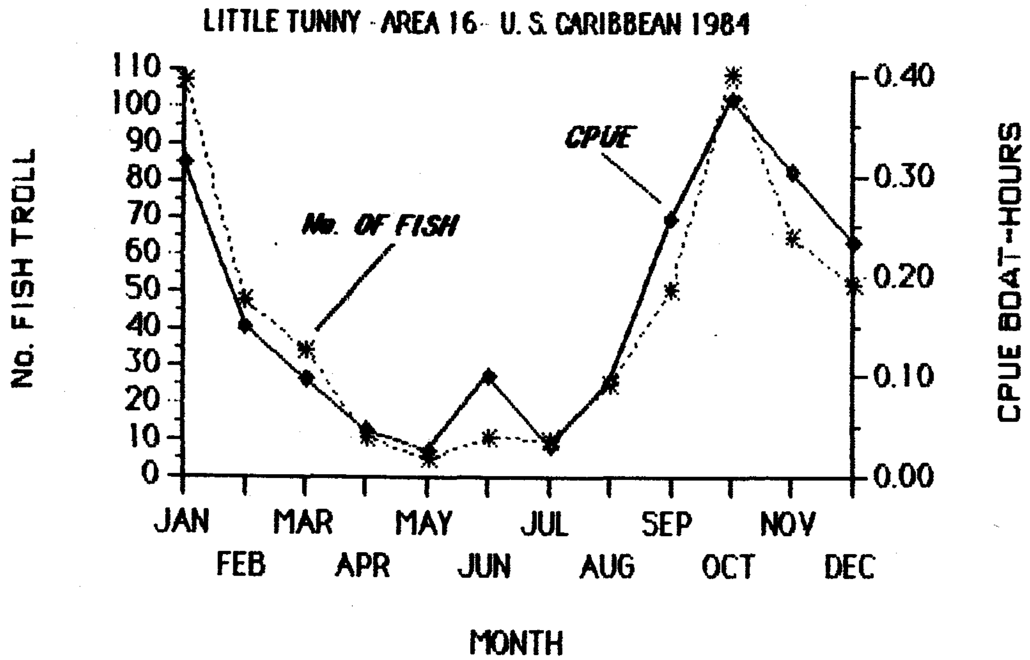
Appendix II. Figure 69.- LITTLE TUNNY. CATCH AND CPUE FOR NORTHWEST FLORIDA. 1984 CHARTERBOAT DATA.



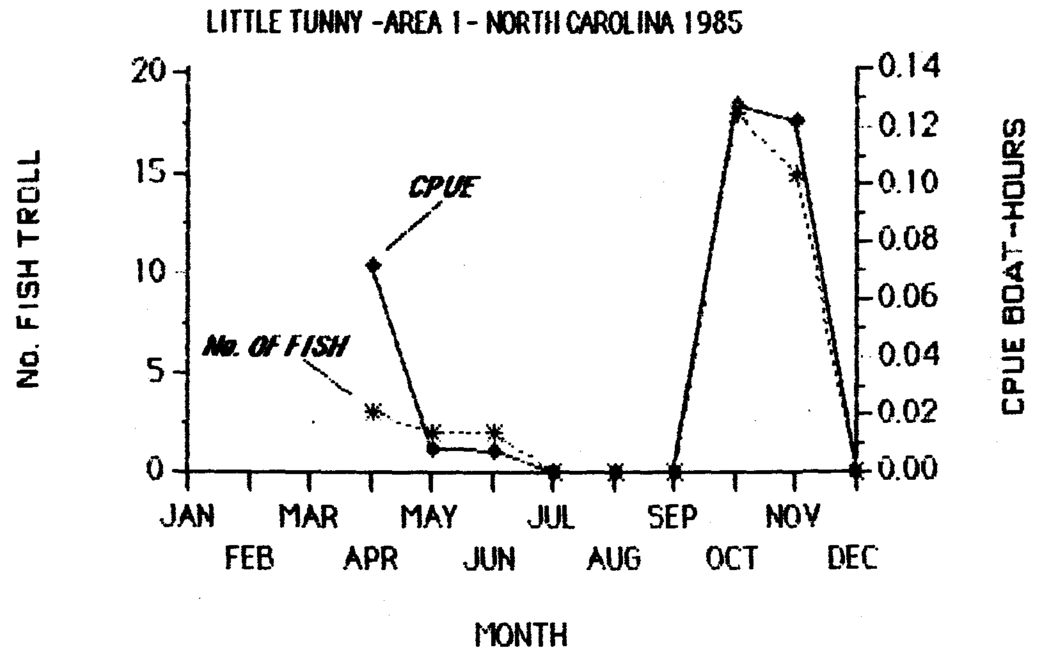
Appendix II. Figure 70.– LITTLE TUNNY. CATCH AND CPUE FOR LOUSIANA. 1984 CHARTERBOAT DATA.



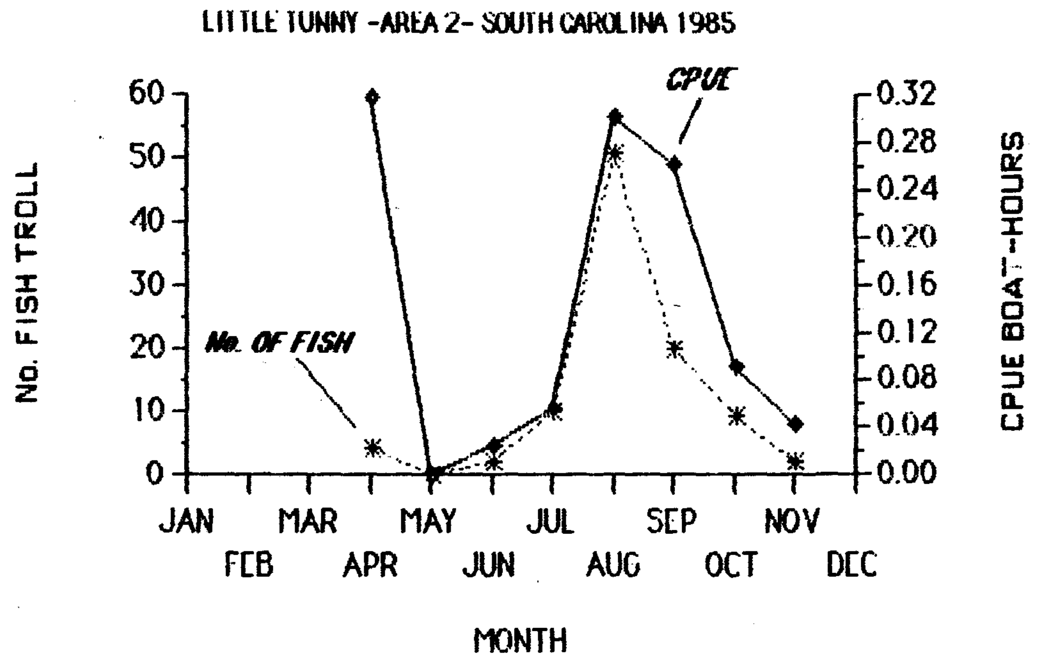
Appendix II. Figure 71.– LITTLE TUNNY. CATCH AND CPUE FOR SOUTH TEXAS. 1984 CHARTERBOAT DATA.



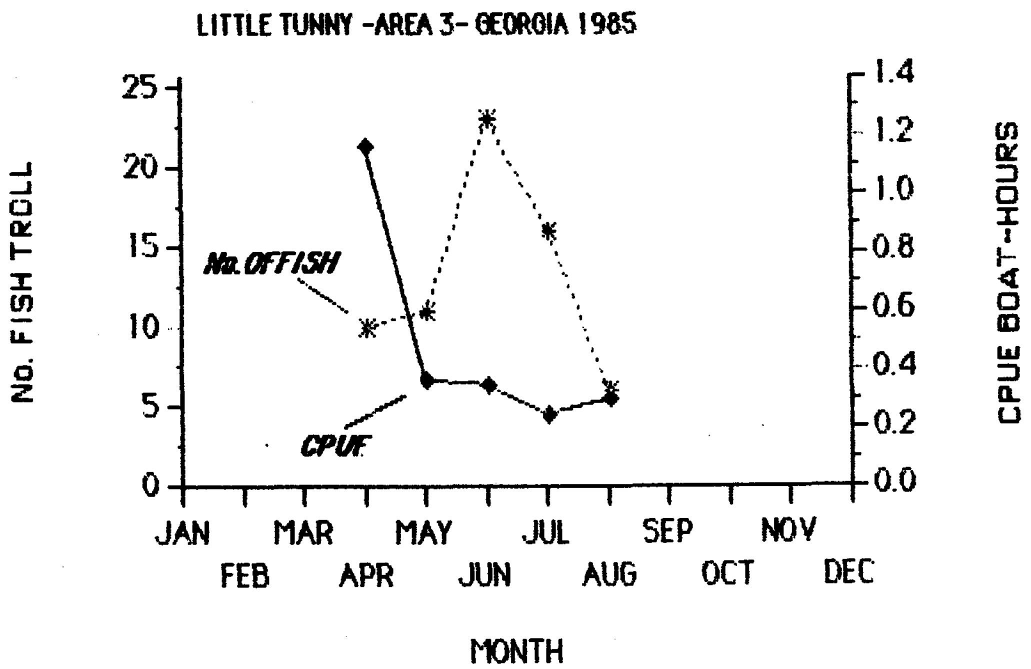
Appendix II. Figure 72.-- LITTLE TUNNY. CATCH AND CPUE FOR THE U. S. CARIBBEAN. 1984 CHARTERBOAT DATA.



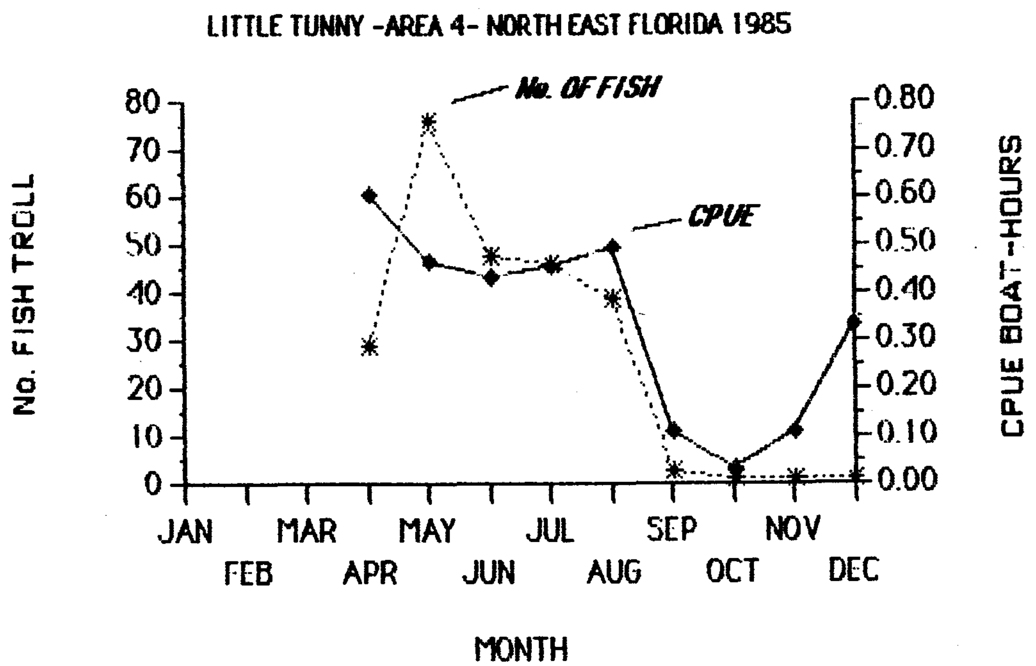
Appendix II. Figure 73. LITTLE TUNNY. CATCH AND CPUE FOR NORTH CAROLINA 1985 CHARTERBOAT DATA.



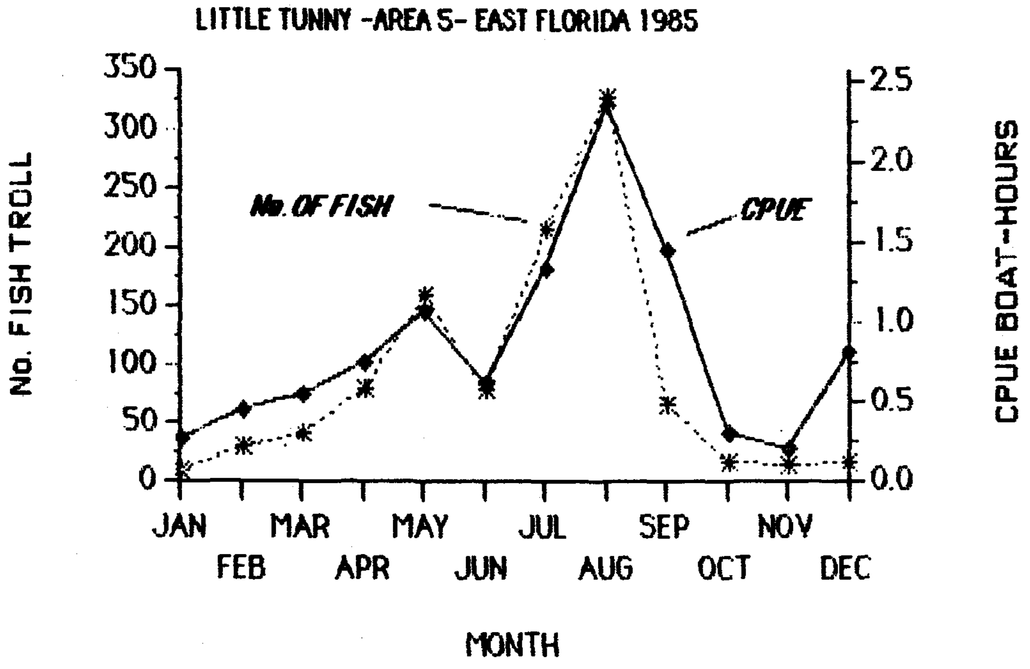
Appendix II. Figure 74.- LITTLE TUNNY. CATCH AND CPUE FOR SOUTH CAROLINA. 1985 CHARTERBOAT DATA.



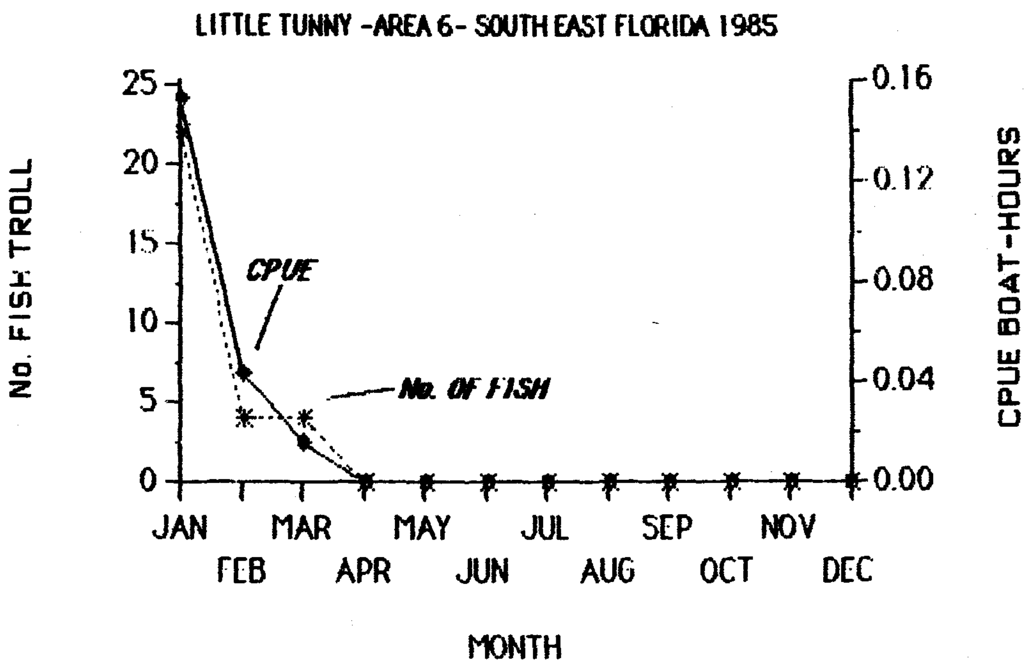
Appendix II. Figure 75.- LITTLE TUNNY. CATCH AND CPUE FOR GEORGIA. 1985 CHARTERBOAT DATA.



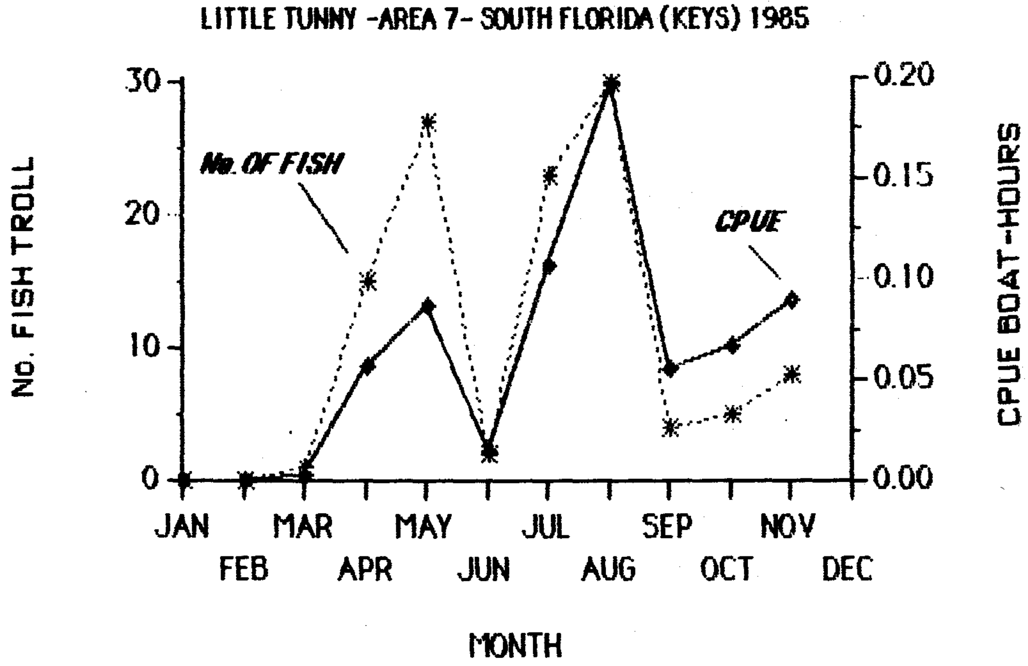
App ndix II. Figur 76.- LITTLE TUNNY. CATCH AND CPUE FOR NORTHEAST FLORIDA. 1985 CHARTERBOAT DATA.



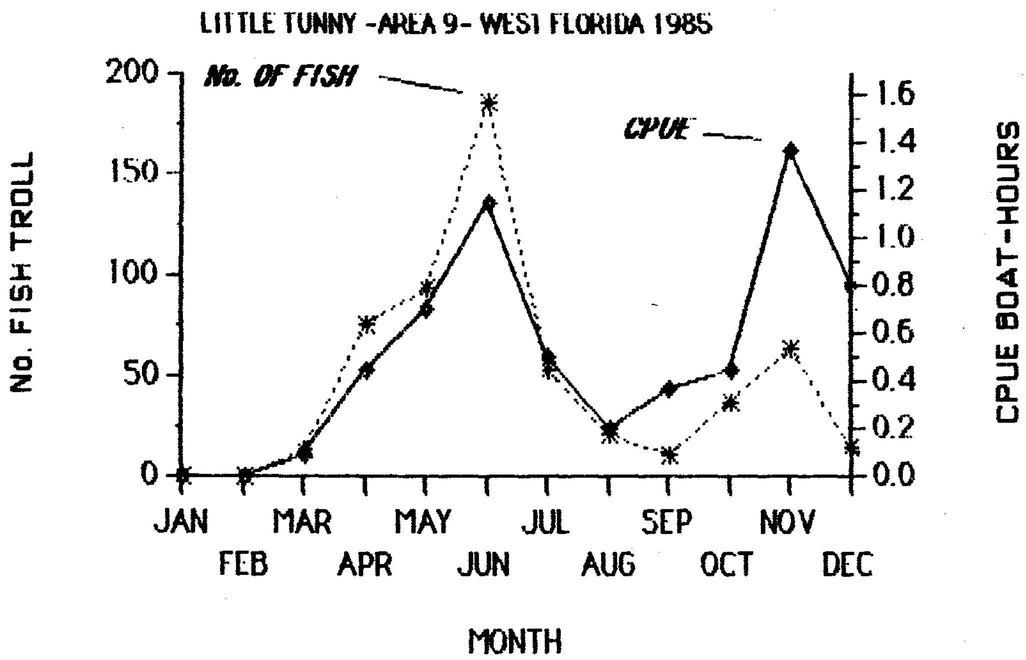
Appendix II. Figure 77.- LITTLE TUNNY. CATCH AND CPUE FOR EAST FLORIDA. 1985 CHARTERBOAT DATA.



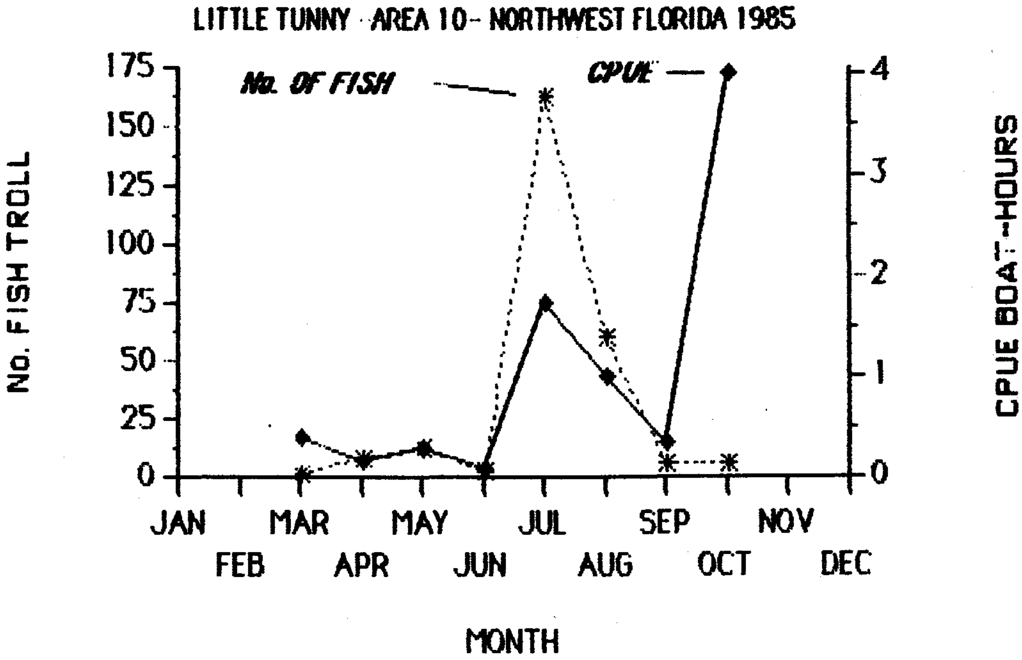
Appendix II. Figure 78.- LITTLE TUNNY. CATCH AND CPUE FOR SOUTHEAST FLORIDA. 1985 CHARTERBOAT DATA.



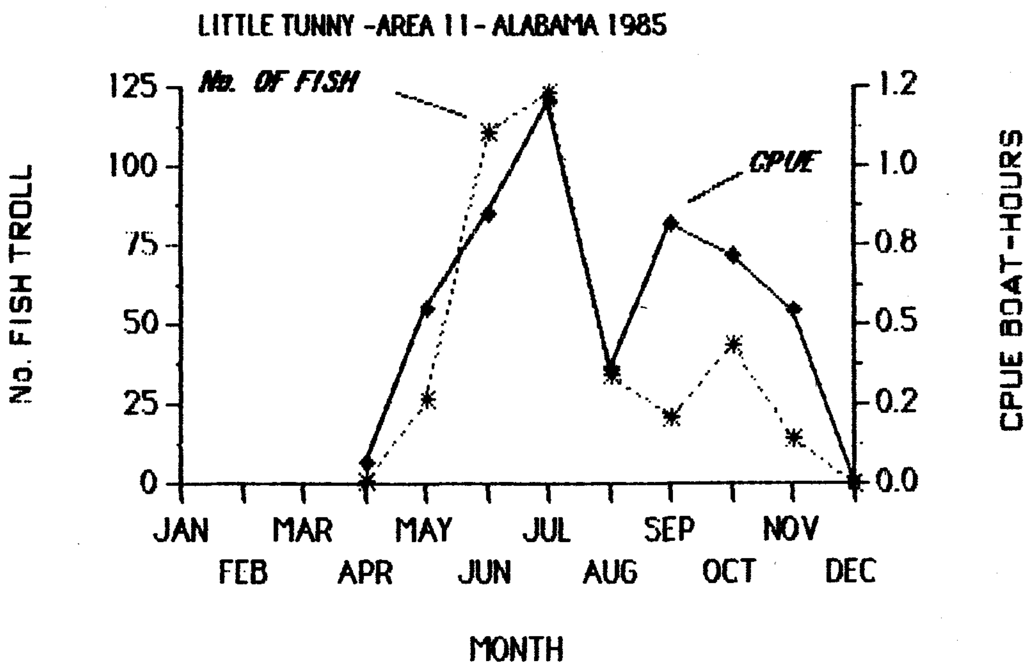
Appendix II. Figure 79.- LITTLE TUNNY. CATCH AND CPUE FOR SOUTH FLORIDA (KEYS). 1985 CHARTERBOAT DATA.



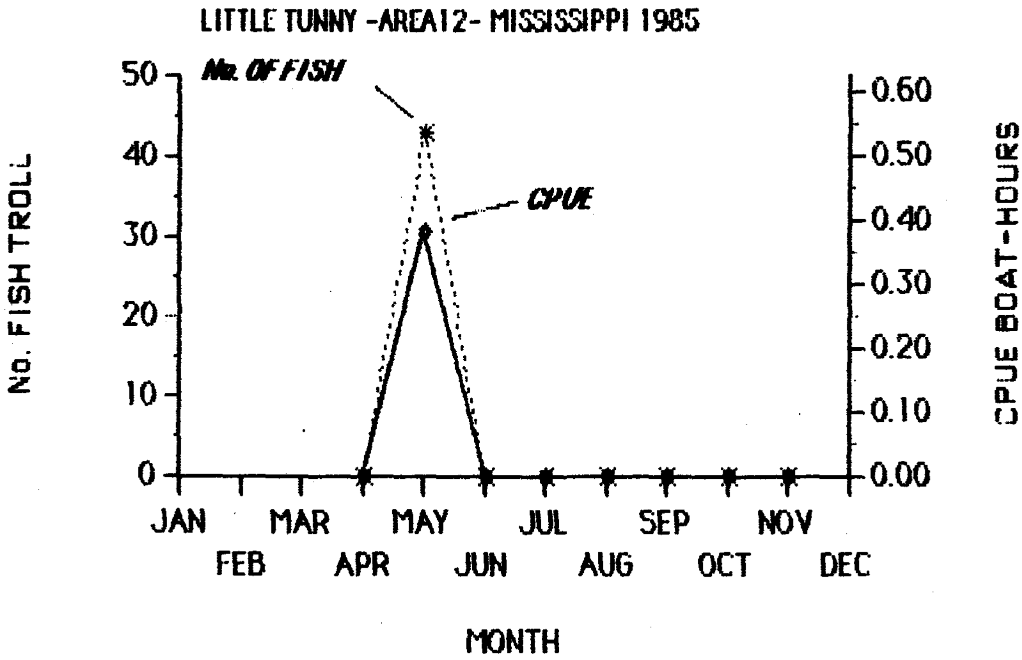
Appendix II. Figure 80.- LITTLE TUNNY. CATCH AND CPUE FOR WEST FLORIDA. 1985 CHARTERBOAT DATA.



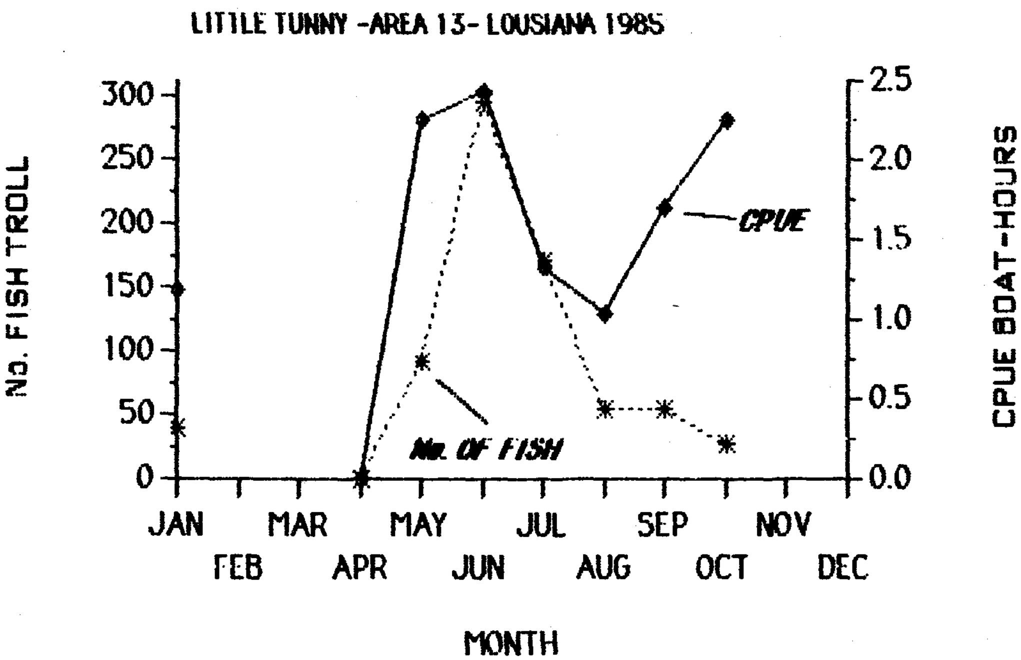
Appendix II. Figure 81.- LITTLE TUNNY. CATCH AND CPUE FOR NORTHWEST FLORIDA. 1985 CHARTERBOAT DATA.



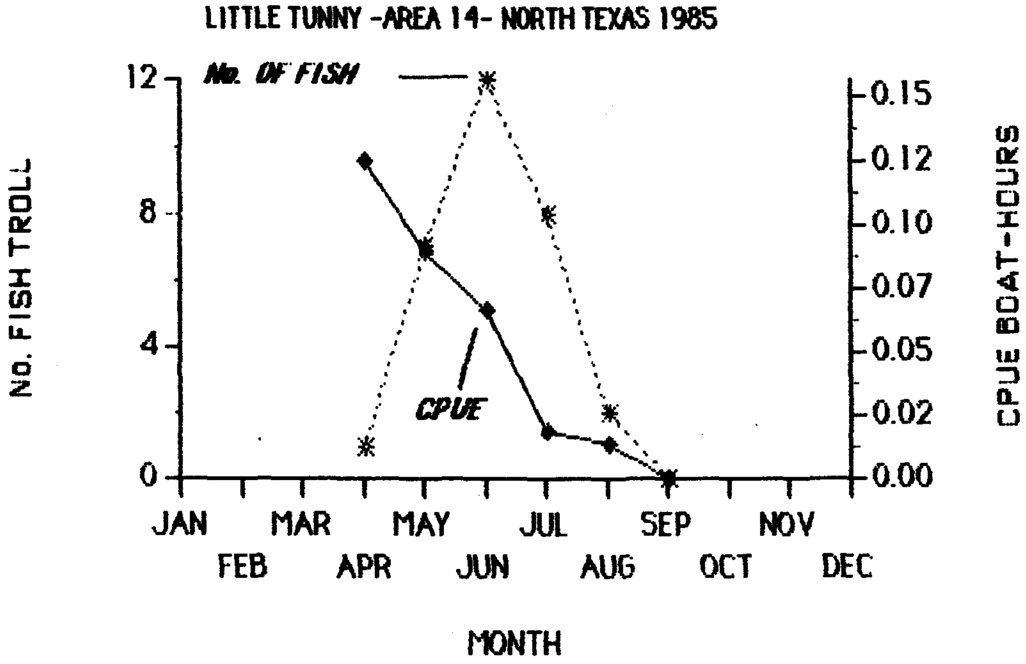
Appendix II. Figure 82.- LITTLE TUNNY. CATCH AND CPUE FOR ALABAMA 1985 CHARTERBOAT DATA.



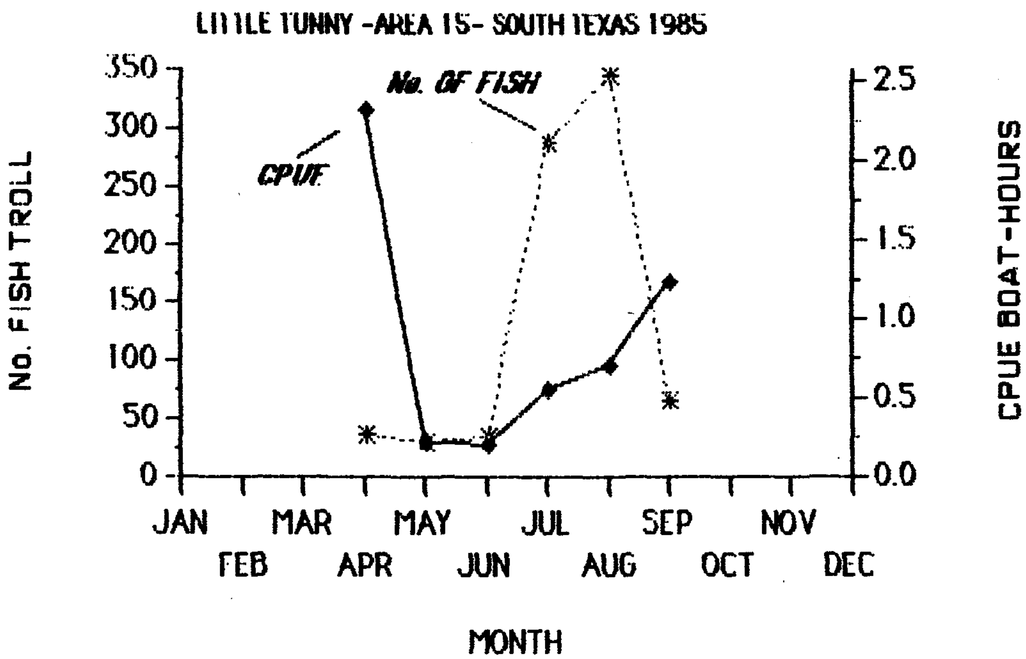
Appendix II. Figure 83.- LITTLE TUNNY. CATCH AND CPUE FOR MISSISSIPPI. 1985 CHARTERBOAT DATA.



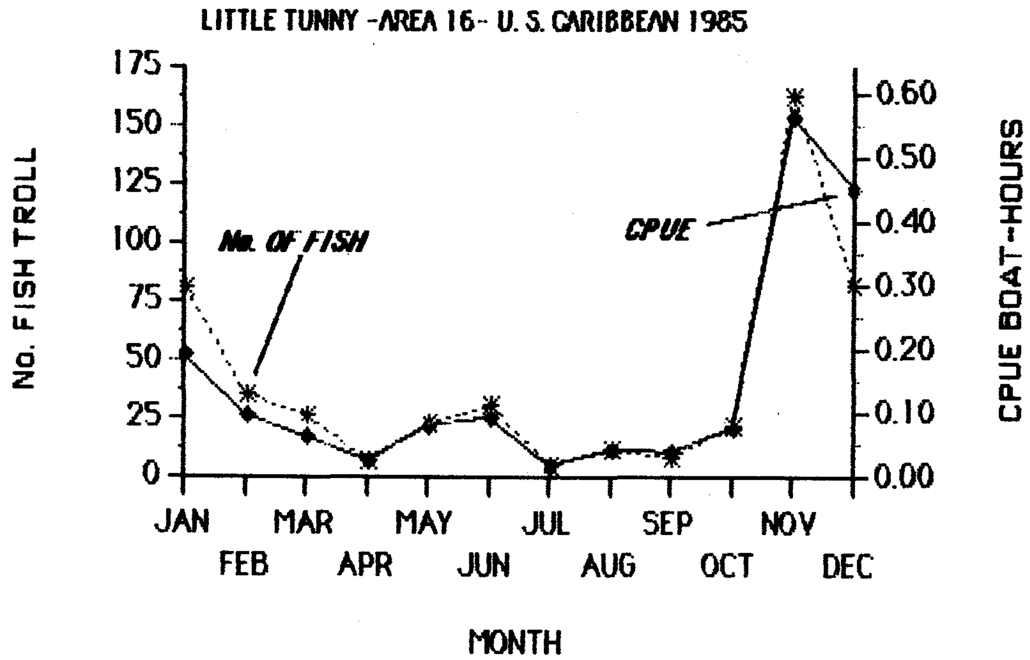
Appendix II. Figure 84.- LITTLE TUNNY. CATCH AND CPUE FOR LOUSIANA. 1985 CHARTERBOAT DATA.



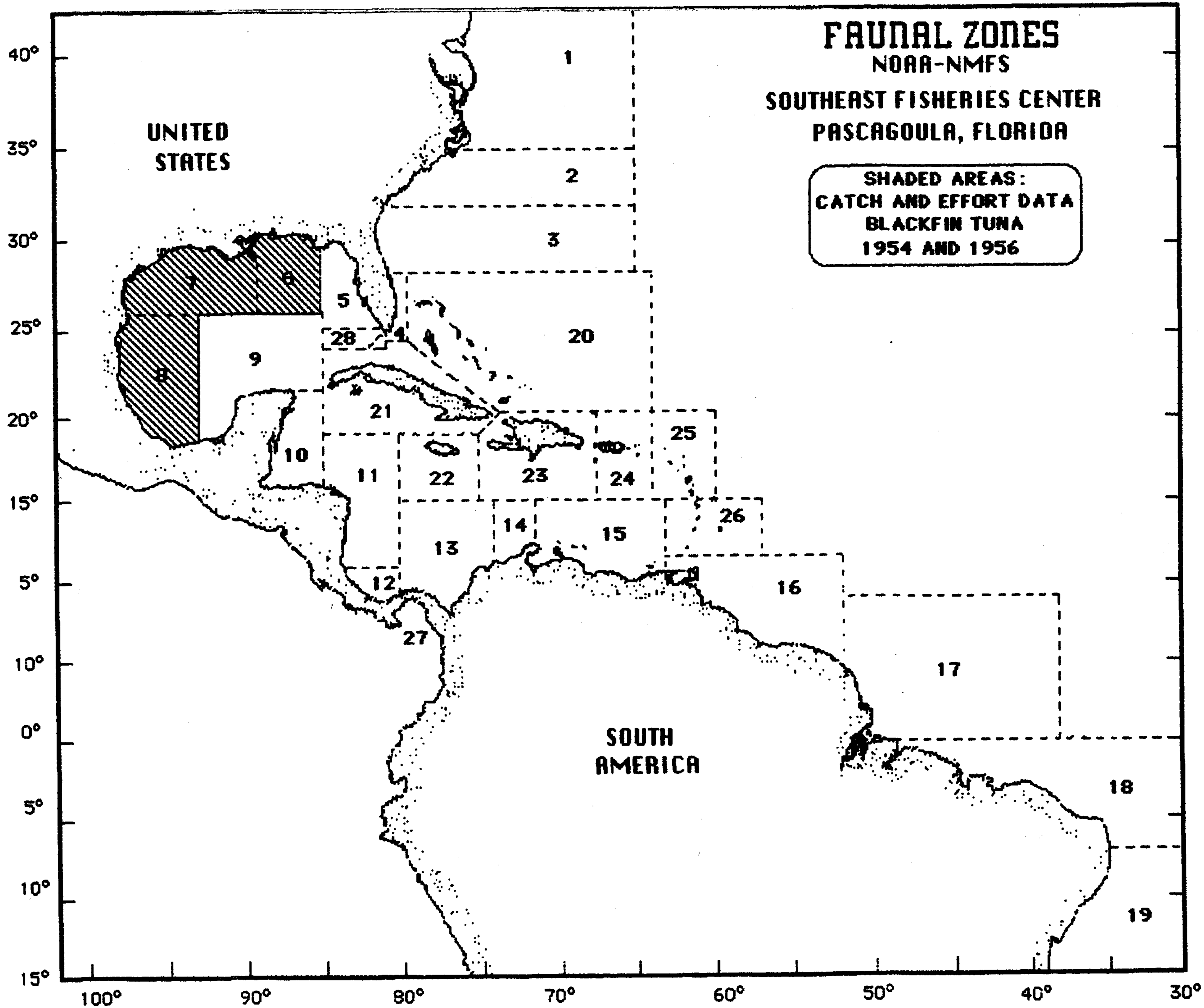
Appendix II. Figure 85.- LITTLE TUNNY. CATCH AND CPUE FOR NORTH TEXAS. 1985 CHARTERBOAT DATA.



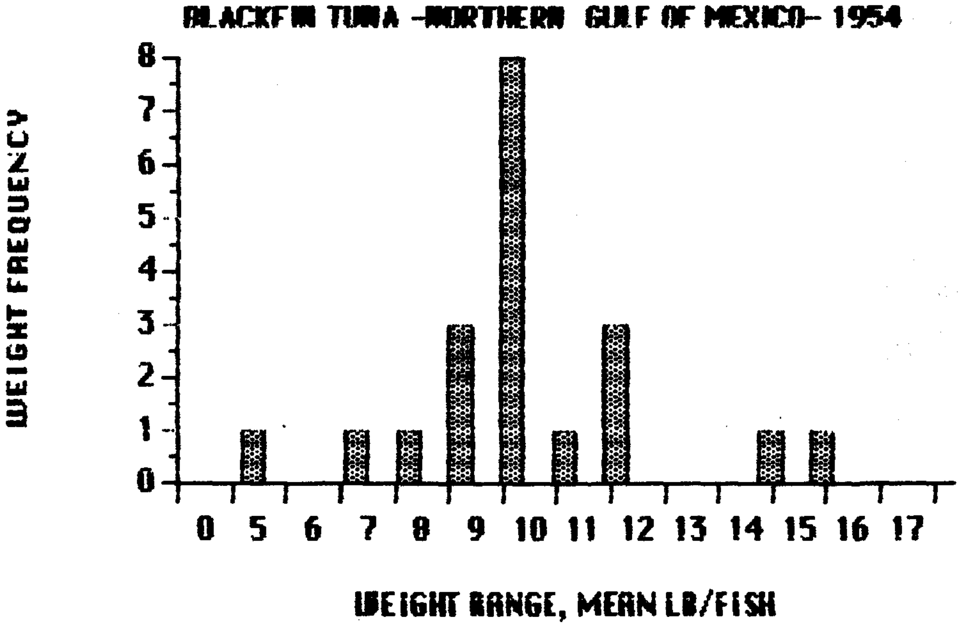
Appendix II. Figure 86.- LITTLE TUNNY. CATCH AND CPUE FOR SOUTH TEXAS. 1985 CHARTERBOAT DATA.



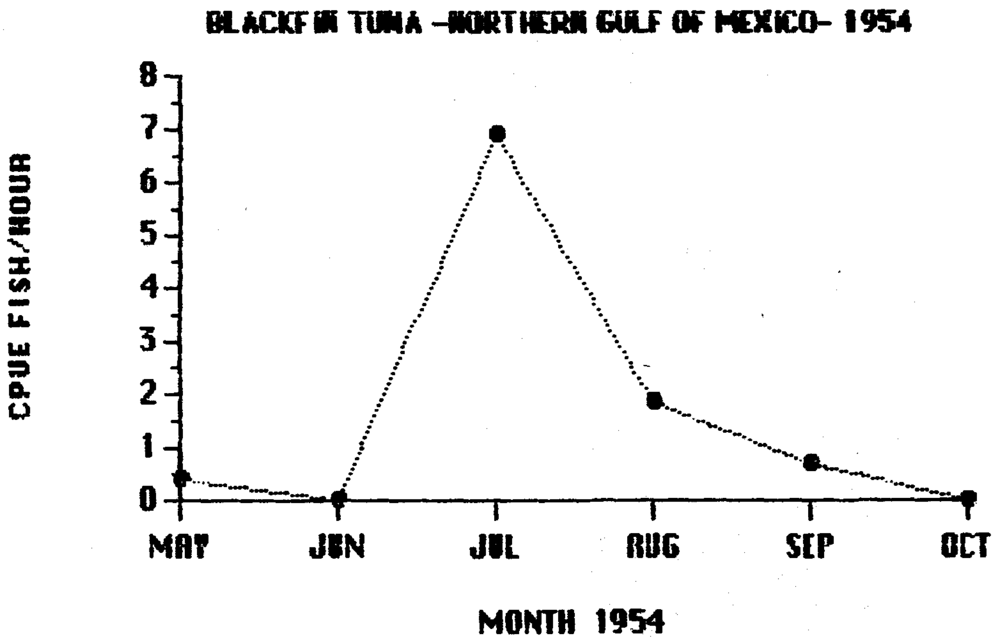
Appendix II. Figure 87.– LITTLE TUNNY. CATCH AND CPUE FOR THE U. S. CARIBBEAN. 1985 CHARTERBOAT DATA.



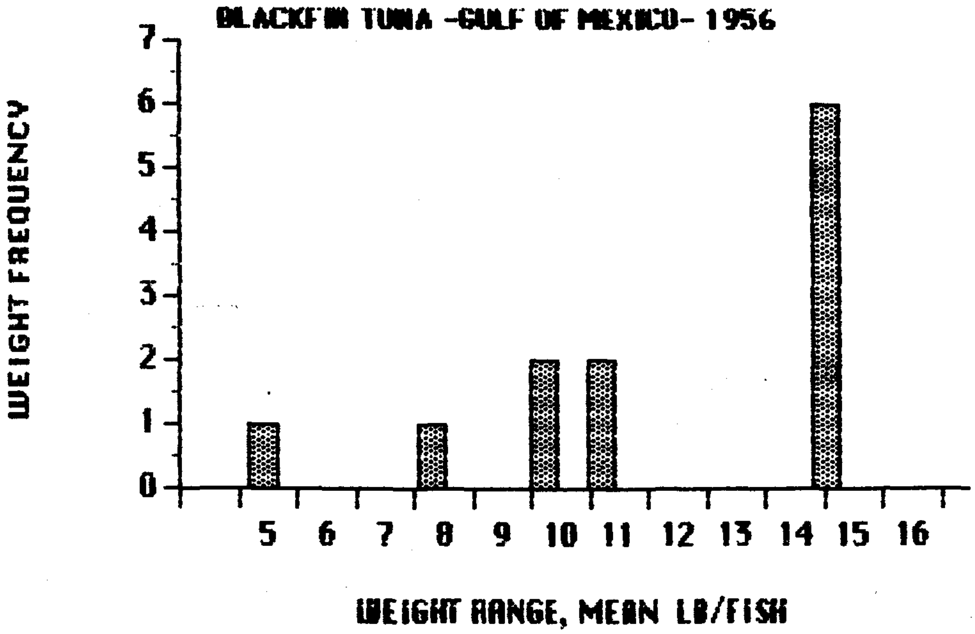
Appendix II. Figure 88.



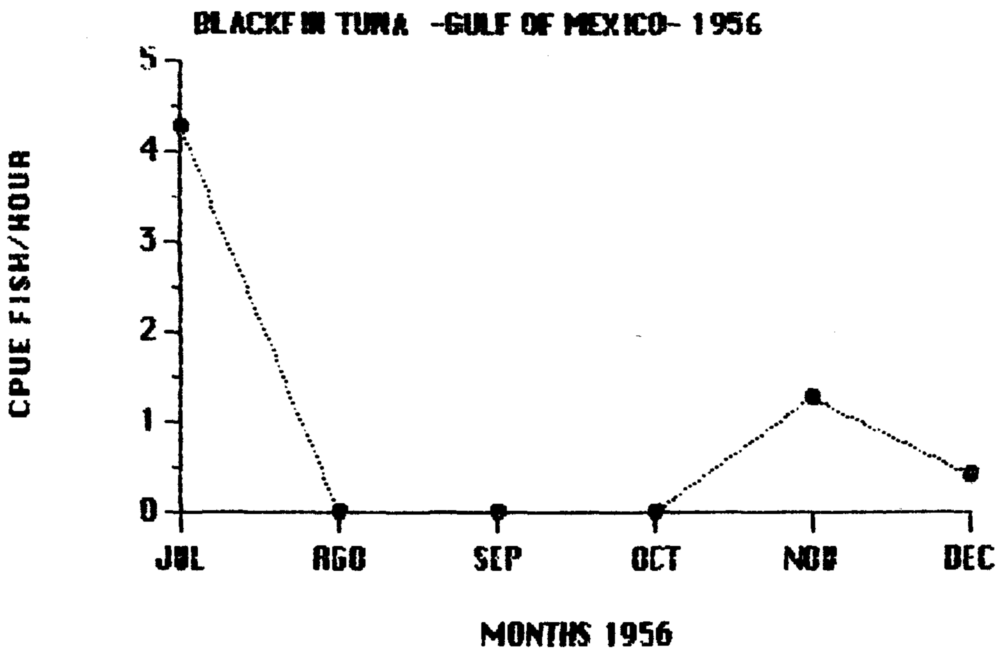
Appendix II. Figure 89.



Appendix II. Figure 90.



Appendix II. Figure 91



Appendix II. Figure 92.

BLACKFIN TUNA NORTHERN GULF OF MEXICO-1954

DATE	ZONE	LATITUDE	LONGITUDE	DEPTH (FA)	GEAR SIZE	GEAR TYPE	MIN FISH	STD TIME	SUR TEMP
5/23/54	8	23 12	97 02	600	26	LL	150	8	78
6/3/54	7	26 10	95 25	40	40	ST	30	17	80
7/14/54	6	28 50	88 11	720	36	LL	135	13	86
7/15/54	6	28 38	88 06	250	36	LL	185	6	88
7/17/54	6	28 17	87 21	400	0	LT	240	19	86
7/19/54	6	28 40	88 00	1260	31	LL	110	6	86
7/20/54	6	29 11	88 00	350	30	LL	120	6	85
7/22/54	6	27 30	89 00	975	0	LT	135	21	
7/22/54	6	27 30	89 00	1000	30	LL	100	6	83
7/22/54	7	27 35	89 35	900	30	LL	95	14	84
7/22/54	7	28 05	89 35	660	30	LL	150	6	86
7/24/54	6	27 58	88 03	1300	30	LL	400	6	83
7/25/54	6	27 51	88 05	1370	30	LL	130	14	83
7/25/54	6	27 52	87 44	1500	0	LT	0		
7/26/54	6	27 50	87 42	1500	30	LL	200	5	83
7/26/54	6	27 52	87 50	1450	30	LL	100	14	83
8/14/54	6	28 50	88 10	1000	39	LL	180	6	83
8/15/54	6	29 05	88 01	600	29	LL	180	6	84
8/18/54	6	29 00	88 15	550	29	LL	190	6	85
8/27/54	6	28 23	89 08	400	0	LT	240	20	84
8/29/54	6	27 40	88 55	1000	49	LL	235	6	84
8/30/54	6	28 12	88 52	750	49	LL	0	5	54
9/27/54	7	26 00	93 30	1250	47	LL	145	6	83
9/28/54	7	26 00	94 45	1630	47	LL	390	6	83
10/2/54	7	26 04	95 22	165	42	LL	0	5	83
10/5/54	7	27 00	89 15	1360	43	LL	0	5	83

NUM FISH	FISH WGT	FISH/HOUR	LB/FISH	WGHT RAN...	WGHT FREQ	MONTH	Σ FISH/HR
1	5	0.40000	5	0	0	MAY	0.40000
0	0	0.00000	0	5	1	JUN	0.00000
2	17	0.88889	8.5	6	0	JUL	6.89724
1	12	0.32432	12	7	1	AUG	1.82643
0	0	0.00000	0	8	1	SEP	0.72149
2	20	1.09091	10	9	3	OCT	0.00000
2	18	1.00000	9	10	8		
0	0	0.00000	0	11	1		
1	10	0.60000	10	12	3		
1	12	0.63158	12	13	0		
1	10	0.40000	10	14	0		
0	0	0.00000	0	15	1		
1	11	0.46154	11	16	1		
0	0	0.00000	0	17	0		
1	10	0.30000	10		0		
2	30	1.20000	15				
2	20	0.66667	10				
1	7	0.33333	7				
1	10	0.31579	10				
0	0	0.00000	0				
2	20	0.51064	10				
2	20	0.00000	10				
1	16	0.41379	16				
2	16	0.30769	8				
2	18	0.00000	9				
1	12	0.00000	12				

APPENDIX II. TABLE I BFT/NMFS PASC 54 (CONTINUED)

BLACKFIN TUNA-GULF OF MEXICO-1956

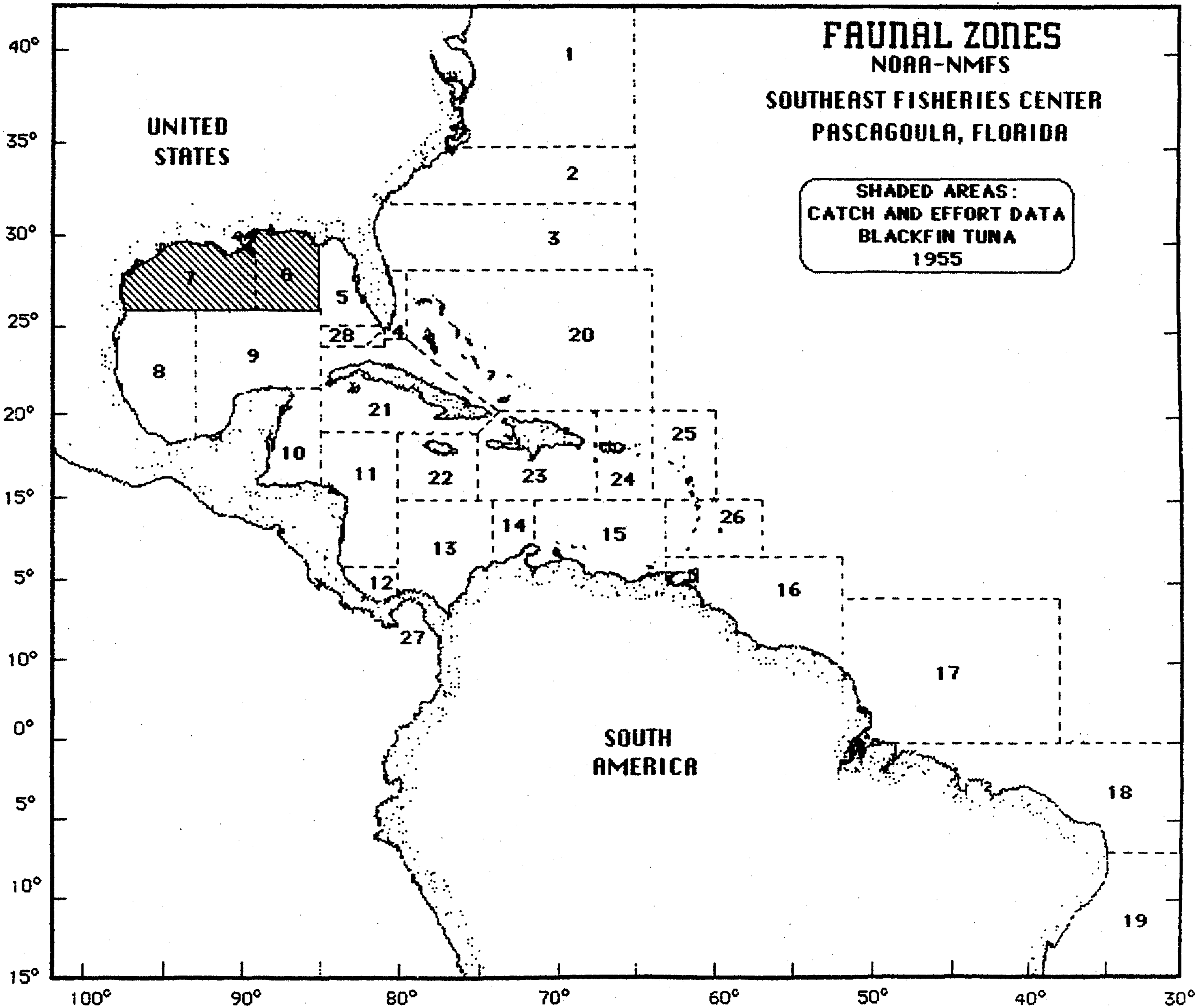
DATE	ZONE	LATITUDE	LONGITUDE	DEPTH (FA)	GEAR SIZE	GEAR TYPE	MIN FISH	STD TIME	SUR TEMP
7/20/56	6	28 58	87 55	900	64	LL	235	6	84
7/23/56	6	28 17	88 33	900	81	LL	205	6	85
7/24/56	6	28 45	88 03	900	101	LL	175	6	84
7/25/56	6	28 51	87 59	800	84	LL	195	6	84
11/20/56	9	24 33	90 12	2050	51	LL	0	6	82
11/24/56	9	20 10	92 25	930	34	LL	0		82
11/25/56	8	20 50	93 00	1160	50	LL	210	7	
11/25/56	8	20 50	93 00	1160	25	LL	87	14	83
12/4/56	6	28 30	88 42	755	102	LL	147	7	76
12/6/56	6	28 30	88 45	675	76	LL	0	6	75
12/10/56	6	28 25	88 43	750	64	LL	0	6	76
12/11/56	6	28 50	88 44	755	96	LL	0	7	75

APPENDIX II. TABLE 2. BFT/NMFS PASC 56

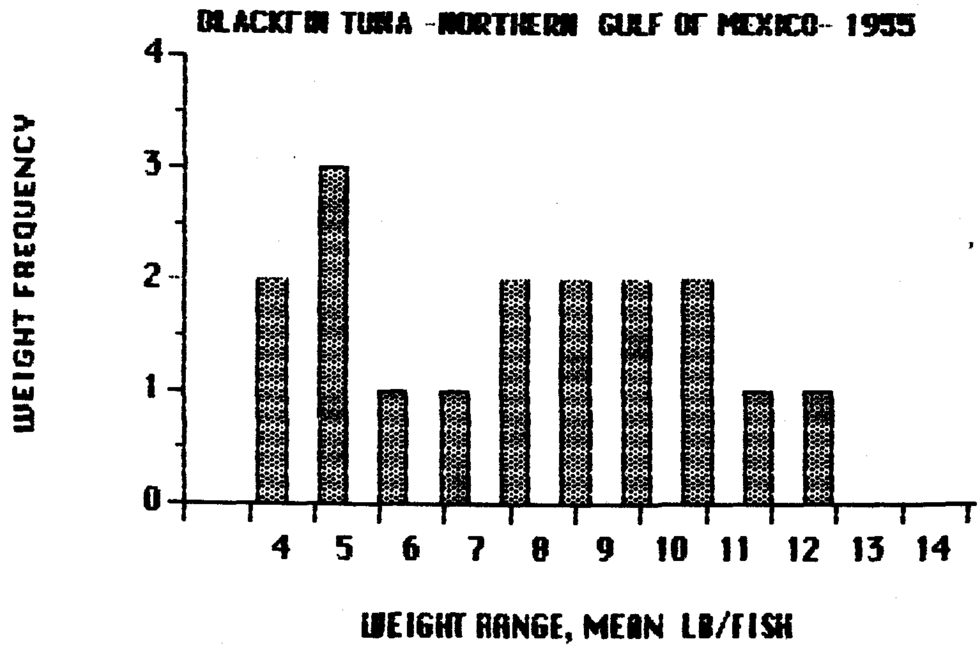
BLACKFIN TUNA-GULF OF MEXICO-1956

NUM FISH	FISH WGT	FISH/HOUR	LB/FISH	WGT RANGE	WGT FREQ	MONTH	Σ FISH/HR
3	45	0.76595745	15			JUL	4.26636
4	30	1.17073171	7.5	5	1	AGO	0.00000
5	55	1.71428571	11	6	0	SEP	0.00000
2	22	0.61538462	11	7	0	OCT	0.00000
1	15	0	15	8	1	NOV	1.26108
1	15	0	15	9	0	DEC	0.40816
2	20	0.57142857	10	10	2		
1	0	0.68965517	0	11	2		
1	15	0.40816327	15	12	0		
1	10	0	10	13	0		
2	30	0	15	14	0		
1	15	0	15	15	6		
				16	0		
					0		

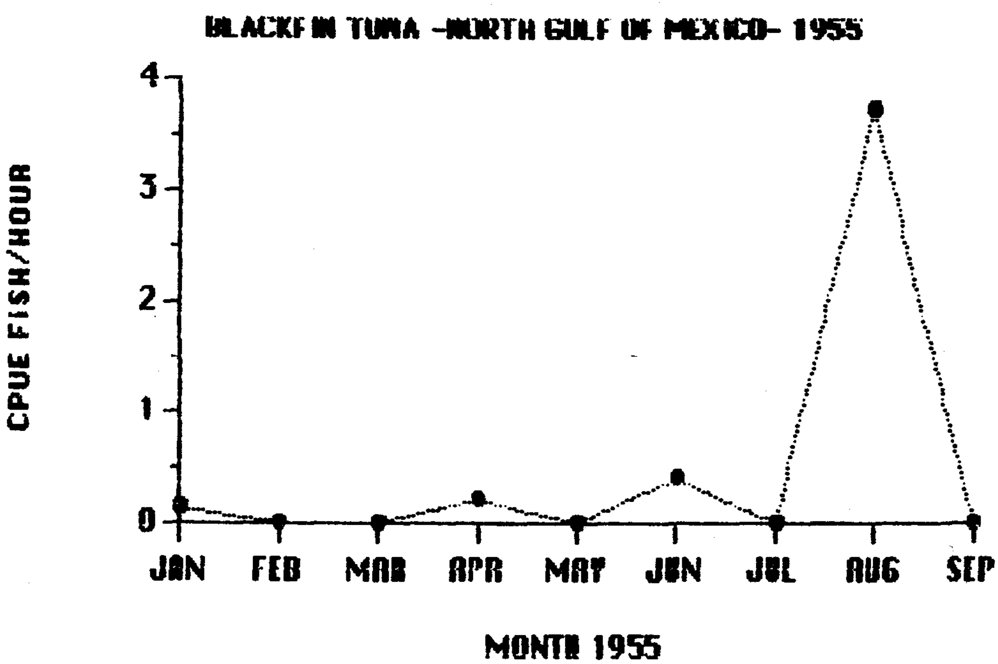
APPENDIX II. TABLE 2. BFT/NMFS PASC 56 (CONTINUED)



Appendix II. Figure 93.



Appendix II. Figure 94



Appendix II. Figure 95.

BLACKFIN TUNA NORTHERN GULF OF MEXICO-1955

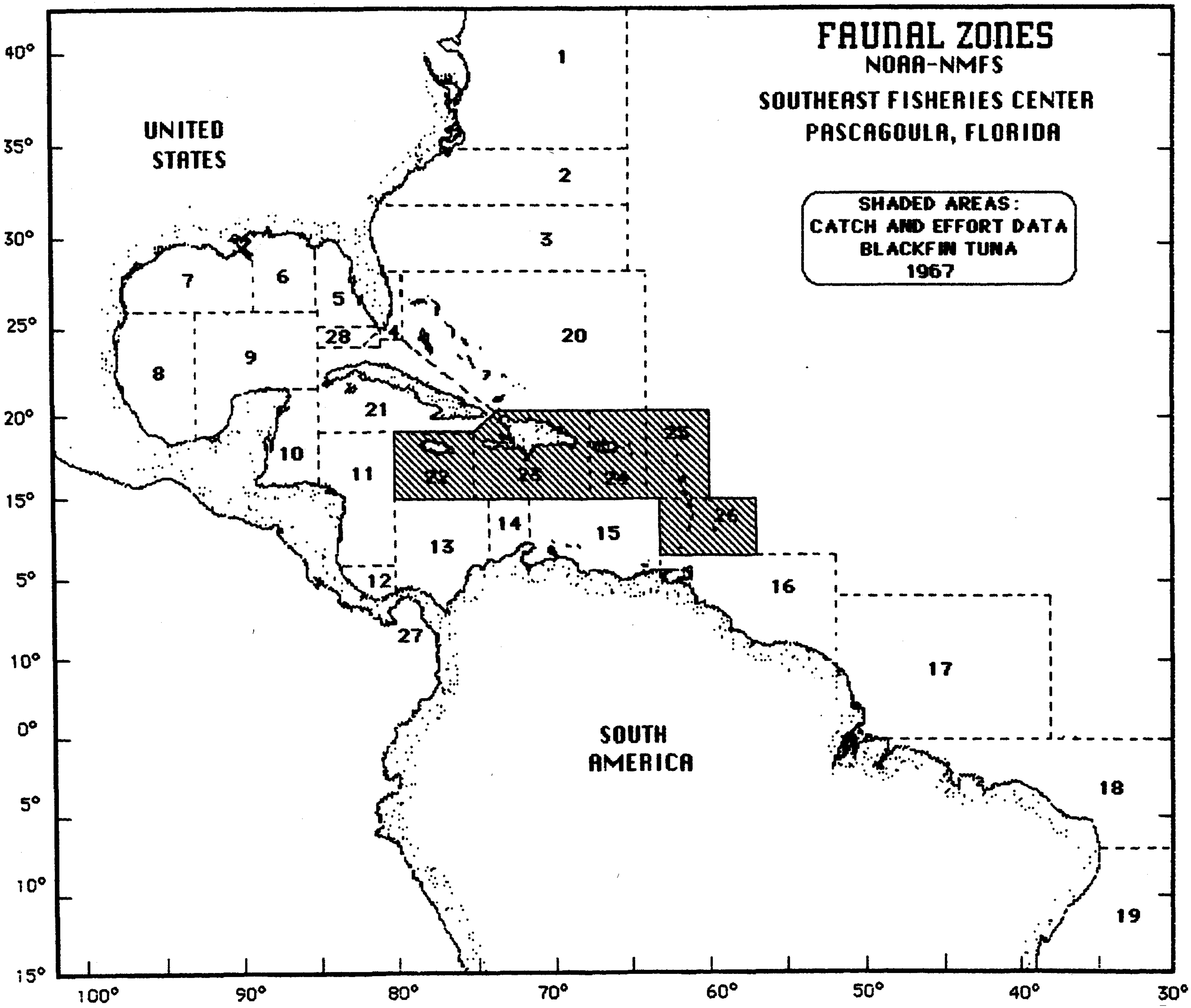
DATE	ZONE	LATITUDE	LONGITUDE	DEPTH (FA)	GEAR SIZE	GEAR TYPE	MIN FISH	STD TIME	SUR TEMP
1/12/55	6	28 20	88 44	890	70	LL	440	6	75
1/13/55	7	25 58	89 47	1350	72	LL	0	5	72
4/30/55	7	25 30	89 15	1400	66	LL	570	5	80
6/6/55	7	27 33	89 25	1090	30	LL	385	5	81
6/9/55	6	27 53	89 07	755	31	LL	240	5	82
8/10/55	6	28 55	87 50	950	56	LL	560	7	84
8/11/55	6	28 47	87 50	1000	104	LL	925	5	85
8/12/55	6	28 50	87 50	0	55	LL	700	5	85
8/13/55	6	28 50	87 48	1100	100	LL	775	5	87
8/14/55	6	28 52	87 52	960	96	LL	660	5	85
8/15/55	6	28 48	87 50	1100	114	LL	300	5	80
8/16/55	6	28 45	87 56	1100	99	LL	200	6	86
8/20/55	6	28 29	88 47	710	104	LL	185	6	85
8/21/55	6	28 52	87 51	900	99	LL	675	5	85
8/22/55	6	28 59	87 50	750	108	LL	765	5	85
8/26/55	6	28 22	88 42	755	50	LL	155	6	85
9/10/55	6	29 27	86 55	350	0	LT	480	20	84
1/20/55	8	22 50	97 10	430	67	LL	0	6	74
4/11/55	21	21 15	84 05	2000	44	LL	205	5	80
4/25/55	21	19 30	76 50	2430	41	LL	330	4	80
4/28/55	10	20 50	86 10	800	39	LL	285	4	80

APPENDIX II. TABLE 3. BFT/NMFS PASC 55

BLACKFIN TUNA NORTHERN GULF OF MEXICO-1955

NUM FISH	FISH WGT	FISH/HOUR	WGT RANGE	WGT FREQ	LB/FISH	MONTH	Σ FISH/HR
1	6	0.13636			6.00000	JAN	0.13636
1	9	0.00000	4	2	9.00000	FEB	0.00000
2	8	0.21053	5	3	4.00000	MAR	0.00000
1	10	0.15584	6	1	10.00000	APR	0.21053
1	8	0.25000	7	1	8.00000	MAY	0.00000
1	10	0.10714	8	2	10.00000	JUN	0.40584
7	75	0.45405	9	2	10.71429	JUL	0.00000
1	7	0.08571	10	2	7.00000	AUG	3.73165
2	25	0.15484	11	2	12.50000	SEP	0.00000
3	26	0.27273	12	1	8.66667		
4	46	0.80000	13	1	11.50000		
3	15	0.90000	14	0	5.00000		
1	5	0.32432		0	5.00000		
1	5	0.08889			5.00000		
2	15	0.15686			7.50000		
1	11	0.38710			11.00000		
0	0	0.00000			0.00000		
0	0						
1	10	0.29268					
7	120	1.27273					
1	5	0.21053					

APPENDIX II. TABLE 3. BFT/NMFS PASC 55 (CONTINUED)


FAUNAL ZONES
NOAA-NMFS
SOUTHEAST FISHERIES CENTER
PASCAGOULA, FLORIDA
SHADED AREAS:
CATCH AND EFFORT DATA
BLACKFIN TUNA
1967
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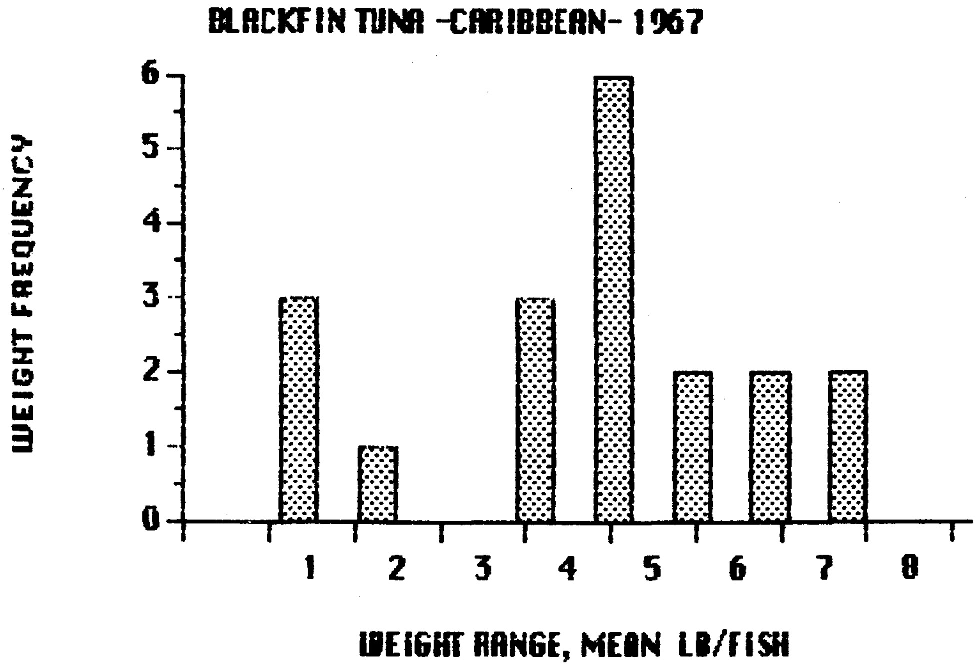
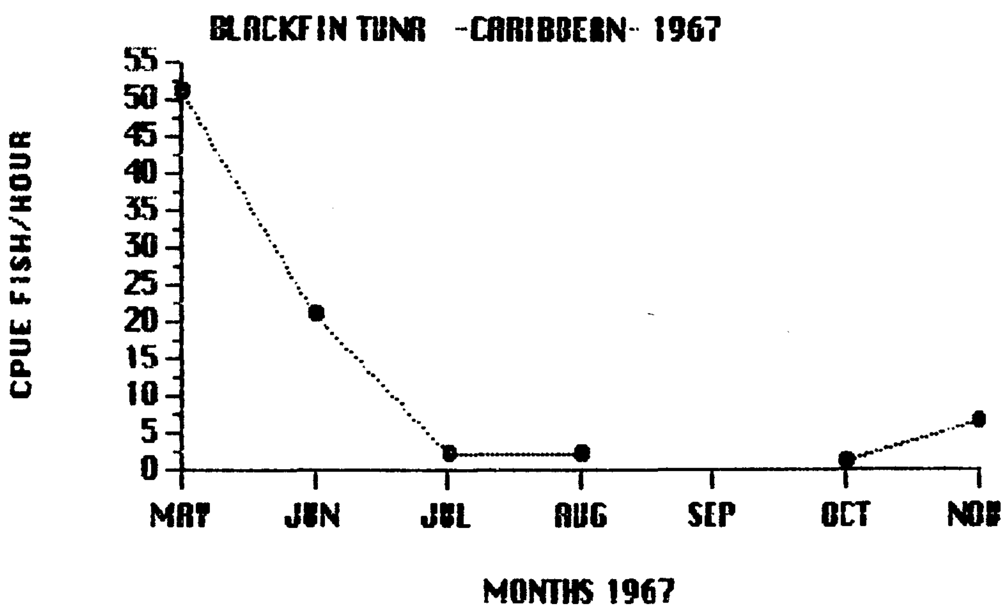


Appendix II. Figure 97.



Appendix II. Figure 98.

BLACKFIN TUNA–CARIBBEAN–1967

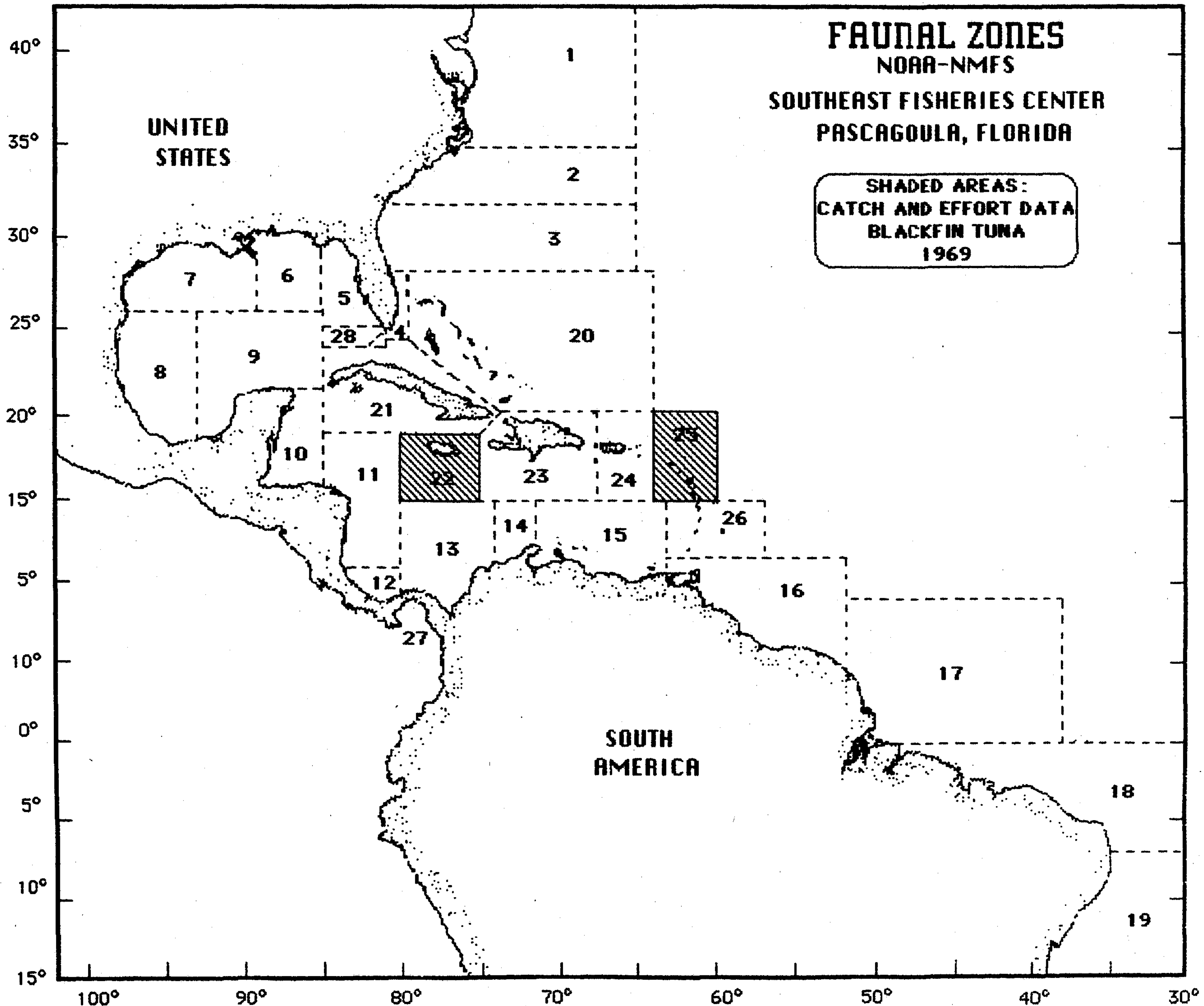
DATE	ZONE	LATITUDE	LONGITUDE	DEPTH (FA)	GEAR SIZE	GEAR TYPE	MIN FISH	STD TIME	SUR TEMP
4/18/67	23	17 51	70 44	0	3	JP	0	12	80
4/27/67	23	17 55	70 10	10	0	JP	0	11	80
4/28/67	23	17 50	74 37	11	3	JP	0	16	82
5/17/67	24	18 20	64 10	112	6	TG	120	12	80
5/22/67	25	17 25	62 56	85	6	TG	150	13	80
5/23/67	25	18 31	63 16	80	8	TG	30	14	81
5/24/67	25	18 29	63 06	80	8	TG	30	8	81
5/29/67	24	18 18	65 03	90	8	TG	520	7	81
5/30/67	25	18 37	63 27	12	8	TG	270	5	81
6/6/67	25	18 01	62 41	20	8	TG	180	15	81
6/7/67	25	18 22	62 35	68	8	TG	435	11	81
6/7/67	25	18 23	62 44	75	8	TG	180	5	81
6/8/67	24	18 41	64 06	120	8	TG	740	6	81
6/9/67	24	18 44	64 48	120	8	TG	790	5	82
7/23/67	22	17 15	75 15	60	6	TG	30	14	
8/18/67	0	0	0	50	3	TG	240	6	82
8/22/67	23	18 30	74 44	35	3	TG	240	6	82
10/12/67	26	12 25	61 45	0	2	TG	55	13	
11/25/67	22	16 55	78 43	25	4	TG	300	20	

APPENDIX II. TABLE 4. BFT/NMFS PASC 67

BLACKFIN TUNA-CARIBBEAN-1967

NUM FISH	FISH WGT	FISH/HOUR	LB/FISH	WT RANGE	WT FREQ	MONTH	Σ FISH/HR
1	0		0			MAY	51.24530
1	0		0.00000	1	3	JUN	20.94903
4	0		0.00000	2	1	JUL	2.00000
9	40	4.50000	4.44444	3	0	AUG	2.00000
24	96	9.60000	4.00000	4	3	SEP	
5	28	10.00000	5.60000	5	6	OCT	1.09091
11	50	22.00000	4.54545	6	2	NOV	6.40000
8	58	0.92308	7.25000	7	2		
19	74	4.22222	3.89474	8	2		
21	127	7.00000	6.04762		0		
31	135	4.27586	4.35484				
23	101	7.66667	4.39130				
21	149	1.70270	7.09524				
4	23	0.30380	5.75000				
1	4	2.00000	4.00000				
1	2	0.25000	2.00000				
7	29	1.75000	4.14286				
1	7	1.09091	7.00000				
32	154	6.40000	4.81250				

APPENDIX II. TABLE 4. BFT/NMFS PASC 67 (CONTINUED)


FAUNAL ZONES
NOAA-NMFS
SOUTHEAST FISHERIES CENTER
PASCAGOULA, FLORIDA
SHADED AREAS:
CATCH AND EFFORT DATA
BLACKFIN TUNA
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UNITED STATES
SOUTH AMERICA
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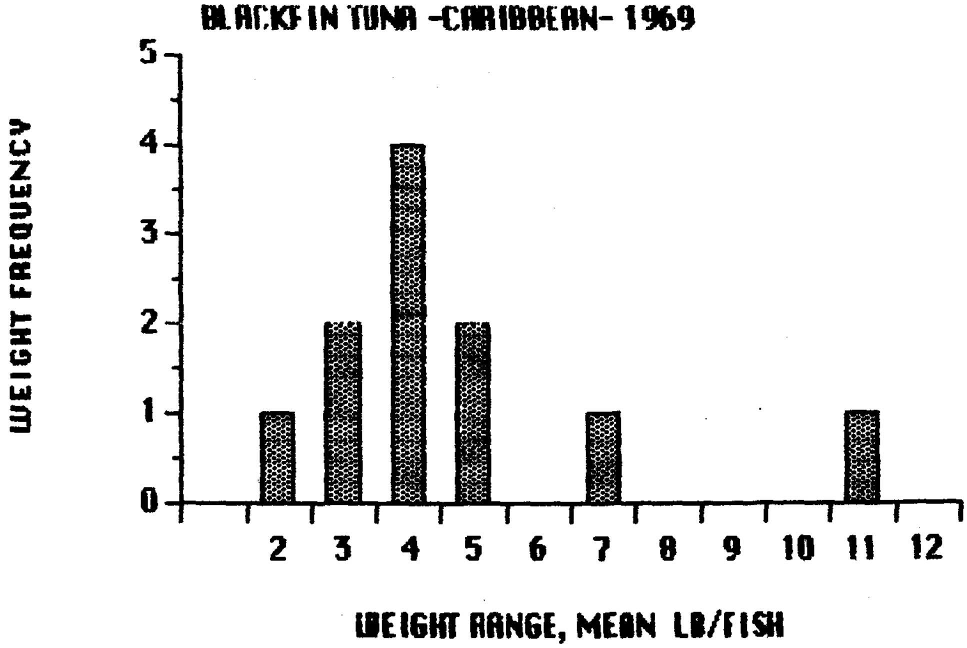
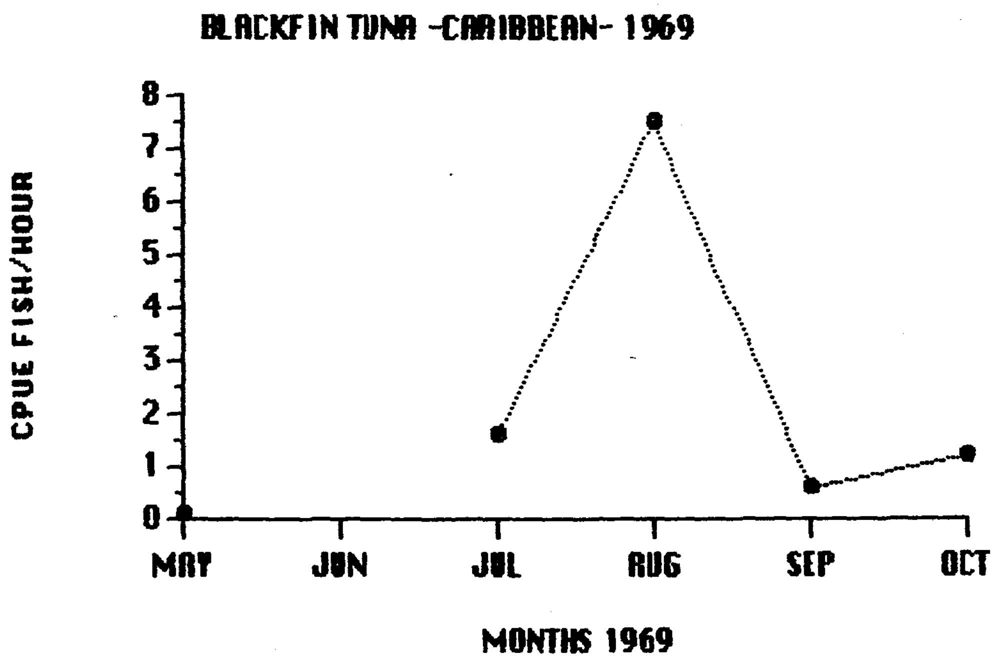


Appendix II. Figure 100.



Appendix II. Figure 101.

BLACKFIN TUNA-CARIBBEAN-1969

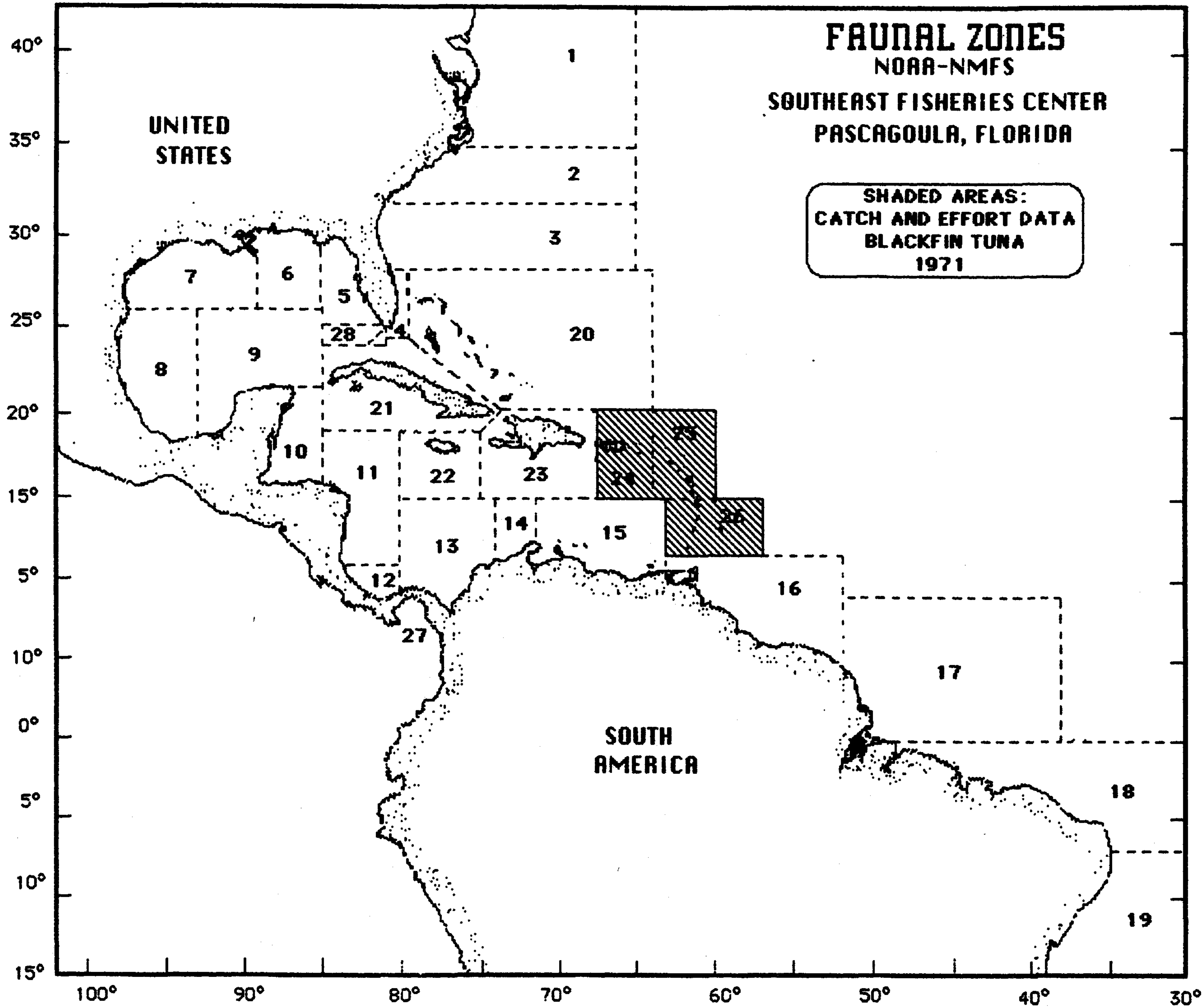
DATE	ZONE	LATITUDE	LONGITUDE	DEPTH (FA)	GEAR SIZE	GEAR TYPE	MIN FISH	STD TIME	SUR TEMP
3/27/69	7	29 00	88 38	180	19	LL	660	18	66
5/25/69	25	17 47	61 56	90	5	HL	780	6	83
7/30/69	25	18 00	62 40	0	6	TG	150	10	
8/1/69	25	18 34	63 10	0	6	TG	246	6	84
8/3/69	25	18 33	63 08	0	6	TG	90	6	
8/5/69	25	18 31	63 18	0	6	TG	360	6	
8/6/69	25	18 28	63 13	0	6	TG	330	6	84
9/23/69	22	17 24	76 15	100	6	TG	705	6	
10/11/69	22	17 15	75 45	100	6	TG	660	6	
10/12/69	22	17 45	75 45	0	6	TG	665	7	
10/13/69	22	17 15	76 15	0	6	TG	0	0	
10/14/69	22	17 15	76 15	0	6	TG	660	6	

APPENDIX II. TABLE 5. BFT/NMFS PASC 69

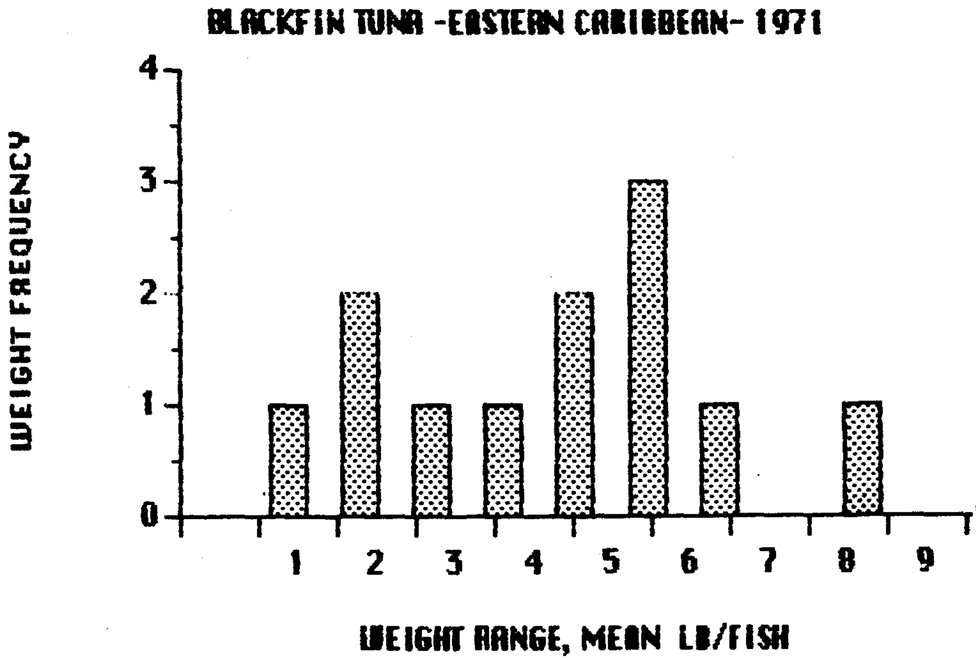
BLACKFIN TUNA-CARIBBEAN-1969

NUM FISH	FISH WGT	FISH/HOUR	LB/FISH	WGT RANG...	WGT FREQ	MONTH	Σ FISH/HR
1	8	0.09091	8		0	MAY	0.07692
1	12	0.07692	12.00000	2	0	JUN	
4	22	1.60000	5.50000	3	1	JUL	1.60000
7	50	1.70732	7.14286	4	2	AUG	7.48004
2	9	1.33333	4.50000	5	4	SEP	0.59574
7	35	1.16667	5.00000	6	2	OCT	1.18045
18	107	3.27273	5.94444	7	0		
7	25	0.59574	3.57143	8	1		
1	5	0.09091	5.00000	9	0		
2	9	0.18045	4.50000	10	0		
7	20		2.85714	11	0		
10	34	0.90909	3.40000	12	1		
					0		

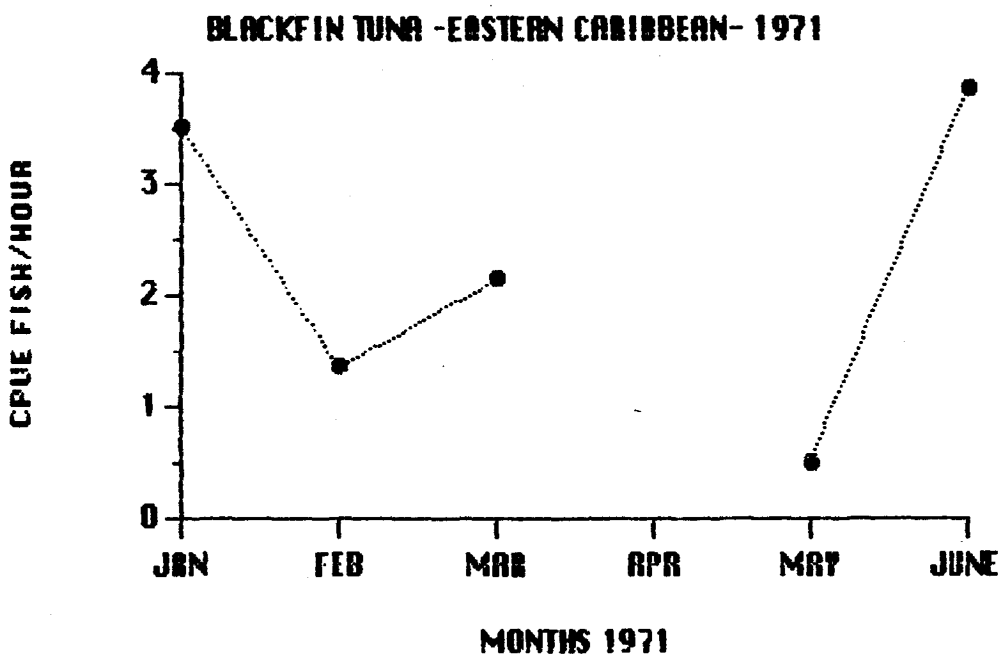
APPENDIX II. TABLE 5. BFT/NMFS PASC 69 (CONTINUED)



Appendix II. Figure 102.



Appendix II. Figure 103.



Appendix II. Figure 104.

BLACKFIN TUNA-CARIBBEAN-1971

DATE	ZONE	LATITUDE	LONGITUDE	DEPTH (FA)	GEAR SIZE	GEAR TYPE	MIN FISH	STD TIME	SUR TEMP
1/30/71	26	11 45	61 45	0	10	TG	130	6	
1/31/71	26	11 45	61 45	0	10	TG	81	8	
2/2/71	26	11 15	60 45	0	10	TG	675	6	
2/4/71	26	13 15	59 45	5	10	TG	285	7	
2/4/71	26	13 15	59 15	5	10	TG	240	11	
2/25/71	25	16 45	61 45	125	10	TG	402	6	
3/28/71	26	12 45	61 15	0	10	TG	195	13	
5/27/71	24	17 46	65 54	77	9	TG	480	7	54
6/3/71	26	13 45	60 45	500	5	TG	660	6	
6/17/71	25	17 00	61 30	0	5	TG	630	7	
6/19/71	25	18 20	62 30	0	7	TG	750	6	
6/20/71	25	18 20	62 30	0	7	TG	750	6	

APPENDIX II. TABLE 6. BFT/NMFS PASC 71

BLACKFIN TUNA-CARIBBEAN-1971

NUM FISH	FISH WGT	FISH/HOUR	LB/FISH	WGT RANGE	WGT FREQ	MONTH	Σ FISH/HR
6	26	2.76923	4.33333		0	JAN	3.50997
1	3	0.74074	3.00000	1	1	FEB	1.35696
1	2	0.08889	2.00000	2	2	MAR	2.15385
2	2	0.42105	1.00000	3	1	APR	
1	2	0.25000	2.00000	4	1	MAY	0.50000
4	14	0.59701	3.50000	5	2	JUNE	3.86251
7	58	2.15385	8.28571	6	3		
4	25	0.50000	6.25000	7	1		
8	44	0.72727	5.50000	8	0		
1	5	0.09524	5.00000	9	1		
10	60	0.80000	6.00000		0		
28	143	2.24000	5.10714				

APPENDIX II. TABLE 6. BFT/NMFS PASC 71 (CONTINUED)