

Preliminary Data on Landing Records and Reproductive Biology of *Coryphaena hippurus* L., in Puerto Rico

RAQUEL N. PÉREZ and YVONNE SADOVY

*Fisheries Research Laboratory
Department of Natural Resources
P.O. Box 3665, Marina Station
Mayagüez, P.R. 00681*

COMPENDIO

El Laboratorio de Investigaciones Pesqueras, del Departamento de Recursos Naturales de Puerto Rico, llevó a cabo una encuesta para determinar el número de torneos de pesca deportiva relacionados con el pez dorado, *Coryphaena hippurus*. Durante el primer año de encuesta se encontró que únicamente 7 de 18 clubes de pesca deportiva marina en Puerto Rico, patrocinan torneos para la pesca de esta especie. Se desarrolló una tabla de registros para documentar los datos biológicos básicos del pez dorado tales como el largo, peso, sexo. Además, se incluyeron datos sobre la captura por unidad de esfuerzo (CPUE) durante éstos. Los tamaños del pez dorado fluctuaron entre 358 mm y 1323 mm (largo horquilla), con diferencias significativas entre los promedios de tamaños machos y hembras. Se encontró que más del 90% de las hembras estaban maduras. Los datos recolectados sugieren un tamaño mínimo de madurez entre 450 mm y 500 mm (LH). Sólo el Club Náutico de La Parguera en Lajas ha mantenido anotaciones para casi todos los torneos llevados a cabo en los pasados 9 años. La captura por unidad de esfuerzo está documentada para la mayoría de estos torneos. Además, se presentan los datos históricos sobre desembarcos comerciales que documentan las tendencias de abundancia anual y estacional del pez dorado en Puerto Rico.

ABSTRACT

Between September 1990 and August 1991 the Fisheries Research Laboratory (FRL) of the Puerto Rico Department of Natural Resources, collected gonad samples from dolphin fish, *Coryphaena hippurus*, caught in tournaments held in Puerto Rico. Seven out of 18 sportfishing clubs around the island sponsor these tournaments between November and May. A log table was developed to record basic dolphin fish biological data (length, weight, and sex) and catch per unit of effort (CPUE) data during these tournaments. Dolphin fish size ranged between 358 mm and 1323 mm (fork length), with significant differences between male and female mean sizes. More than 90% of the females were found to be mature. Data gathered suggest a minimum size class of maturity of between 450 and 500 mm (FL). Only La Parguera Nautical Club in Lajas has kept complete records for most of the tournaments held in the past 9 years. Catch per unit effort is documented for most of the tournaments. Historic commercial landings data documenting the annual and seasonal trends of dolphin fish in Puerto Rico are presented.

KEY WORDS: *Coryphaena hippurus*, dolphin fish, recreational fisheries, reproduction dynamics, landings data.

INTRODUCTION

The pantropical and subtropical distribution of *Coryphaena hippurus* has been well documented (Kojima, 1956; Lozano-Cabo, 1961; Beardsley, 1967; Lewis and Axelson, 1967; Wang, 1979; Palko *et al.*, 1982; Goldberg, 1985). Both the recreational and commercial value of this species has been addressed (Hassler and Rainville, 1975; Chen, 1979; Hagood *et al.*, 1981; Oxenford and Hunte, 1983; 1986; 1987). Currently, the dolphin fish is recognized as an important fisheries species by many Caribbean countries (Erdman, 1977; Gibbs and Collette, 1959; Palko *et al.*, 1982; Oxenford and Hunte, 1983; 1986). Its migratory behavior expands the population boundaries of this species to regional levels (Mahon, 1987). Recent studies suggest that two different populations visit the eastern Caribbean and western central Atlantic throughout the year (Oxenford and Hunte, 1986) and stress the need for cooperative management efforts to enable proper utilization and development of what may be most likely shared stock populations.

Since the early 1950's, Puerto Rico has been developing big game and sportfishing activities (Erdman, 1977; Griffith *et al.*, 1988; Berrios *et al.*, 1989). The pelagic dolphin fish is the target species of many sportfishermen and several local tournaments. Although the popularity of *C. hippurus* and its importance as a recreational species is well known amongst sportfishermen, no basic biological or tournament landings data have been collected. The Fisheries Research Laboratory (FRL) of the Natural Resources Department of Puerto Rico is pursuing its first sportfishing research project sponsored with Dingell/Johnson funds provided by the United States Fish and Wildlife Service. The main objectives of this project are: 1) to produce an assessment of data available from dolphin tournaments for future monitoring efforts; 2) to evaluate the spawning dynamics of *C. hippurus* and; 3) to evaluate existing commercial landings data available to Laboratory files. This paper presents a preliminary summary of the biological and catch-effort data collected during the first year of this project.

METHODS AND MATERIALS

Tournament Surveys

To pinpoint the major dolphin fish tournaments around the island, all marina sportfishing clubs were contacted prior to and during billfish tournaments sponsored by the Puerto Rico Sportfishing Association (PRSA). Informal interviews with organizers and club members provided basic information on local clubs sponsoring dolphin fish tournaments. In addition to historical tournament data assessment, a protocol or log table, was developed to help gather basic biological information on the sampled fishes (weight, length,

sex), as well as fishing effort for the monitored tournaments (i.e., number of fish caught, fishing hours, number of boats and fishermen). When historical tournament data were available, catch per unit of effort was estimated using official fishing time schedules, as well as boats and fishermen numbers provided by tournament organizers. Catch per unit of effort (CPUE) or catch-effort units for *C. hippurus* are defined as the number of fish caught per boat-hour irrespective of the number of fishermen on board (generally parties from two to four). All historic records on dolphin fish tournaments kept by the clubs, as well as commercial landings data over the last nineteen years have been reported as pounds (lbs.). Therefore, the convention of reporting landings data as pounds will be followed throughout this report to facilitate the comparison of recently acquired data with historical data.

Spawning Dynamics

Dolphin fish caught incidentally during billfish tournaments were measured for length (total, fork and standard in mm), and weight (kg), and sexed. A minimum of fifteen gonad samples per month were collected for most months from cooperating sportfishermen. When tournaments were not scheduled for a particular month, samples were gathered from cooperating recreational and commercial fishermen, and by Laboratory research vessels. Since dolphin fish gonads are considered a delicacy by most fishermen in Puerto Rico, at times they were difficult to collect. When possible, intact gonads were weighed and a small portion of each sample was preserved in Davidson's fixative for histological analysis. Coolridge and Howard (1979) staining procedures were followed for slide preparation using eosin and hematoxylin. Gonads were divided into mature and immature stages, where mature gonads were defined as having a few scattered eggs in vitellogenesis (stage three eggs and over, as described by Moe, 1969). This criteria was used to establish the smallest size class at which minimum of 50% of the individuals are sexually mature.

Ten samples were prepared to compare stages of gonadal development throughout the gonad lobules. Two sections (i.e. transverse and longitudinal) from three gonad areas (i.e. anterior, central and posterior region of the lobules) were prepared. Standardization of area gonad sample collection tends to be difficult due to their market value as a delicacy. When possible, samples were taken from the central area of the lobules.

Historic Landings Data

The Fisheries Research Laboratory began compiling commercial landings data in the early 1970's. Landings tickets were completed by cooperating fishermen, and collected by Laboratory port agents approximately once per week from fishing centers around the coast of Puerto Rico. Tickets included information such as fisherman's name and buyer, date, location, species caught,

and pounds landed. All tickets were searched for dolphin records to compile information on temporal (seasonal and annual) and spatial variations in abundance around Puerto Rico. Each record was transcribed to computer and analyzed by month and fishing port using computer programs (Dbase III-Plus and Lotus 123). Total pounds (lbs) of dolphin fish landed were calculated and plotted for each recorded year (Figure 1). To obtain seasonal variation, total pounds of *C. hippurus* landed per month each year were combined and expressed as percentages relative to the total amount of pounds landed over nineteen years (Figure 2).

Catch-effort information was rarely annotated on the landings tickets. The only information available is the total number of tickets reporting dolphin fish per month and year (Table 1). No consistent format was followed by fishermen in completing the landings tickets. Very often no clear delineation was made between daily or weekly catch effort making difficult subsequent calculations of pounds per trip.

RESULTS AND DISCUSSION

Tournament Survey

The dolphin fish season extends from November to May. To date, there are 18 marine sportfishing clubs around Puerto Rico (Berrios *et al.*, 1989; Mr. Casellas, PRSA, pers. comm.), seven of which sponsor dolphin fish tournaments. These are in the municipalities of Carolina, San Juan, Arecibo, Cabo Rojo, Lajas, Patillas, Guayama (Figure 3). During personal communications with club leaders we found that most records are scattered or have been lost. An exception is the southwestern Nautical Club of La Parguera (PNC) in Lajas, which has kept most of their catch-effort records since 1983 (Table 2). Each year this Club holds a famous islandwide dolphin fish tournament which coincides with the maximum seasonal abundance of bullhead (big head male) dolphin fish near its shelf-edge zone (Ramirez, PNC, pers. comm.). These records document the variability of fishing success throughout the nine year period (Table 2). Weight composition of landed dolphin fish per year are represented in Figure 4. In general, most individuals caught during La Paraguera tournaments range between 10 and 40 lbs. with scattered specimens between 50 and 60 lbs. Table 3 shows catch data from different dolphin fish tournaments held during 1991 and shows the relatively high fishing success of La Paraguera compared to other clubs for this year. Interestingly, tournaments are held between November and January by the north coast clubs and between April and May by the clubs on the south and southwest coasts.

A total sample of 343 dolphin fish were measured, weighed and sexed. From a subsample of these gonads, samples were retained for histology. Fork length (FL) ranged in size from 358-1323 mm (Figure 5 and 6). As previously reported by Beardsley (1967) and Palko *et al.* (1982), mean sizes of males and

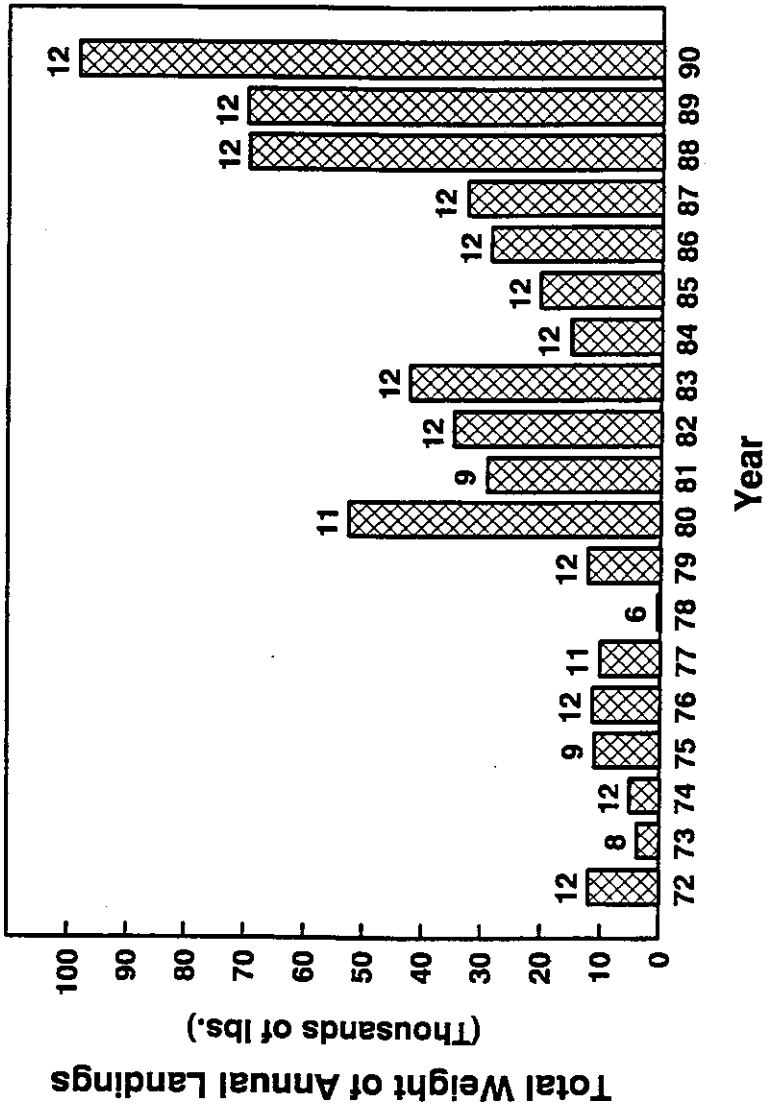


Figure 1. Annual total landings (lbs.) over 19 years for *Coryphaena hippurus* commercial landings in Puerto Rico. The numbers above each bar are the number of months for which complete landings records are available.

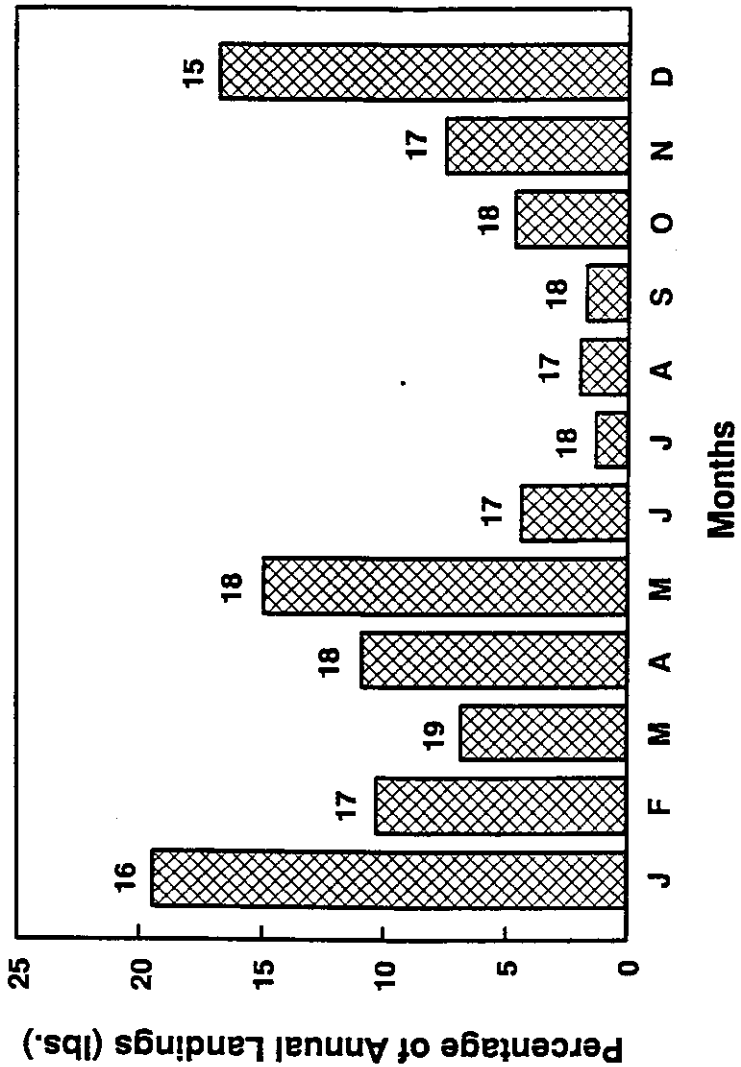


Figure 2. Seasonal variation over a 19 year period in *Coryphaena hippurus* commercial landings in Puerto Rico. The numbers above each bar are the number of years for which monthly landings records are available.

Table 1. Total number of landings records containing data on *Coryphaena hippurus*.

	Y E A R																			
	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	SUM
JAN	19	18	09	00	16	31	00	8	141	86	00	69	21	29	23	42	89	130	212	943
FEB	22	20	10	00	18	30	00	5	106	33	07	86	27	20	24	20	40	60	98	626
MAR	03	12	13	15	07	17	03	04	24	08	16	44	13	11	23	28	40	52	90	423
APR	37	07	12	63	23	13	00	8	113	22	28	64	17	25	25	23	64	100	116	760
MAY	46	00	21	54	54	14	1	21	126	66	44	129	21	45	25	65	66	132	175	1105
JUN	18	00	04	13	32	00	01	17	20	17	26	38	17	22	67	39	54	75	34	494
JUL	7	2	4	2	4	3	0	2	3	3	9	10	1	22	25	7	12	47	25	188
AUG	03	00	04	00	04	04	02	05	21	04	05	04	03	09	18	14	23	21	16	160
SEP	04	00	05	02	04	07	04	16	25	04	13	10	11	11	20	25	12	31	41	245
OCT	8	10	08	01	20	14	12	07	20	00	47	27	19	19	24	40	46	54	94	470
NOV	1	15	06	05	14	10	00	11	20	00	46	23	22	31	41	67	90	65	70	537
DEC	0	14	15	04	13	11	00	27	00	0	153	43	32	37	58	78	144	121	115	865
SUM	168	98	111	159	209	154	23	131	619	243	394	547	204	281	373	448	680	888	1086	6816

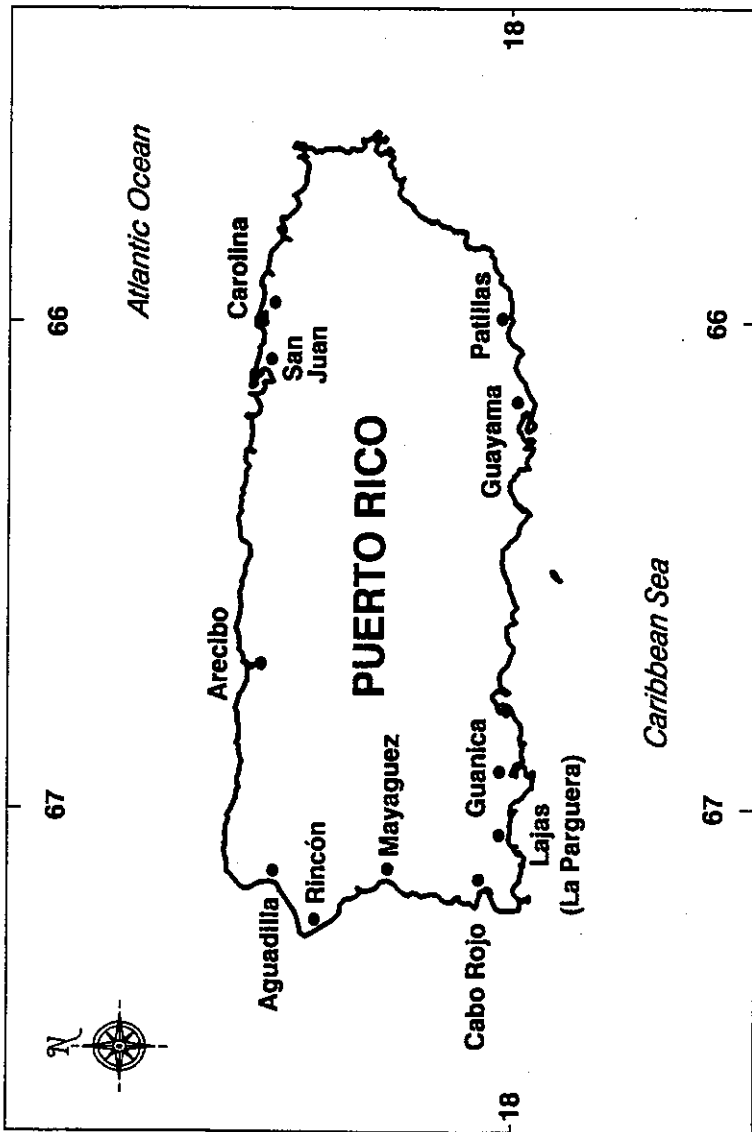


Figure 3. Coastal towns with reported *Coryphaena hippurus* landings discussed in the text.

Table 2. La Parguera Nautical Club dolphin fish tournament data and estimated catch per unit of effort (CPUE).

Tournament Year	CPUE No. Fish/Boat hr.	Number Fishermen	Fishing Number Boats	Lbs. Hours	C. h.*	Caught
1983	0.48	49	16	18	138	1200.00
1984	N/A	N/A	N/A	N/A	N/A	N/A
1985	0.46	57	15	18	125	2103.75
1986	0.16	100	25	18	72	1606.50
1987	0.14	116	29	18	72	1476.25
1988	N/A	N/A	N/A	N/A	N/A	N/A
1989	0.31	38	19	18	106	3021.00
1990	0.29	88	22	18	115	3366.00
1991 (to Sept)	0.55	133	34	18	338	5510.50

**Coryphaena hippurus*

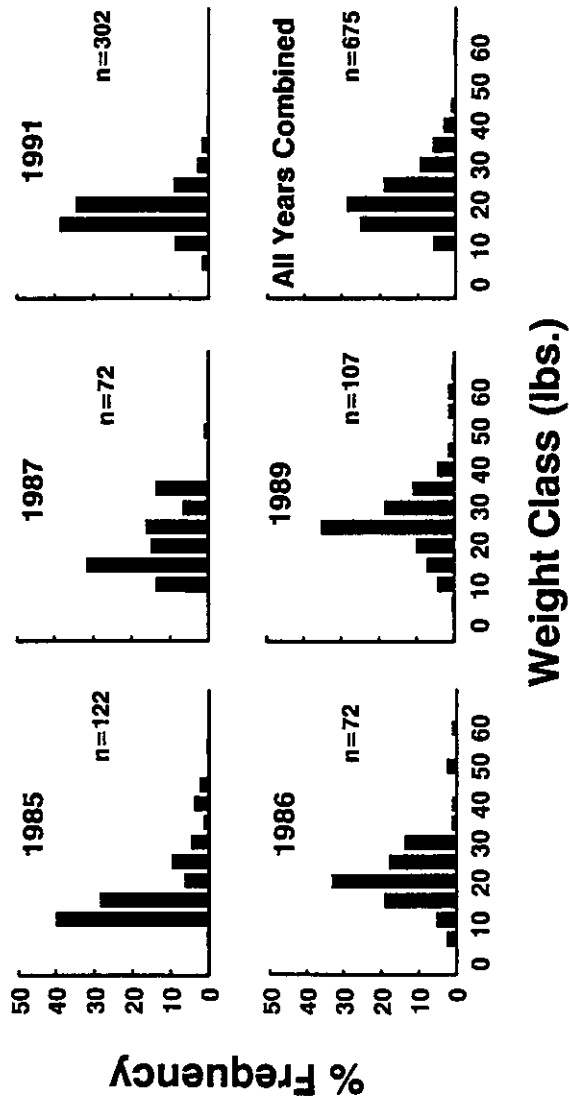


Figure 4. Weight frequency distribution of *Coryphaena hippurus* from La Parguera Nautical Club tournaments. These data are reported using five pound weight classes.

Table 3. Catch data for several *Coryphaena hippurus* tournaments around Puerto Rico during 1991.

Club Location	San Juan (N)	Carolina (N)	Patillas (SE)	Cabo Rojo (SW)	La Parguera (S)
Fishing Date	26-27 Jan 91	9-10 Feb 91	20-21 Apr 91	23 Apr 91	4-5 May 91
Fishing Hours per Boat	16	19.5	18.5	9.5	18
Number of Boats	29	35	25	29	34
Number of Fishermen	112	108	96	110	133
Boat Hours	464	682.5	462.5	275.5	612
Fishermen Hours	4792	2106	1776	1045	2394
Number of C. h.* Caught	158	51	77	39	338
Fish per Boat Hours	0.341	0.075	0.166	0.105	0.55
Fish per Fishermen Hours	0.088	0.024	0.043	0.037	0.14

* *Coryphaena hippurus*

Table 4. Total landings of *Coryphaena hippurus* in Puerto Rico by coastal region from 1986 to 1988.

Coastal Region	Total Landings (lbs.)
Northwest Coast	64,529 lbs.
North Coast	34,495 lbs.
Southwest Coast	25,462 lbs.

females are significantly different (t-test, $n=327$, $p<.01$). A log weight-length relationship was calculated ($\text{Log Wt (g)}=2.919 (\text{Log FL mm}) -4.855$, $n=332$, $r^2=0.96$) (Figure 7).

Spawning Dynamics

Due to low abundance of dolphin fish during July and August, samples were not obtained for these months in either 1990 or 1991. A total of 242 gonad samples from dolphin fish were collected between September 1990 and August 1991 (177 female and 65 male). Evaluation of histological samples of ovaries suggest that mature females are present throughout much of the year, and 92.5% ($n=147$) of the samples were considered mature. The male to female sex ratio is 1:2.7. These results are in concordance with data previously reported for Puerto Rico by Erdman (1977). Results based on histological observations of gonad samples collected between September 1990 and August 1991 suggest a size of sexual maturity of approximately 450-500 mm (FL) (50% criterion) (Figure 8). Additional female samples smaller than 600 mm are needed to more precisely establish the minimum size of sexual maturation. The presence of more than one maturation stage of oocytes in the same ovary suggests a multiple spawning behavior as described by other studies (Gibbs and Collette, 1959; Beardsley, 1967; Goldberd, 1985; Oxenford and Hunte, 1986).

Historic Landings Data

A total of approximately 380, 000 tickets in the Fisheries Statistics Division (FRL) covers the nineteen years of historic landings data examined. Only 6, 816 of these tickets reported dolphin fish landings (Table 1). Total annual landings of dolphin fish show wide fluctuations over the 19 years for which records are available, with greater numbers of landings documented for the early and late 1980's (Figure 1). A total of 561, 435 lbs. of dolphin fish were reported landed over this period. Records on seasonal variation of abundance from 1972 to 1991 indicate two peaks, one in January and a smaller one in May (Figure 2), and contrasts with a unique peak description of Puerto Rico's landings suggested by Oxenford and Hunte (1986), based on their analysis of total landings from all Puerto Rico locations summed. However, conclusions regarding trends in these

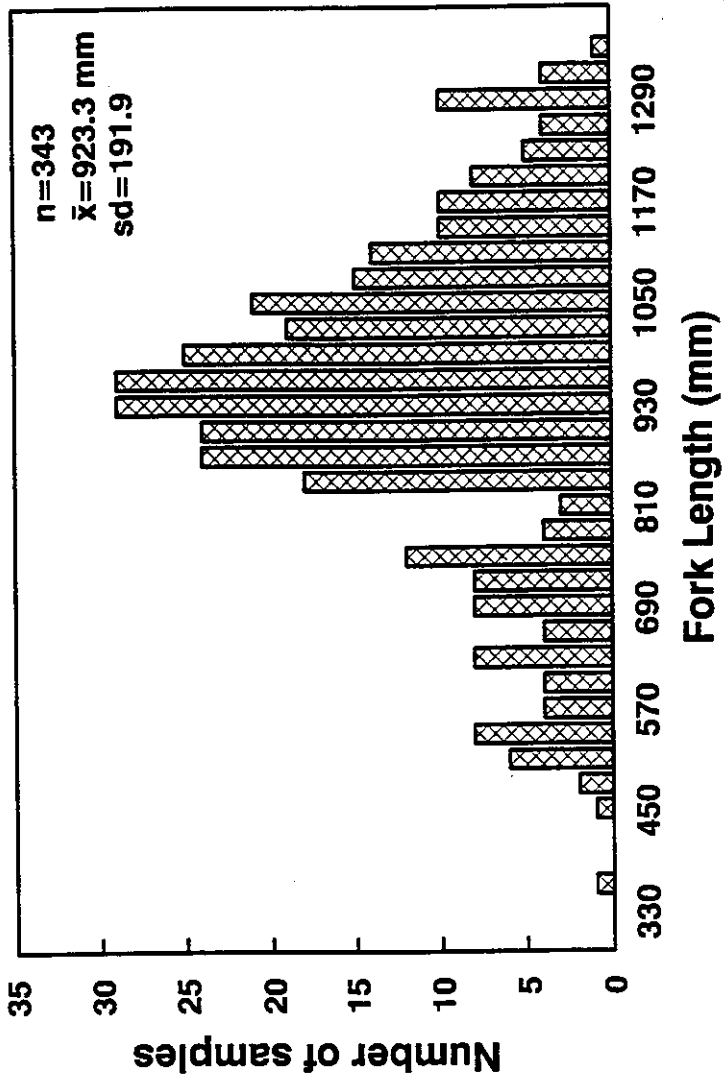


Figure 5. Size frequency distribution of *Coryphaena hippurus* from September 1990 to August 1991. Class size was chosen at 30 mm intervals.

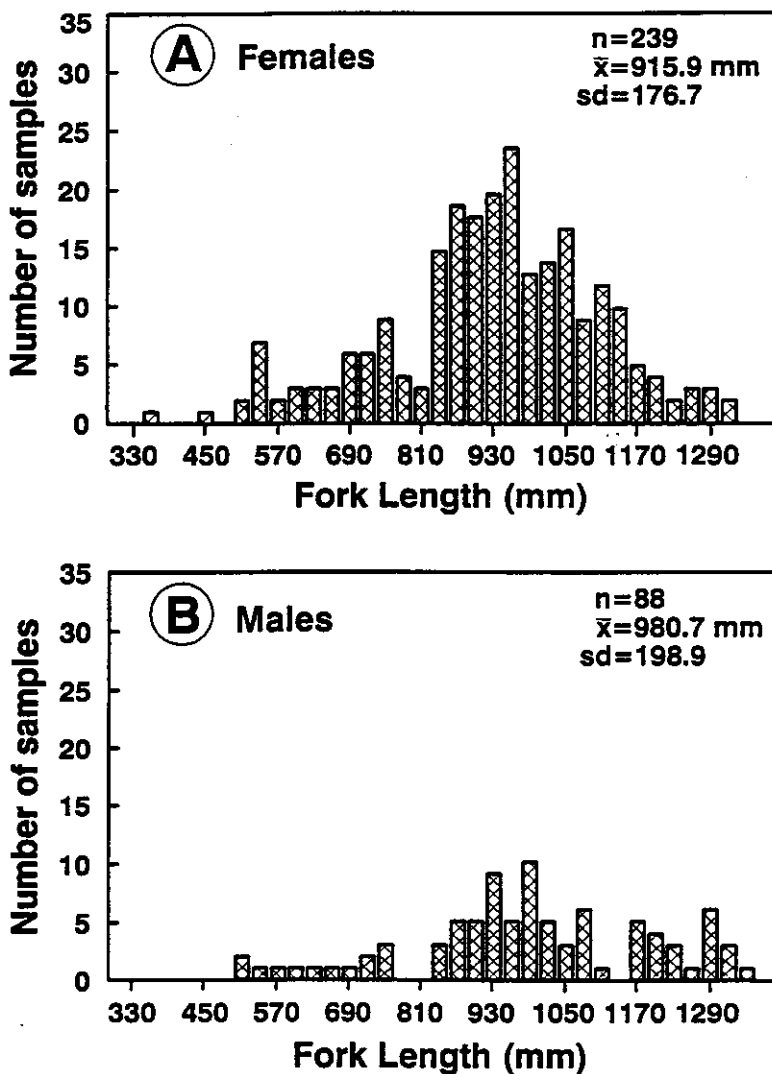


Figure 6. Size frequency distribution of *Coryphaena hippurus* from September 1990 to August 1991 for (A) females and (B) males. Class size was chosen at 30 mm intervals.

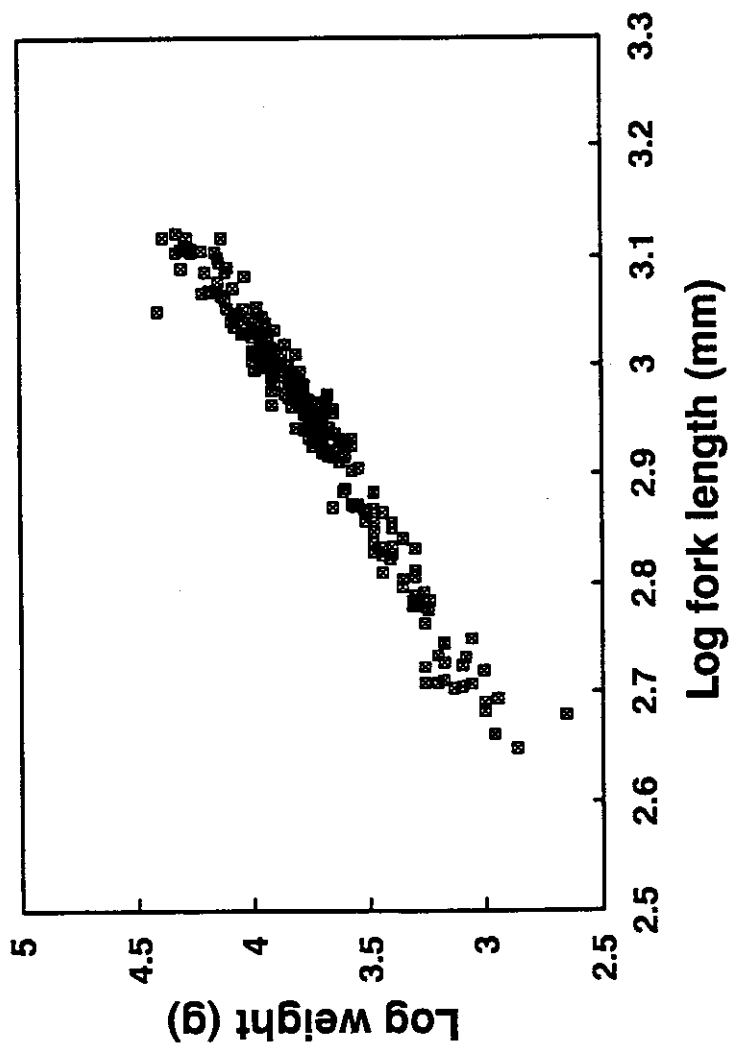


Figure 7. The log of weight versus the log of fork length of *Coryphaena hippurus* samples collected around Puerto Rico in 1990-91.

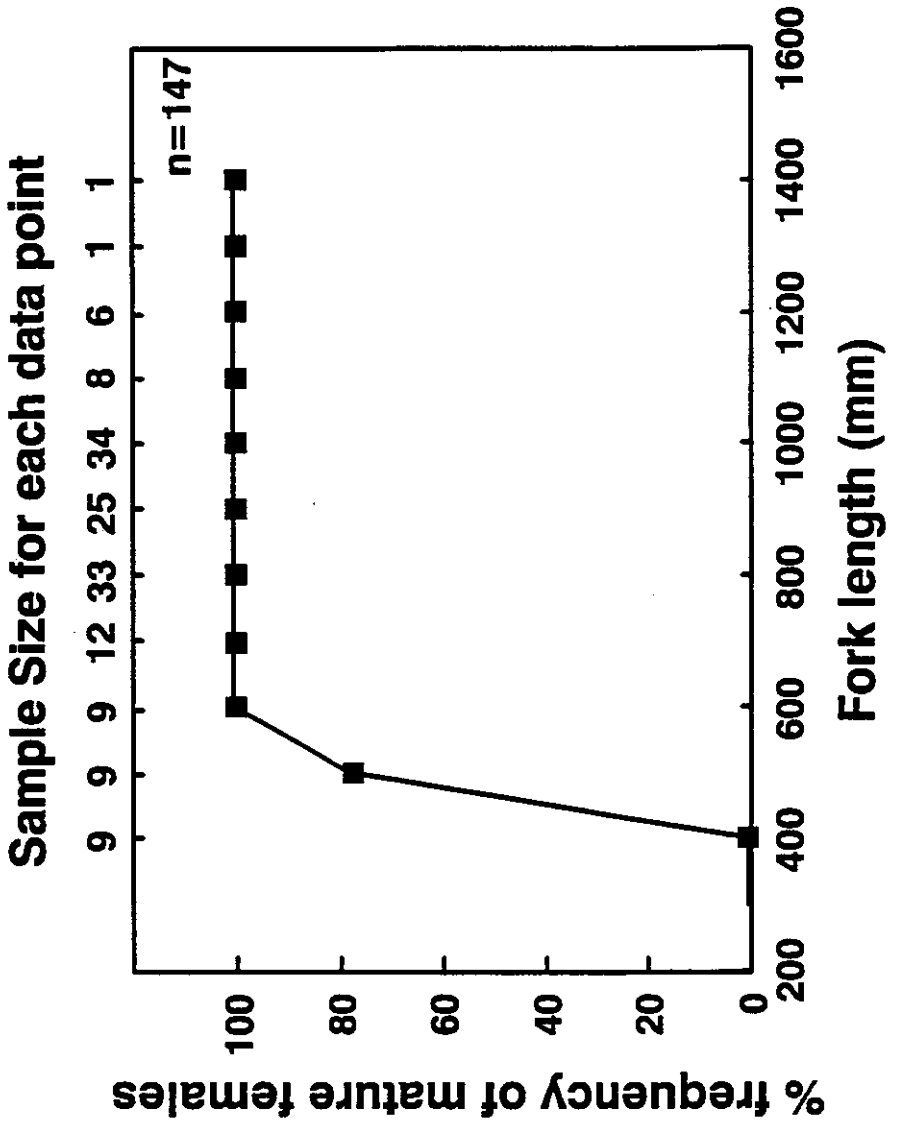


Figure 8. Percent frequency of mature female *Coryphaena hippurus* by size class.

data are limited without additional information on fishing effort and the number of commercial fishermen each year.

Temporal trends in abundance were examined using data from 1986 through 1988. Data were sorted by geographical location and by month. Landings were summed for each location during the 3 year period. Most landings were reported from northwest coast (Aguadilla to Rincón) with a total of 64, 529 pounds. The north coast (Arecibo to Carolina) reported the second highest landings of 34,491 pounds, and the southwest coast (Mayagüez to Guánica) reported 25,462 pounds. While the absence of effort data limits the conclusions that may be derived from these data, there is an indication that the north and northwest coasts of the island account for most of the dolphin fish landings between December and January, while southwest coast landings are more evenly distributed throughout the year (Figure 9). Full evaluation of these trends requires the collection of effort data.

Regarding the proposed two stock population theory (Oxenford and Hunte, 1986), the occurrence of two distinct periods of abundance, one on the north coast (November to February) and the other on the south coast (April to May), at least support the hypothesis that Puerto Rico is visited by more than one population. Detailed examination of the reproductive trends and comparison between samples collected around Puerto Rico are in progress to further address this theory.

The importance of marine recreational fishing (MRF) for Puerto Rico and the U.S. Virgin Islands has already been established by Campos and Muñoz-Roure (1987) and Griffith *et al.* (1988). Similar to Puerto Rico, other Caribbean islands have documented an increase in their total weight landed by commercial fishermen (Oxenford and Hunte, 1987). The true economic potential of MRF for tourist oriented development is stressed in these studies. Government awareness of the importance for informed conservation, protection and management of these resources is needed (Campos and Muñoz-Roure, 1987). Acquisition of basic biological information on the life cycle and population structure of pelagic species which periodically frequent Puerto Rico and the U.S. Virgin Islands are necessary for planned resource use. The objectives of the Dingall-Johnson project provide the first step toward a better understanding of the fisheries resources available in Puerto Rico waters.

ACKNOWLEDGEMENTS

This project is being funded by the U.S. Fish & Wildlife Service, Dingall-Johnson Program. We are grateful to all cooperating fishermen and nautical clubs that have allowed us to gather samples and tournament records. We also acknowledge the field and laboratory assistance of Kathleen Hall, Ana Román, Glauco Rivera, the Exploratory Team and administrative support of the Fisheries Research Laboratory personnel.

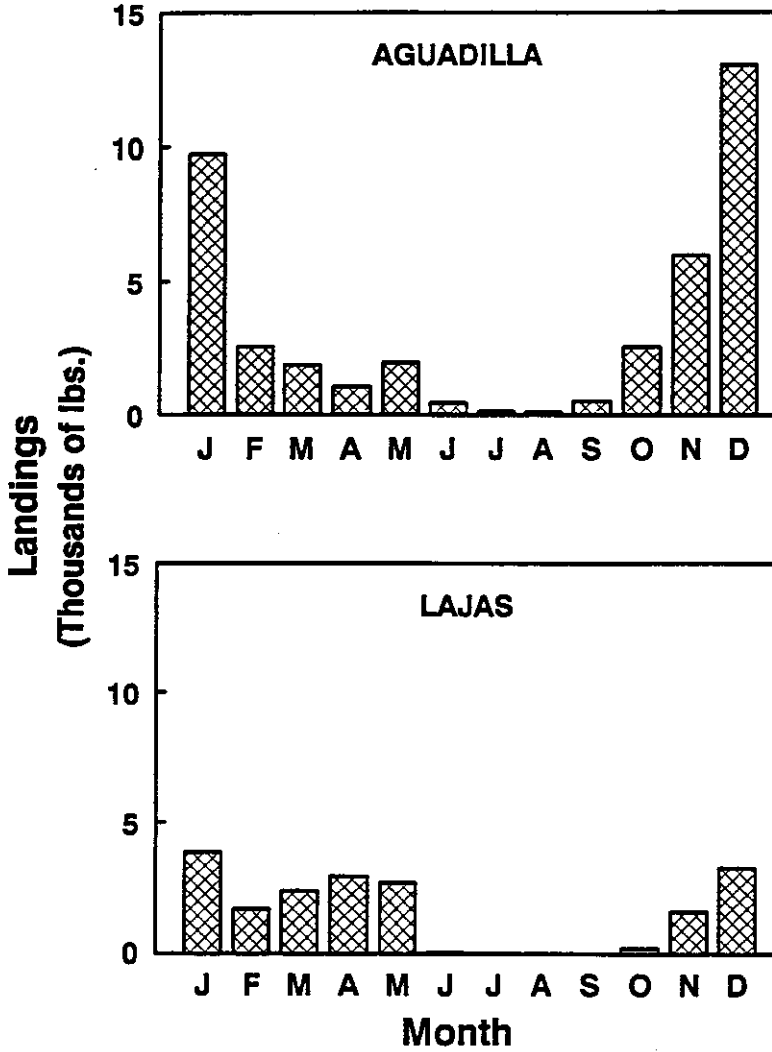


Figure 9. Total landings (lbs.) of *Coryphaena hippurus* from 1986 through 1988 for Aguadilla and Lajás municipalities.

LITERATURE CITED

- Beardsley, G.L. 1967. Age, growth, and reproduction of the dolphin, *Coryphaena hippurus*, in the Straits of Florida. *Copeia* 2:441-451.
- Berrios, J.M., E.I. Medina, H. Ferrer and I. Diaz. 1989. Marine sport fisheries creel survey. United State Fish and Wildlife: Final Report Project F-5-6. 184p.
- Brandon, M. 1987. Marine recreational fishing statistics of the United States Virgin Islands, January, 1983 to September, 1985. *Proc. Gulf Carib. Fish. Inst.* 1987: 665-683.
- Campos, J.L. and O. Muñoz-Roure. 1987. Sportfishing: A complement to a balanced tourism program for the tropical Caribbean. *Proc. Gulf Carib. Fish. Inst.* 1987: 684-687
- Chen, S.C. 1979. Aspects of fishery for common dolphin, *Coryphaena hippurus* L. in Taiwan waters. *Bulletin of Taiwan Fisheries Research Institute* 31: 171-188.
- Coolridge, B.J. and R.M. Howard. 1979. Animal histology procedures. United States Department of Health, Education and Welfare. National Institute of Health Publication No. 80-275. 198p.
- Erdman, D.S. 1977. Spawning patterns of fish from the northeastern Caribbean. Agricultural and Fisheries Contribution. Department of Agriculture, July 1976. 8(2):37p.
- Gibbs, R.H. and B.B. Collette. 1959. On the identification, distribution and biology of the dolphins, *Coryphaena hippurus* and *C. equiselis*. *Bulletin of Marine Science of Gulf and Caribbean* 9(2): 117-152.
- Goldberg, S.R. 1985. Notes on spawning in the dolphin fish, *Coryphaena hippurus* (Coryphaenidae) from Peru. *Bulletin Southern California Academy of Sciences* 84(1): 51-52.
- Griffith, D.C., J.C. Johnson, M. Valdes-Pizzini, J.D. Murray and R.Chaparro. 1988. Developing marine recreational fishing in Puerto Rico and the United States Virgin Islands. Final Report NOAA/NMFS (S-K) Grant NA86NC-H-06108. 155p.
- Hagood, R.W., G.N. Rothwell and M. Swafford. 1981. Preliminary report on the aquacultural development of the dolphin fish, *Coryphaena hippurus* (Linnaeus). *Journal of World Mariculture Society* 12(1): 135-139.
- Hassler, W.W. and R.P. Rainville. 1975. Techniques for hatching and rearing dolphin *Coryphaena hippurus*, through larvae and juvenile stages. University of North Carolina. Sea Grant Publication UNC-SG-75-31. 16p.
- Kojima, S. 1956. Fishing for Dolphins in the western part of the Japan Sea - II. Why do the fish take shelter under floating materials. *Bulletin of Japanese Society for Scientific Fisheries* 21(10): 1049-1052.

- Lewis, J.B. and F. Axelsen. 1967. Food of the dolphin, *Coryphaena hippurus* Linnaeus, and the yellow fin tuna, *Thunnus albacares* (Lowe) from Barbados, West Indies. *Journal of Fisheries Research Board of Canada* 24(3): 683-686.
- Lozano-Cabo, F. 1961. Biometría, biología y pesca de la lampuga, *Coryphaena hippurus* L, de las islas Baleares. Memorias de la Real Academia de Ciencias exactas, físicas y naturales de Madrid. Serie de Ciencias Naturales. Tomo XXI: 1-93.
- Mahon, R. (ed). 1987. Report and proceedings of the Expert Consultation on shared fishery resources of the Lesser Antilles Region. Mayagüez, P.R., 8-12 September, 1986. *FAO Fish. Rep.* (383): 278pp.
- Moe, M.A., Jr. 1969. Biology of the red grouper, *Epinephelus morius* (Valenciennes), from the eastern Gulf of Mexico. Florida Department of Natural Resources Laboratory Professional Paper Series 10:95 p.
- Oxenford, H.A. and W. Hunte. 1983. Age and growth of dolphin, *Coryphaena hippurus*, as determined by growth rings in otoliths. *Fisheries Bulletin* 84(4) : 906-909.
- Oxenford, H.A. and W. Hunte. 1986. Migration of the dolphin, *Coryphaena hippurus*, and its implications for fisheries management in the Western Central Atlantic. *Proc. Gulf Carib. Fish. Inst.* 37: 510-527.
- Oxenford, H.A. and W. Hunte. 1987. Long-term trends in abundance of the dolphin (*Coryphaena hippurus*) near Barbados. *Proc. Gulf Carib. Fish. Inst.* 38: 510-527.
- Palko, B.J., G.L. Beardsley and W.J. Richards. 1982. Synopsis of the biological data on dolphin-fishes, *Coryphaena hippurus* Linnaeus and *C. equiselis* Linnaeus. NOAA Technical Report NMFS 4433. *FAO Fisheries Synopsis* No. 130. 28 p.
- Wang, C.H. 1974. A study of population dynamics of dolphin fish, *Coryphaena hippurus*, in waters adjacent to eastern Taiwan. *Acta Oceanografica of Taiwan* 10: 233-251.