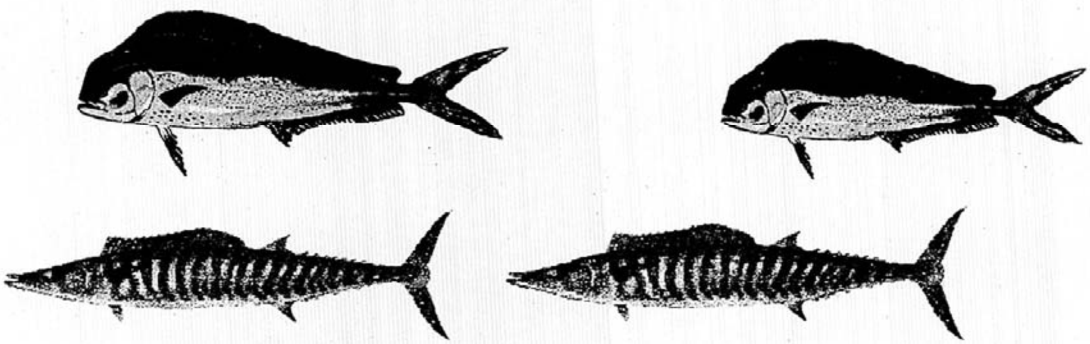
STOCK ASSESSMENT AND FISHERY EVALUATION REPORT FOR DOLPHIN AND WAHOO

FISHERY MANAGEMENT PLAN FOR THE DOLPHIN/WAHOO FISHERY



MAY 1999

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prepared by the
South Atlantic Fishery Management Council

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1.0 INTRODUCTION

The *Guidelines for Fishery Management Plans (602 Guidelines)* published by the National Marine Fisheries Service (NMFS) require that a stock assessment and fishery evaluation (SAFE) report be prepared and reviewed annually for each fishery management plan (FMP). The SAFE reports are intended to summarize the best available scientific information concerning the past, present, and possible future condition of the stocks and fisheries under federal management. Appendix A to the *Guidelines* lists the desired components of SAFE reports as follows: 1) information on which to base harvest specifications; 2) information on which to assess the economic and social condition of persons and businesses that rely on recreational and commercial use of fish resources including fish processing industries; and 3) any additional economic, social, and ecological information pertinent to the success of management or the achievement of objectives of each FMP.

The Stock Assessment section of the SAFE report for dolphin and wahoo fisheries managed under the Fishery Management Plan was compiled by the Council staff with input from the SAFMC Workshop, the Mackerel Stock Assessment Panel, Antonio Alexander Bentivoglio, Dr. C. Phillip Goodyear (SAFMC Consultant), NMFS SEFSC Researchers, and NMFS SERO analysts. Our goal was to include the most recent information on issues that have been raised or are likely to be raised during the Council's development of the Dolphin/Wahoo Fishery Management Plan. The detailed information is found in the attached reports and we have only attempted to extract a very brief overview for inclusion in Sections 2, 3 and 4.

A very summary overview of stock status is presented in Section 2.0 Overview of Stock Assessment. Overviews of economic and social status of the fishery are presented in Section 3.0 Fishery Evaluation. This section contains material from the Council's Sustainable Fisheries Act Amendment describing fishing communities. Ecosystem considerations are presented in Section 4.0 Ecosystem Considerations using material from the Council's Habitat Plan and Habitat Amendment. These sections rely very heavily on the identified Council documents and the following appendixes:

Appendix A. Results of Literature Search.

A computer search of published literature was conducted. These results, along with the literature cited sections of the papers included in Appendix A through Appendix K, should provide most if not all of the pertinent literature.

Appendix B. Characterization of the Dolphin fish (Coryphaenidae, Pices) Fishery of the United States Western North Atlantic Ocean (MSAP/98/03).

This paper was prepared by Nancy Thompson of the Southeast Fisheries Science Center for the 1998 Mackerel Stock Assessment Panel. Descriptions of the commercial and recreational fisheries for dolphin in the southeastern U.S. are included as well as catch information for both fishing sectors, evaluations of weight-length relationships, gear type used by the commerial sector and catch per unit of effort for the recreational sector.

Appendix C. 1998 Report of the Mackerel Stock Assessment Panel (March 23-26,1998).

This report was prepared by the Mackerel Stock Assessment Panel in 1998 and summarizes the findings of the panel.

Appendix D. 1999 Report of the Mackerel Stock Assessment Panel

Dolphin were not addressed in the 1999 assessment.

Appendix E. Economic Assessment for Dolphin/Wahoo

No deliverable was received.

Appendix F. SAFMC Dolphin/Wahoo Workshop Proceedings

These proceedings from the workshop held by the Council in May 1998 include the latest information on the stock structure, growth and mortality rates, reproductive characteristics, trophic relationships, and management alternatives for dolphin and wahoo.

Appendix G. Investigations Into the Growth, Maturity, Mortality Rates and Occurrence of the Dolphin (*Coryphaena hipurus*, Linnaeus) in the Gulf of Mexico.

Growth, maturity, mortality rates and occurrence of dolphin were analyzed by Dr. Antonio Alexander Bentivoglio in 1988; results are presented in a dissertation from the University College of North Wales, United Kingdom and was provided to the SAFMC by Dr. Hazel Oxenford.

Appendix H. Trends in Dolphin and Wahoo Commercial and Recreational Catch Rates: A Study for the South Atlantic Fishery Management Council.

Trends in commercial and recreational catch rates for dolphin and wahoo were analyzed by Dr. C. Phillip Goodyear in 1999 under contract to the SAFMC.

Appendix I. Commercial landings Update: Coastal Migratory Pelagic Fish (SERO-ECON-99-06).

This report prepared by Dr. John Vondruska (NMFS Fisheries Economics Office) updates summaries of data on commerical landings and exvessel prices for coastal migratory pelagic fish (including dolphin and wahoo) for the Atlantic and Guld Coast states.

Appendix J. Summary Report of Methods and Descriptive Statistics for the 1997-98 Southeast Region Marine Recreational Economics Survey, Fishery Management Data (SERO-ECON-99-01).

This report was prepared by Dr. Stpehen G. Holiman (NMFS Fisheries Economics Office) for the Gulf of Mexico Fishery Management Council Coastal Migratory Pelagics Fishery Socioeconomic Panel Meeting on April 15-16,1999. Information on dolphin and wahoo are included.

2.0 OVERVIEW OF STOCK ASSESSMENT

2.1 Stock Identification

The following sections are taken directly from the proceedings of the dolphin/wahoo workshop (Appendix F):

"2.1 Stock Structure

2.1.1 Dolphin

The common dolphin (*Coryphaena hippurus*), subsequently referred to as dolphin, is an oceanic pelagic fish found worldwide in tropical and subtropical waters. The range for dolphin in the western Atlantic is from George's Bank, Nova Scotia to Rio de Janeiro, Brazil. They are generally restricted to the 20° C isotherm. They support economically important fisheries from North Carolina through the Gulf of Mexico, and within the Caribbean Sea including the northeast coast of Brazil.

There is pronounced seasonal variation in abundance. Dolphin are caught off North and South Carolina with the majority being landed from May through July. Dolphin are caught off Florida's east coast mainly between April and June. February and March are the peak months off Puerto Rico's coast. They are caught in the Gulf of Mexico from April to September with peak catches in May through August.

There has been one preliminary investigation of dolphin stock structure within the western central Atlantic. Results suggest that there are at least two separate unit stocks located in the northeast and southeast regions of the western central Atlantic. The hypothesis was based on: observed seasonality (months of peak abundance) and mean size of dolphin from commercial and sport fisheries (which suggested two different migratory circuits; see Figure 1); a comparison of life history characteristics of dolphin from North Carolina, Florida, and Barbados (which showed marked differences in average first year growth rates, fecundity-length relationships, size and age at first maturity, and mean mature egg size); and on observed differences in allelic frequencies at the IDH-2 locus determined through electrophoresis.

Possible alternative hypotheses of (1) a generalized north-south movement of a broadly distributed population, and (2) a seasonal onshore-offshore movement, have been suggested. However, no alternative stock structure hypothesis has yet been tested.

Therefore, it was agreed that the working hypothesis should be a two stock model for the Western Central Atlantic and that the northern stock should include dolphin from the Gulf of Mexico, the U.S. South Atlantic including Puerto Rico and the U.S. Virgin Islands, the Mid-Atlantic, and the New England coasts.

Given this working hypothesis, estimates of biological parameters for dolphin from the northern area were used in preference to those from the southern area.

Figure 1. Working stock hypothesis.

2.1.2 Wahoo

The wahoo (*Acanthocybium solandri*) is an oceanic pelagic fish found worldwide in tropical and subtropical waters. Wahoo are present throughout the Caribbean area, especially along the north coast of western Cuba where it is abundant during the winter (from FAO species guide). Wahoo are known to support economically important fisheries in the U.S., Bermuda, and through the Caribbean to Tobago.

There is pronounced seasonal variation in abundance. They are caught off North and South Carolina primarily during the spring and summer (April-June and July-September), off Florida's east coast year-round, off Puerto Rico and the U.S. Virgin Islands year-round with peak catches between September and March, in the Gulf of Mexico year-round, in the eastern Caribbean between December and June, and in Bermuda between April and September.

There have been no investigations of wahoo stock structure. Given this, it was agreed that the working hypothesis should be a single stock model for the Western Central Atlantic."

2.2 Biology

The following sections are taken directly from the proceedings of the dolphin/wahoo workshop (Appendix F):

"2.2 Mortality Rates and Longevity

2.2.1 Dolphin

There is one study reporting total instantaneous mortality estimates for dolphin from the northern area. These come from the Gulf of Mexico and are given below:

Mortality Model Used	Total Mortality (Z)	Actual Annual Mortality (A)
Robsen & Chapman (1961)	8.18	99.97%
	8.23	99.97%
	8.67	99.98%

There are no natural mortality estimates for the northern area, however, natural mortality estimates from the southern area range from M=0.66 to M=3.3 (A=48% to 96%).

Dolphin in the northern area have a maximum longevity of 4 years but most die before age 2. In North Carolina 96% die before age 2. In Florida 98% die before age 2, and in the Gulf of Mexico 100% die before age 2.

2.2.2 Wahoo

The only mortality estimates available are from a study conducted in St. Lucia. The values are listed below for five different years

Mortality Model Used	Total Mortality (Z)	Annual Mortality (A)
Length based catch curve	1.17	68.96%
	1.52	78.13%
	1.45	76.54%
	1.75	82.62%
	2.34	90.37%

Longevity is believed to be at least 5 years based on work from North Carolina (Source: Hogarth, W.T. 1976. Life history aspects of the wahoo, *Acanthocybium solandri*, (Cuvier and Valenciennes) from the coast of North Carolina. NC State Univ. Dissertation. 107p.)

2.3 Growth Rates

2.3.1 Dolphin

Dolphin grow rapidly and show average first year daily growth rates ranging from 4.2 mm FL (Gulf of Mexico) to 1.6 mm FL (North Carolina). There are a number of estimates of L_∞ from the northern area. It was agreed that values of 1400 to 1500 mm FL are appropriate for this stock. Estimates of k ranged from 0.31 to 3.13 annually.

2.3.2 Wahoo

Wahoo appear to be very fast growing in their first year. Estimates of L_∞ range from 2210 mm FL (North Carolina) to 1560 mm FL (St. Lucia). Estimates of k (annual) range from 0.152 (North Carolina) to 0.37 (St. Lucia).

2.4 Reproductive Characteristics

2.4.1 Dolphin

Dolphin are batch spawners and have a protracted spawning season. Size at first maturity ranges from 350 mm FL (Florida) to 530 mm FL (Gulf of Mexico) for sexes combined. Males first mature at a larger size than females. Size at full maturity ranges from 550 mm FL (Florida) to 600 mm FL (Puerto Rico) for females.

The sex ratios in the catch tend to be female-biased although they vary with size of fish captured. The batch-fecundity-length relationship is strongly exponential ranging from 85,000 (approximately 400-600 mm FL) to 1.5 million (approximately 1300-1400 mm FL) eggs per batch.

2.4.2 Wahoo

Estimates of size at first maturity from North Carolina are 86 cm FL for males and 101 cm FL for females. Preliminary estimates from Bermuda are similar (males = 102 cm FL; females = 95 cm FL).

Fecundity estimates from North Carolina range from 560,000 eggs (for a 6.13 kg wahoo) to 45 million eggs (for a 39.5 kg wahoo).

2.5 Trophic Relationships

2.5.1 Dolphin

Dolphin are voracious, surface water, day-time predators. They eat a wide variety of fish species including: small oceanic pelagic species (e.g., flying fish, halfbeaks, man-o-war fish, sargassum fish and rough triggerfish); juveniles of large oceanic pelagic species (e.g., tunas, billfish, jacks, dolphin); and pelagic larvae of neritic, benthic species (e.g., flying gurnards, triggerfish, pufferfish, grunts). They also eat invertebrates (e.g., cephalopods, mysids, scyphozoans) suggesting that they are essentially non-selective, opportunistic foragers. Rose (1966) examined the stomach contents of 373 dolphin off North Carolina and found the following food items by relative weight: Exocoetidae - 24%, Scombridae - 22%, Carangidae - 12%, Invertebrates - 12%, Miscellaneous Fish Families - 11%, Monacanthidae - 7%, Coryphaenidae - 5%, Unidentified Fish - 4%, and Balistidae - 3% (Source: Rose, C.D. 1966. The biology and catch distribution of the dolphin, *Coryphaena hippurus* (Linnaeus), in North Carolina waters. Ph.D. Thesis. North Carolina State Univ. at Raleigh, 153 p.)

2.5.2 Wahoo

Wahoo are essentially piscivorous. Based on work in North Carolina, fish accounted for 97.4% of all food organisms. These fish included mackerels, butterfishes, porcupine fishes, round herrings, scads, jacks, pompanos, and flying fishes. Invertebrates, squid and the paper nautilus comprised 2.6% of the total food.

2.3 Catch and Catch Per Unit Effort

Average commercial and recreational catches of dolphin from 1984-97 are shown by area in Table 1.

Table 1. Recreational and Commercial Landings of Dolphin in Pounds from the South Atlantic, Gulf of Mexico, M
Atlantic and New England for 1984-1997 (Source: NMFS & Goodyear, 1999).

Year	South Atlantic		Gulf of Mexico		Mid-Atlantic		New
	Recreational	Commercial*	Recreational	Commercial	Recreational	Commercial	Recr
1984	3,475,817	426,960	1,018,393	14,943	-	1,700	
1985	5,569,740	316,102	1,351,060	96,323	78,904	5,000	
1986	6,834,766	532,078	3,060,354	150,216	193,127	4,200	
1987	4,395,920	483,681	2,810,116	132,949	72,777	13,400	
1988	6,334,041	481,207	1,168,446	230,229	166,468	26,600	
1989	9,830,209	995,556	2,949,645	461,054	806,282	81,700	
1990	7,430,291	961,088	5,114,615	654,013	349,224	69,106	
1991	11,271,890	1,529,261	5,524,808	1,006,432	554,896	90,722	
1992	5,192,498	605,072	4,091,231	451,437	692,209	72,946	
1993	5,414,984	847,245	4,107,896	270,255	1,783,267	97,553	
1994	9,643,594	1,114,114	2,743,800	176,971	393,450	123,646	
1995	12,194,620	1,976,776	6,829,386	359,930	825,140	238,438	
1996	7,480,014	1,147,694	4,775,537	435,500	563,485	59,341	
1997	10,419,160	1,488,460	11,922,140	396,048	207,940	127,566	
Ave. 84-97	7,534,825	921,807	4,104,816	345,450	514,398	72,280	

*South Atlantic commercial landings 1984-1993 include all of Monroe County, Fl landings of dolphin

The following information on dolphin catch per unit of effort is directly from Appendix B (page B-9):

"Catch per unit of effort was estimated from the three recreational data bases as the total number of fish caught per angler per hour (Figures 5 and 6). In this way, these CPUE indices can be compared between sampling programs, water bodies, and years. CPUE for the Gulf of Mexico was estimated from the Texas creel survey, the head boat survey, and the MRFSS. Notably, the total catches from the head boat survey are small as would be expected gtiven that these trips are generally prosecuted nearshore and not in deeper shel waters where dolphin fish are found. The Texas creel survey data are also consistently low except from 1993 to 1995 when a significant peak in CPUE occurred. Note that the 1996 data are pleminary only and incomplete. CPUE from the MRFSS is higher as expected since the charter boat fishery is a large component of the catch where there are generally more than a single angler on board and they most likely are targeting pelagic species including dolphin. Since dolphin tend to aggregate at certain size classes they are easily caught in large numbers by several anglers. In addition, in federal waters there is no limit to the numbers which can be landed and even in Florida state waters, the bag limit is currently 10. CPUE from the MRFSS fluctuates almost annually suggesting that this species may in fact be an annual crop.

Estimated CPUE for the S. Atlantic included the MRFSS and head boat survey only since Texas is limited to the Gulf of Mexico (Figure 3). CPUE for the head boat fishery fluctuates without trend over the past 16 years. CPUE for the MRFSS appears to have increased from 1986 to 1990 and been somewhat stable and comparatively high since 1991. The CPUE estimated for 1996 is preliminary as the data are incomplete for this year."

Average commercial and recreational catches of wahoo from 1984-97 are shown by area in Table 2.

2.4 Size Frequency Data

Dolphin recreational size data are presented in Appendix H. on page H-4. Approximately 5% of the catch based on number of fish was below 451 mm FL. Dolphin commercial size data are presened on page H-21. Less than 7% of the catch based on number of fish was below 500 mm FL.

Wahoo recreational size data are presented in Appendix H on page H-24. Approximately 9% of the catch based on nubmer of fish was below 901 mm FL. Wahoo commercial size data are presened on page H-38. Approximately 10% of the catch based on number of fish was below 901 mm FL.

AS ORIGINAL

Table 2. Recreational and Commercial Landings of Wahoo in the South Atlantic, Gulf of Mexico, Mid-Atlantic & New England for 1984-1996 (Source: NMFS & Goodyear, 1999).

Year	South Atlantic		Gulf of Mexico		Mid-Atlantic		Ne
	Recreational	Commercial*	Recreational	Commercial	Recreational	Commercial	Recreati
1984	413,791	25,137	20,095	5,182	-	100	-
1985	423,073	28,426	121,166	10,869	14,442	200	-
1986	2,470,098	26,593	202,927	24,290	52,313	200	-
1987	797,015	51,403	372,602	90,313	13,310	400	-
1988	833,251	52,149	437,435	227,870	-	1,000	-
1989	708,463	43,949	66,225	241,163	25,026	800	-
1990	430,188	58,258	149,066	112,832	-	1,812	-
1991	532,886	62,329	456,182	187,156	2,198	829	-
1992	644,407	64,758	347,221	295,338	-	1,948	-
1993	632,521	74,053	566,735	257,360	-	2,911	
1994	772,795	67,503	134,575	156,530	41,638	3,813	-
1995	969,534	102,277	412,773	144,081	11,439	7,119	-
1996	848,356	79,793	327,667	145,010	11,878	2,325	-
1997	890,020	91,473	469,806	162,298	-	2,393	[illegible]

*South Atlantic Commercial landings 1984-1993 include all of Monroe County, FL landings of wahoo

2.5 Stock Status

The following sections are from the workshop proceedings (Appendix F):

"2.6 Stock Status and Management Implications

2.6.1 Dolphin

To date there has been no attempt at a comprehensive stock assessment for dolphin from the northern area. There are, however, time-series data from which there are no indicators of a decline in stock abundance nor a decrease in mean size of individual fish.

A preliminary stock assessment has been conducted for dolphin from the southern area (Barbados). The key implications of this assessment for management of dolphin in the northern area are given below:

A. There is a high risk of stock depletion with little warning given that the fishery may remain feasible at low stock levels because of the tendency of the fish to aggregate, and the current trends for increasing fishing effort.

B. There is a potential for recruitment overfishing given that fish are economically valuable before size at first maturity, and the high interannual variability in abundance apparently driven by environmental factors.

C. That a yield-per-recruit (YPR) approach to selecting a management target is probably inappropriate since even the more conservative $F_{0.1}$ values are likely to lead to a significant reduction in spawning stock biomass.

D. A precautionary approach to management which in the first instance attempts to maintain the status quo of the fishery is recommended. This will require that current catch levels not be exceeded and that recent conflict between sectors of the fishery (commercial longliners and recreational fishers) be resolved. Status quo might reflect trends (average catch and effort levels) in the fishery over the last five years (through 1997).

2.5.2 Wahoo

There has been no attempt at a stock assessment to date.

3.0 FISHERY EVALUATION
3.1 Economic Status of The Fishery

DOLPHIN

In the western Atlantic dolphin fish (*Coryphaena hippurus*) range from George's Bank, Nova Scotia to Rio de Janeiro in Brazil. Results from a preliminary investigation into the stock structure of dolphin fish indicates that there are two migratory groups; one located in the northeast region North of the Virgin Islands; and the southeast migratory group located South of the Virgin Islands to Brazil. It was suggested that for management purposes dolphin from the U.S. Gulf of Mexico, South Atlantic, North and Mid Atlantic regions, Puerto Rico, and the Virgin Islands be managed as a single unit.

In the United States commercial and recreational fishing for dolphin fish is concentrated in the Gulf of Mexico and off the southeastern coast. There are no federal regulations in place to manage this fishery, however many states have implemented size and bag limits for this species. States with regulations in place for this fishery include Florida, North Carolina, and Georgia.. At a SAFMC workshop held last year a number of management options were discussed including trip limits, bag limits, minimum size limits and gear restrictions (Appendix F).

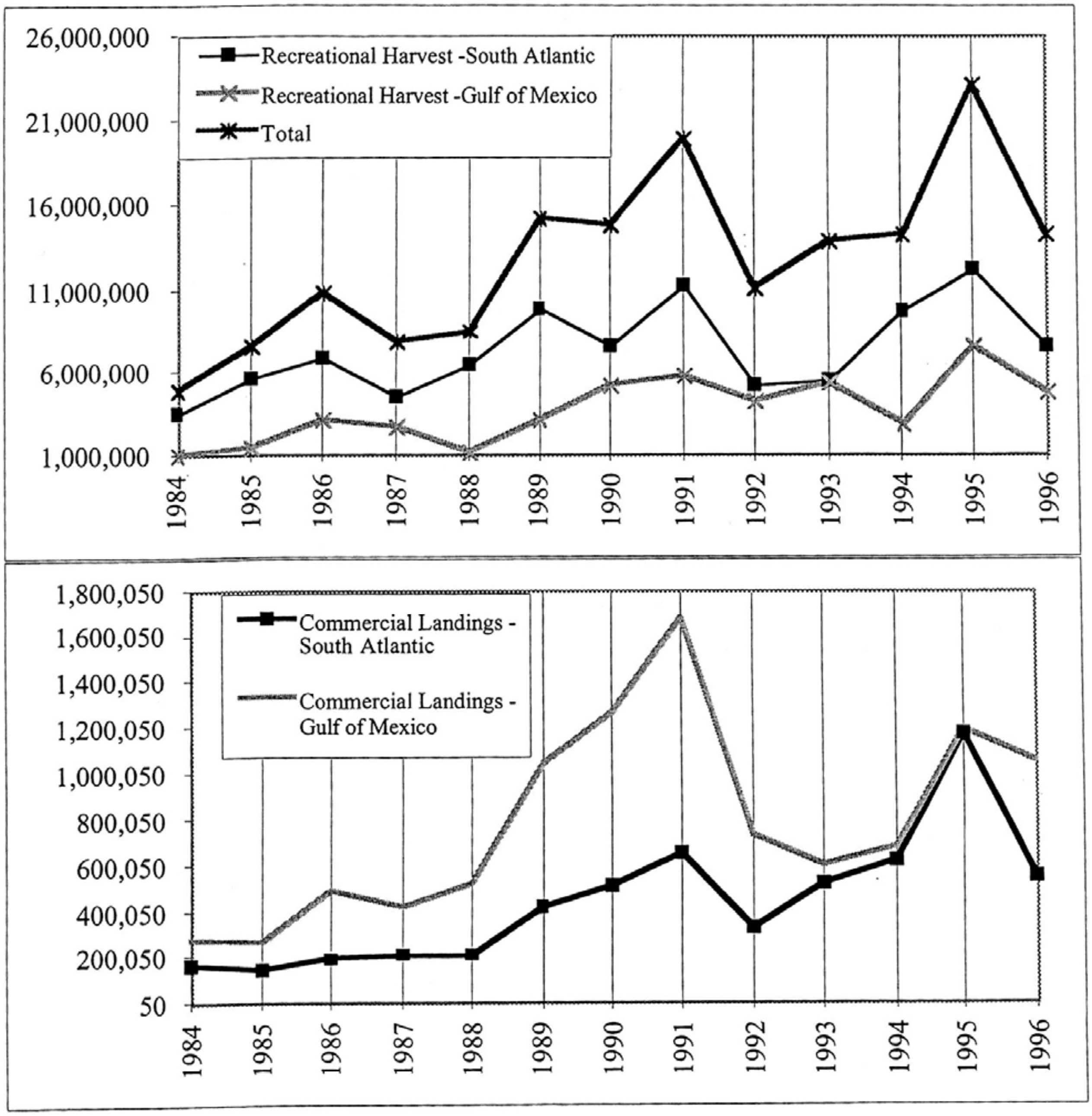
Table 3: Proportion of Total Recreational and Commercial Dolphin Landings by Region. Data on the Northeast were taken from MRFSS and Vondruska (1999). Gulf of Mexico and South Atlantic Commercial Landings and Recreational Harvest came from Thompson (Appendix B) .

Year	Northeast		South Atlantic		Gulf of Mexico	
	Commercial Landings	Recreational Harvest	Commercial Landings	Recreational Harvest	Commercial Landings	Recreational Harvest
1984	0.0%	0.0%	3.2%	69.5%	5.7%	21.5%
1985	0.1%	1.1%	1.9%	74.6%	3.6%	18.7%
1986	0.0%	1.7%	1.8%	63.4%	4.6%	28.5%
1987	0.2%	0.9%	2.7%	56.8%	5.4%	33.9%
1988	0.5%	1.7%	2.5%	75.1%	6.2%	13.9%
1989	0.6%	5.3%	2.8%	64.6%	6.8%	19.8%
1990	0.6%	2.4%	3.4%	50.3%	8.5%	34.9%
1991	0.5%	2.8%	3.3%	56.6%	8.4%	28.3%
1992	0.7%	6.2%	2.9%	46.6%	6.5%	37.0%
1993	0.9%	14.0%	3.8%	39.3%	4.3%	37.8%
1994	0.8%	2.8%	4.4%	67.9%	4.8%	19.4%
1995	0.9%	3.3%	5.1%	52.9%	5.2%	32.7%
1996	0.4%	3.6%	3.8%	51.9%	7.3%	33.0%

Commercial Fishery

The commercial landings of dolphin fish increased from 9% of total harvest in 1984 to about 12% by 1996 (Table 3). In 1995 commercial landings in the Atlantic were twice the weight of previous years (Figure 1). This sector's landings exceeded one million pounds in 1989, and doubled in 1995. Prior to the 1970s most landings occurred in Florida, however by the mid 70s there were significant landings in other areas within the South Atlantic region. During the late 1970s landings increased from Alabama to Texas, and in the northeast from Maine to Virginia.

Figure1: Commercial and Recreational Landings (pounds) of Dolphin Fish in the South Atlantic and Gulf of Mexico



Dolphin are caught off North and South Carolina mainly from May through July. Off Florida's east coast the main season occurs between April and June. February and March are the peak months off Puerto Rico's coast. In the Gulf of Mexico fishing takes place from April to September but peak catches of dolphin are reported in May through August (Thompson, 1998).

During the past three years longline and hand lines accounted for anywhere between 87-90% of the total commercial harvest, with the longline catch increasing from 26 to 36%. This could be the result of increased landings of dolphin caught incidentally in the directed swordfish and shark fisheries.

Table 4: Commercial Dolphin Landings (pounds) by Gear Type (Goodyear, 1999).

Year	Hook and Line	Long Lines	Total
1994	929,351	453,232	1,528,768
1995	1,493,093	1,025,654	2,826,985
1996	988,692	507,506	1,815,520
1997	1,104,947	812,059	2,202,323

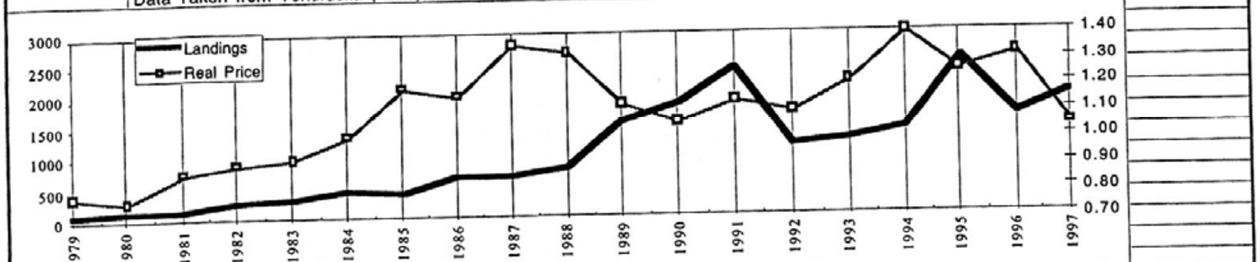
Table 5: Commercial Landings (pounds x 1,000) by State/Region (Vondruska, 1999)

State/Region	1994	1995	1996	1997
North East	115	210	52	120
North Carolina	161	356	127	230
South Carolina	107	288	144	296
Georgia	9	27	8	0
Florida -East Coast	342	496	268	364
Florida -West	556	926	743	717
Alabama-Louisiana	118	247	294	262
Texas	9	21	11	7

Price Fluctuations in the Dolphin Fishery

Dolphin and wahoo prices are similar to that of king mackerel-cero. Price trend in the entire US commercial dolphin fishery is depicted in Figure 2. Even though landings increased significantly during the early and mid 1980s, real prices continued to increase. This trend continued until 1989 when landings doubled from the previous year and prices declined. Price trends in the 1990s reached an all time high in 1994 and declined thereafter.

Figure 2: Ex Vessel Dolphin Landings (thousand pounds) and Real Price (1990 cents)
Data Taken from Vondruska (1999)



It is difficult to determine what factors are responsible for the decrease in prices in the years following 1995. Some of this may be due to increased landings that peaked in 1995 at 2.57 million pounds. Also, imports may have played a role in this price trend, however this data are only available from 1997. In addition, only imports of dolphin fillets are reported. In 1997 7.16 million pounds of dolphin fillets were imported at a value of $20.23 million dollars. However, this may be an underestimate of dolphin imports. Information from seafood distributors indicate that fresh de-headed and gutted dolphin and other product forms are also imported by U.S. buyers (Rhodes, 1998). Given the lack of historical and complete import data it is difficult to speculate on the influence of imports on domestic prices.

Rhodes (1998; Appendix F) contains a good discussion of the price variability for dolphin fish landed in the South Atlantic region. Real and nominal prices increased from 1982 reaching a peak in 1994, despite the increase in landings during this period. Rhodes (1998) speculated that the market demand was the result of unmet demand for other seafood products that could be substituted with dolphin products such as mahi-mahi steaks. This increasing trend did not continue when landings reached 2.6 million pounds in 1995. Prices declined in 1995 and this declining trend continued. Rhodes (1998) also analyzed monthly price data and surmised that in the South Atlantic prices are at their lowest in the first half of the year, usually May to June.

Recreational Fishery

The recreational dolphin fish fishery in the Atlantic and Gulf of Mexico lands anywhere from 88 to 90% of the total U.S. harvest (Table 3). Most of this recreational activity occurs in the summer months and the majority of the recreational catch of this species is taken by charter boat and private boat modes (Table 6).

Table 6: Recreational Harvest of Dolphin by mode. Weight in pounds (Goodyear, 1999).

	Headboat		Charterboat		Private/Rental		Total	
Year	Number	Weight	Number	Weight	Number	Weight	Number	Weight
1994	10,897	39,113	1,158,643	6,310,622	1,036,197	6,428,897	2,206,731	12,787,150
1995	12,720	70,943	1,254,486	10,873,300	1,003,538	8,974,380	2,272,314	19,920,700
1996	14,668	54,172	800,878	6,699,763	891,306	6,069,741	1,706,852	12,823,680
1997	11,639	48,348	1,273,035	13,765,780	931,847	8,743,603	2,216,521	22,557,710

The number of fish landed have been fairly constant, however the size of fish landed has increased in both the Gulf and Atlantic. The catch per unit effort (CPUE) in terms of numbers of fish caught per hour has decreased slightly from 1994 to 1996 by all modes. CPUE was on a decreasing trend in the Gulf of Mexico recreational fishery since 1985. In the Atlantic, recreational CPUE was on an increasing trend from 1984 to 1991 and has been decreasing since 1991 (Thompson, 1998).

The size distribution of the catch from the recreational sector differs depending on the mode of fishing (Goodyear, 1999). Headboats harvest smaller fish compared to the other two modes. Just over 55% of the headboat catch is dominated by fish below 550 mm fork length. For the most part the size distribution of fish harvested by private/rental boats and party/charter boats are fairly similar for both groups. Analysis of this data will be important in determining the impacts of proposed minimum size regulations.

Table 7: Cumulative percentage of number of fish harvested by size category (Goodyear, 1999).

Length Category (Fork Length)	Headboats	Party/Charter	Private/Rental	Total
<300	1.5	0	0.1	0
300-350	3.6	0.1	0.5	0.1
351-400	11.8	0.9	3.8	1.5
401-450	23.8	3.5	9.9	4.6
451-500	38.4	14.3	18.9	15.1
501-550	55.7	36.1	30.3	35.1
551-600	67.2	50.2	41.1	48.6
601-650	73.3	59.5	50.9	58.0
651-700	78.0	65.1	57.9	63.9
701-750	83.0	68.9	64.4	68.1
751-800	85.7	73.4	68.3	72.5
801-850	90.1	78.0	72.9	77.1
851-900	92.6	83.3	78.3	82.5
901-1000	96.6	92.2	91.1	92.0

At the SAFMC Dolphin/Wahoo workshop (held during May 6-8, 1998), one of the possible management options discussed was size limits in the dolphin fish fishery for active gear (hook and line and trolling), where fish is brought on-board alive. A minimum size limit could be size at first maturity (400-500 mm FL) or even full maturity (550-600 mm FL). This regulation may not apply to passive gear such as long lines as the fish are brought up dead and undersized fish could not be released alive. In addition, a limit of 500 mm FL would have a minor impact on this fishery as landings below 500 mm account for less than 1% of the total harvest by weight (Table 7).

Other management options discussed were bag limits and trip limits. It was suggested that bag limits in the rang of 5-10 fish per person per trip would contain recreational fishing mortality in this fishery. Goodyear (1999) also analyzed the impact of bag limits and trip limits by mode of fishing. Provided there are no behavioral shifts within the recreational sector in response to regulations, a bag limit of 5 fish would result in a 25% reduction in the number of fish harvested by recreational anglers, while a 10 fish bag limit would yield a 7% reduction in recreational harvests (Table 8).

Other management measures discussed at this workshop include the following:

1. Time and areal closures may have some merit in managing this fishery to protect essential fish habitat and reduce juvenile fish mortality.

2. There may be some need to allocate between the various user groups given the current conflict between recreational and commercial fishers.

3. It may be necessary to designate allowable gear to prevent further expansion and conflict within this fishery.

4. Other alternative management approaches could be considered such as area specific co-management and individual transferable quotas.

Table 8: Percent Reduction in Number of Fish Harvested Under Different Bag Limits.

Bag Limit	Headboats	Party/Charter	Private/Rental	Total
1	40.2	78.8	56.3	73.2
2	27.0	64.0	36.2	57.5
3	19.3	52.2	25.5	46.0
4	14.1	42.3	19.3	37.0
5	10.5	33.8	15.2	29.5
6	7.9	26.8	12.3	23.2
7	6.0	20.4	10.1	17.9
8	4.6	15.2	8.4	13.5
9	3.6	10.9	7.0	9.9
10	2.8	7.4	5.9	6.9
11	2.3	5.6	5.3	5.4
12	1.8	4.2	4.7	4.2
13	1.4	3.3	4.2	3.4
14	1.2	2.6	3.8	2.8
15	1.0	2.1	3.5	2.3

Table 9: Percent Reduction in Number of Fish Harvested Under Different Trip Limits.

Trip	Headboat	Party/Charter	Private/Rental	Total
5	63.9	78.4	34.7	69.9
10	51.0	64.1	20.9	55.7
20	37.2	43.1	10.2	36.9
30	29.1	27.4	5.8	23.6
40	23.6	15.9	3.4	13.9
50	19.4	7.5	2.0	7.0
60	16.0	1.9	1.0	2.3
70	13.3	1.1	0.7	1.5
80	11.2	0.6	0.4	1.0
90	9.6	0.3	0.2	0.7
100	8.2	0.1	0.2	0.5

WAHOO

Wahoo (*Acanthocybium solandri*) is present mostly in tropical and subtropical waters worldwide. There is a lack of information on stock structure of this species and it is assumed that a single stock model would be used to model the fishery in the western central Atlantic. In the United States fisheries exist off North and South Carolina primarily from April to September, year round in the Gulf of Mexico and off Florida's east coast. In Puerto Rico and the US Virgin Islands even though fisheries exist year round catches peak between September and March. Fisheries also exist in the eastern Caribbean and Bermuda.

The National Marine Fisheries Service first recorded landings of wahoo in the commercial catch in 1974, when they amounted to 1,000 pounds primarily off Florida. Landings during the period 1987 to 1993 ranged between 140,000 to 370,000 pounds (Vondruska, 1999). Recently Louisiana has lead in landings. In fact in 1997 more than 50% of total wahoo commercial landings came from Louisiana.

Like dolphin fish the recreational landings of this species account for a larger proportion of the total harvest. In 1997 the total commercial harvest amounted to 258,000 pounds, compared to 1.36 million pounds harvested by recreational anglers. Nearly 80% of the recreational harvests is landed by charterboats (Table 10).

Table 10: Recreational Harvest of Wahoo in the United States (Goodyear, 1999).

Year	Headboat		Charterboat		Private/Rental		Total	
	Number	Weight (lb.)	Number	Weight (lb.)	Number	Weight (lb.)	Number	Weight (lb.)
1994	219	5,385	28,041	550,670	19,822	392,952	48,082	949,029
1995	278	8,901	45,669	847,456	30,170	520,836	77,210	1,393,745
1996	149	4,366	23,371	564,068	23,875	619,467	47,395	1,187,901
1997	258	3,394	52,022	1,068,091	15,669	288,341	67,949	1,359,826

Management plans for this fishery would most likely include fisheries in the Caribbean and Latin America. Possible options for management of this stock discussed at the 1998 SAFMC dolphin/wahoo workshop include the following:

1. It was the consensus that it is not appropriate to consider trip limits or minimum size limits given the current lack of information on this fishery. However, the workshop panel recommended that expansion of this fishery should not be encouraged while management measures are being considered.
2. A control date can be used to allow for future limited entry into the commercial fishery.
3. Time and areal closures may have some merit in managing this fishery to protect essential fish habitat and reduce juvenile fish mortality.
4. There may be some need to allocate between the various user groups to prevent further expansion and future conflict between recreational and commercial fishers.
5. It may be necessary to designate allowable gear to prevent further expansion and conflict within this fishery.
6. Other alternative management approaches could be considered such as area specific co-management and individual transferable quotas.

3.2 Social Evaluation - South Atlantic Fishing Communities as Defined in the Sustainable Fisheries Act Amendment (SAFMC, 1998a)

"4.3.3 Fishing Communities - Identify and define fishing communities

Identifying fishing communities provides a basis for analyzing impacts of management measures on fishing communities rather than on a fishery-wide basis. This would be more relevant in situations where impacts are differential because of the location, level of activity and dependency on fishing, availability of alternative job opportunities, etc. in different fishing communities. This measure would allow fishery managers to obtain information on the impacts of future management measures on different fishing communities. It could make for the formulation of management measures that would minimize impacts on fishing communities that have less opportunities to adapt to changes imposed by the measures.

Identification and definition of fishing communities would normally have a positive impact, except that, for the South Atlantic, there are no data collected on fishing communities. National Standard 8 imposes requirements on the council and the fishery management regulatory process that cannot be satisfied given existing data. Current data available do not allow for a meaningful definition of fishing community, moreover, do not provide a measure of dependence upon fishing and will not contribute to useful impact analysis.

At its March meeting, the Gulf of Mexico Fishery Management Council's Socio-economic Panel recommended that further research be initiated and funded by National Marine Fisheries Service as soon as possible to aid in the identification and definition of fishing communities in the Southeast. The panel also recommended the scope of this problem be addressed at a national level, such that impacts upon fishing communities can be analyzed across regions as well as within. A key area for expanded research is ethnographic and survey research to identify, not only communities, but those who provide supporting services to the economy and culture of fishing communities. Especially important in the Southeast is the need to provide a realistic portrayal of recreational fishing, diving, and eco-tourism and their importance to a fishing community.

The Council concluded incorporating all available information at this time will meet the mandates of the recent Magnuson-Stevens Act amendments relative to fishing communities.

With the addition of National Standard 8, FMPs must now identify and consider the impacts upon fishing communities to assure their sustainable participation and minimize adverse economic impacts [MSFCMA section 301 (a) (8)].

The proposed guidelines for this new standard state: *"... fishing communities are considered geographic areas encompassing a specific locale where residents are dependent on fishery resources or are engaged in the harvesting or processing of those resources. The geographic area is not necessarily limited to the boundaries of a particular city or town. No minimum size for a community is specified, and the degree to which the community is 'substantially engaged in' or 'substantially dependent on' the fishery resources must be defined within the context of the geographical area of the FMP. Those residents in the area engaged in the fisheries include not only those actively working in the harvesting or processing sectors, but also ``fishery-support services or industries," such as boat yards, ice suppliers, or tackle shops, and other fishery-dependent industries, such as ecotourism, marine education, and recreational diving."* [Federal Register Volume 62, Number 149 (August 4, 1997)]

"The term 'sustained participation' does not mandate maintenance of any particular level or distribution of participation in one or more fisheries or fishing activities. Changes are inevitable in fisheries, whether they relate to species targeted, gear utilized, or the mix of seasonal fisheries during the year. This standard implies the maintenance of continued access to

fishery resources in general by the community. As a result, national standard 8 does not ensure that fishermen would be able to continue to use a particular gear type, to target a particular species, or to fish during a particular time of the year." [Federal Register Volume 62, Number 149 (August 4, 1997)]

"The term 'fishing community' means a community that is substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew, and fish processors that are based in such communities. A fishing community is a social or economic group whose members reside in a specific location and share a common dependency on commercial, recreational, or subsistence fishing or on directly related fisheries-dependent services and industries (for example, boatyards, ice suppliers, tackle shops)." [Federal Register Volume 62, Number 149 (August 4, 1997)]

In order to determine a community's "substantial dependence" or "sustained participation" on fishing, those communities must first be identified. Presently, the NMFS has not identified fishing communities, nor their dependence upon fishing in the South Atlantic. Moreover, there are no ongoing data collection programs to gather the necessary information that would allow for the identification of fishing communities in the South Atlantic or other regions. Also, there are no future plans to implement any such data collection program that would determine dependence upon fishing in order to provide the Councils with important information necessary for social and economic impact analysis of fishing communities. This leaves the councils with existing data collected through other agencies, not always specific to fisheries management, i.e., census data, regional economic census, and previous research on specific fisheries. Although this data can be useful, it is often not specific enough to identify or provide a clear representation of a community and its dependence upon fishing. One reason for this difficulty is that fishermen in a specific fishery often do not reside within one particular municipality that can easily be identified as a fishing community or one that is substantially dependent upon fishing. Also, that information is often not provided at the municipality level, but more often at the county level.

Commercial fishermen may have a domicile (home) in one community and dock their boat in another. They may sell their fish in either place or an entirely different location. Recreational fishermen often do not live on the coast, but drive from inland counties and may launch their boats or fish from several different sites. For these reasons, identifying a "fishing community" becomes problematic in that such a community does not fit the normal geographic boundaries or fall within the metes and bounds that would surround a normal incorporated municipality.

The impacts of fisheries management may be minimal in a single community, but, when taken overall may be substantial to an entire county or several county area. Those same measures may have a small impact on a large metropolitan area, but, to a neighborhood where most fishing families live or most fishing activity originates it could be substantial. Therefore, a "fishing community" may encompass a single municipality, a county, several counties or one neighborhood within a major metropolitan area depending upon a variety of demographic, social, economic and ecological factors that one must consider.

One important circumstance to consider when assessing the impacts upon fishing communities is the difference between rural and urban areas, as many fishing communities exist in rural areas on the Southeast coast. There are several ways in which rural areas differ from the more urban or metropolitan as illustrated in *Understanding Rural America* (ERS-USDA, 1993).

Rural areas have consistently lagged behind urban areas with respect to real earnings per job and education levels. Rural areas have also seen a rise in subgroups who are prone to economic disadvantage--families headed by single mothers and minorities. However, these differences vary across the country and are influenced by several factors, one of which is the availability of natural resources. In order to explain and examine some of these differences, counties within the U.S. have been classified as either metropolitan or non-metropolitan. A further subdivision of non-metro counties provides a more clear understanding into each subtype's dependence upon certain economic specialization and the importance of those differences to the residents of those counties (ERS-USDA, 1993). The following classification system may also suggest a possible method for defining an area's dependence upon fishing using the appropriate criteria.

Six types of non-metro counties have been classified, three of which are based upon economic specialization - farming, manufacturing and services. The other three county classifications are based upon their relevance to policy -- retirement-destination; Federal lands; and persistent poverty. Using earned income as a measure of dependence, the classification for counties based upon economic specialization is as follows:

Farming counties - 20% or more earned income from farming
Manufacturing - 30% or more earned income from manufacturing
Services - 50% or more earned income from services industries

Those counties whose classification is based upon economic specialization are mutually exclusive; the other three classification types are not mutually exclusive (ERS-USDA, 1993).

This type of classification system, based upon a percentage of earned income or other measure, might be used to determine a community, county or region's dependence upon fishing. However, like farming counties, those dependent upon fishing have likely seen a decline in the dependence upon fishing over time. This is probably due to significant increases in the population of coastal areas since the 1970's. Much of the population growth has been in the form of immigration of people 60 and older who seek coastal areas for retirement destinations. The increase in this population sector, in turn, brings a greater dependence upon service industries. Choosing such a measure of dependence is not possible at this time and would have to be developed through further analysis and/or research.

Griffith and Dyer developed a typology of fishing community dependence for the Northeast Multi-species Groundfish Fishery (MGF) (Aguirre, 1996). In that typology, they identified critical indicators of dependence which included specific physical-cultural and general social-geographic indicators, i.e., number of repair/supply facilities; number of fish dealers/processors; presence of religious art/architecture dedicated to fishing; presence of secular art/architecture dedcicated to fishing; number of MGF permits; and number of MGF vessels. Using previous results and supplemental research of their own, they were able to develop a fishery dependence index score for the five primary ports in the MGF.

From their research Griffith and Dyer were able to document five variables which best predicted dependence upon the MGF:

1. Relative isolation or integration of fishers into alternative economic sectors, including political participation. To what extent have the fleets involved in the MGF enclaved themselves from other parts of the local political economy or other fisheries? How much have the MGF fleets become, similar to an ethnic enclave, closed communities?

2. Vessel types within the port's fishery. Is there a predominance of large vessels or small vessels, or a mix of small, medium, and large?

3. Degree of specialization. To what extent do fishers move among different fisheries? Clearly, those fishers who would have difficulty moving into alternative fisheries or modifying their vessels with alternative gears are more dependent on the MGF than those who have histories of moving among several fisheries in an opportunistic fashion.

4. Percentage of population involved in fishery or fishery-related industries. Those communities where between five and ten percent of the population are directly employed in MGF fishing or fishing-related industries are more dependent on the MGF than those where fewer than five percent are so employed.

5. Competition and conflict within the port, between different components of the MGF. Extensive competition and conflict between fishers within the same port--as well as between different actors in the MGF, such as boat owners and captains--seem to be associated with intensive fishing effort and consequent high levels of dependence on the MGF. In this case, dependence may have a strong perceptual dimension, with fishers perceiving the resources they are harvesting to be scarce and that one fleet's gain is another fleet's loss.

It is important to understand that these factors are appropriate for the MGF and are not necessarily the best predictors for all fishing communities. Fisheries in the Southeast will differ markedly from those in other regions of the country, especially with regard to their integration into other economies and notably the tourist economy. Recreational fishing is an integral part of the tourism and service economy that has developed for coastal communities in the South Atlantic. For these communities, dependence upon fishing will undoubtedly be tied to commercial and recreational fishing and their associated businesses. Therefore, it is important for fishery dependence models to be developed specifically for the South Atlantic.

Griffith and Dyer (Aguirre 1996) also discuss their description of fishing communities as it relates to the term Natural Resource Community (NRC). Dyer et. al define a NRC as "a population of individuals living within a bounded area whose primary cultural existence is based upon the utilization of renewable natural resources" (1992:106). Natural Resource Communities possess an elementary connection between biological cycles within the physical environment and socio-economic interactions within the community. An adaptation to working on the water by fishermen has important implications for the community as a whole because of the necessary support activities that take place on land, i.e., net hanging & mending; fish handling & preparation; boat building & repair. This important tie to the physical environment not only dictates occupational participation, but structures community interaction and defines social values for those living in Natural Resource Communities. While fishing communities in the MGF are not bounded or set apart from the larger community in which they reside, they still manifest certain recognizable features that would classify them as NRCs (Aguirre 1996). Fishing communities in the South Atlantic will also show signs of being integrated into the larger economy, but may still maintain certain vestiges of an NRC. Fishermen in the South Atlantic, like those in the Northeast MGF, will not likely see their ecological systems being closed, but affected by a host of other forces, both globally and locally. Far more detailed research will need to be conducted among South Atlantic fishing communities to determine changes in integration of the larger economy. One of the most likely changes will be an increasing dependence upon the service sectors as recreational fishing and other recreational activities play an increasing role in the economies of coastal communities. While there will continue to be a connection between the social and physical environments, the nature of that interaction will undoubtedly change.

At this time there is insufficient data to completely identify and define fishing communities in the South Atlantic. The following description of fishing communities provides information to explore ways of defining fishing communities that range from geographical regions to a well bounded municipality. With varied levels of research or data available for each state, descriptions of fishing communities will depend upon the amount of data available and the specific nature and timeliness of that data. In some cases, it may be possible to find a municipality that will clearly fit a definition of fishing community and meet a criterion for dependence upon fishing. In others, it may be a series of communities or counties designated a "fishing community" or possibly a particular sector of a large metropolitan area.

Readily available data will be discussed to allow for public input on the best way to identify fishing communities and determine their dependence upon fishing. Following the discussion of fishing communities in the South Atlantic a discussion of data needs and format will provide possible directions for data collection and analysis. The Council welcomes comments on all aspects of incorporating this new national standard, in order to devise a classification system which will assist in assessing the impacts of fishery management upon fishing communities.

4.3.3.1.1 South Atlantic Fishing Communities

According to NMFS, South Atlantic commercial fishermen have harvested well over 250,000 pounds of seafood in each of the years 1995 and 1996 (Table 1). Those landings have represented over $200,000,000 in harvest value. The value of those landings can become even greater once it diffuses throughout South Atlantic fishing communities as it provides employment and other benefits to other sectors within each community's economic base.

Table 1. U.S. Domestic Commercial Fishing Landings by Region, 1995 and 1996.
Source Fisheries of the United States, 1996.

	1995		1996	
Region	**Thousand pounds**	**Thousand dollars**	**Thousand pounds**	**Thousand dollars**
New England	592,665	580,957	641,821	564,169
Middle Atlantic	240,413	179,747	241,936	181,869
Chesapeake	845,632	174,229	728,830	158,736
South Atlantic	**277,035**	**238,112**	**268,990**	**209,407**
Gulf of Mexico	1,464,718	724,619	1,496,875	680,304

Commercial seafood landings also represent other forms of expenditure which have an impact upon fishing communities, such as: fuel, gear, groceries, etc. Support industries like, gas stations, tackle shops, grocery stores all have an investment in the harvesting capability of the local fishing fleet.

As with commercial fishing, recreational fishing activity will also contribute to the economic base of a fishing community as fishermen buy fuel, bait, tackle and food & beverage for fishing trips. Figure 1 demonstrates an increasing trend in recreational fishing trips for most

South Atlantic states, but, also substantial variation in the number of trips over time. Such variation can mean significant economic impacts for those communities that rely upon recreational fishing.

South Atlantic fishing communities will depend upon both recreational fishing and commercial fishing for determining the importance of fishing to their economic base. The supporting role of associated businesses will also need to be incorporated into any measure of dependence. Such businesses as: seafood dealers and processors, marinas, gas stations, bait and tackle shops, dive shops, trucking firms, restaurants and many others, all have some role in determining dependence upon fishing. Unfortunately, data that is robust and/or specific enough does not exist to include in such a determination.

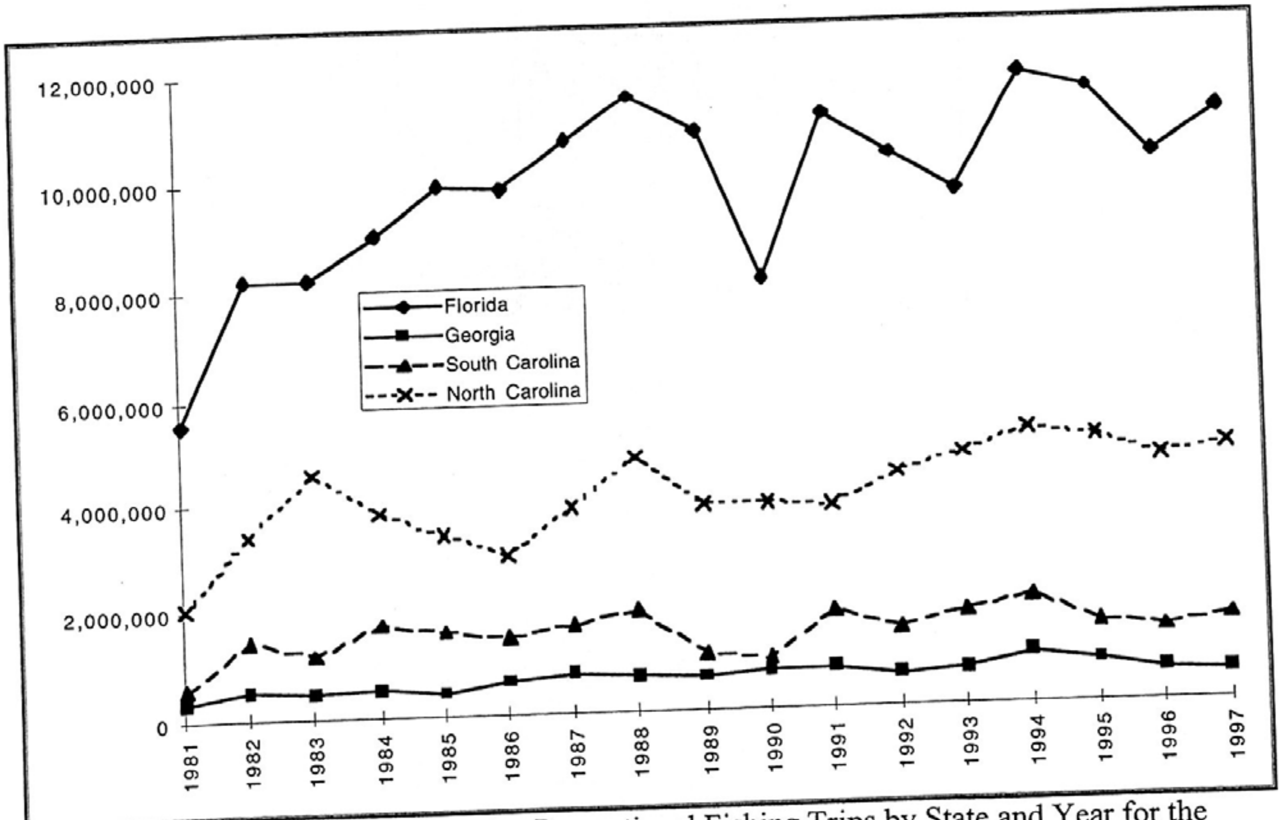


Figure 1. Estimated Number of Marine Recreational Fishing Trips by State and Year for the South Atlantic. Source: Personal communication from the National Marine Fisheries Service, Fisheries Statistics and Economics Division.

To identify fishing communities in the South Atlantic one might begin with the National Oceanic and Atmospheric Administrations publication *Fisheries of the United States* (1996). Among the various statistics listed are commercial landings of major U.S. ports. These ports could be considered to be substantially dependent upon fishing. Table 2 lists the major ports for the South Atlantic in 1996 and 1995 for quantity and value of landings. Some ports are listed as individual communities while others are a combination of several communities over a limited geographical range. This characterization may be useful as we attempt to further delineate fishing communities in each state. Other sources of information helpful in defining fishing communities include the United States Census and Bureau of Economic Research, which include economic information for many areas of the U.S.

Table 2. Quantity, Value and Rank of Commercial Landings for South Atlantic Ports among Major U.S. Ports Source: Fisheries of the United States, 1996.

Port	1995 Quantity*	1995 Rank	1995 Value*	1995 Rank	1996 Quantity*	1996 Rank	1996 Value*	1996 Rank
Key West	23.4	32	66.7	5	23.7	37	62.8	4
Beaufort-Morehead City, NC	87.0	16	35.0	15	75.4	18	20.3	34
Wanchese-Stumpy Point, NC	39.0	25	25.0	24	43.4	24	24.6	27
Charleston-Mt.Pleasant, SC	11.0	58	19.0	32	---	--	---	--
Cape Canaveral, FL	10.1	--	16.9	35	21.2	43	17.7	42
Darien-Bellville, GA	---	--	11.0	50	---	--	---	--
Beaufort, SC	---	--	11.0	51	---	--	---	--
Englehard-Swanquarter, NC	11.0	58	---	--	15.0	50	---	--
Oriental-Vandemere, NC	9.0	--	10.0	--	14.0	53	13.3	50
Bellhaven-Washington, NC	---	--	6.0	--	---	--	11.5	58

*Value and quantity are in millions of dollars and pounds respectively.

4.3.3.1.2 North Carolina

The 1990 Census of Population and Housing provides the following information for North Carolina regarding individuals who reported their occupation as fisher in Table 3. This data will likely include those individuals who commercially fish fresh water areas and others who are not impacted by fisheries management of marine fisheries at the council level. This information does provide data for comparison and could help set parameters for a measure of dependency upon fishing. It is not recommended that these figures be used to determine dependency upon fishing, however. The 1990 Census classifies year-round full-time workers as all persons 16 years old and over who usually worked 35 hours or more per week for 50 to 52 weeks in 1989.

Table 3. Number of Fishers and Mean Annual Income for North Carolina in 1990. Source: U.S. Bureau of the Census.

	Year Round/Full Time	Other	Total
Number of fishers			
Male	989	1,271	2,260
Female	47	105	152
Total	1,036	1,376	2,412
Mean Annual Income ($)			
Male	16,315	13,069	14,489
Female	11,518	4,489	6,662
Total	16,097	12,414	13,996

The 1990 Census also provides the following information for North Carolina regarding individuals who reported their occupation as captain of a fishing vessel in Table 4. It is interesting to note that there were no females listed as captain of fishing vessels. This concurs with the much of the research on the occupation of fishing which finds very few women in this role. Although women often play an important role in the fishing operation, they are rarely in the position of captain of fishing vessels.

Table 4. Number of Captains of Fishing Vessels and other officers and Mean Annual Income for North Carolina in 1990. Source: U.S. Bureau of the Census.

	Year Round/Full Time	Other	Total
Number of Captains			
Male	102	141	243
Female	0	0	0
Total	102	141	243
Mean Annual Income ($)			
Male	26,917	33,640	30,818
Female	0	0	0
Total	26,917	33,640	30,818

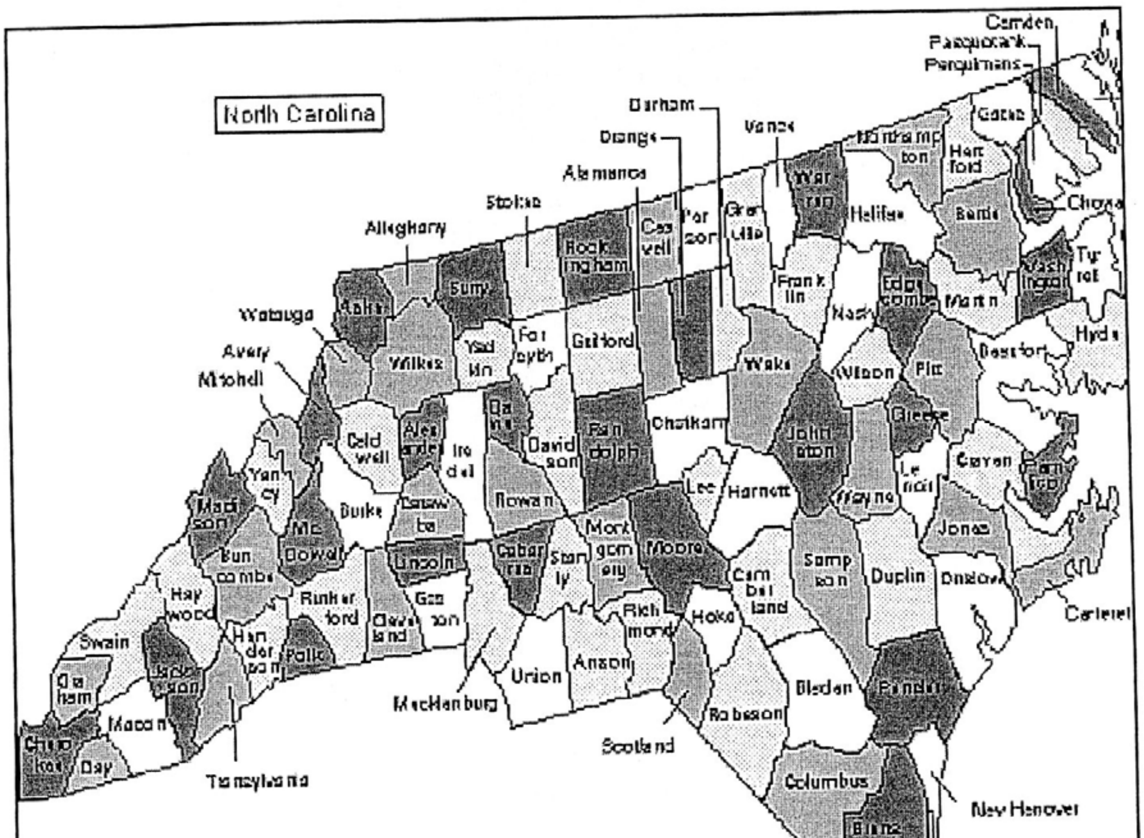


Figure 2. North Carolina Counties. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

Johnson and Orbach (1996) have divided North Carolina into six areas for their research on effort management of North Carolina commercial fisheries. Those areas were determined to be distinct with regard to species/gear combinations in addition to sociological, ecological and environmental differences. The areas defined are as follows:

Area 1: Albermarle Area - Currituck, Camden, Pasquotank, Perquimans, Chowan, Bertie, Washington, and Tyrell Counties.

Area 2: Dare County

Area 3: Southern Area - Brunswick, Pender, New Hanover, and Onslow Counties

Area 4: Pamlico Area - Craven, Pamlico, Beaufort, and Hyde Counties.

Area 5: Carteret County

Area 6: Inland Counties.

Area 1: Albermarle Area

The Albermarle area includes the following counties: Currituck, Camden, Pasquotank, Perquimans, Chowan, Bertie, Washington and Tyrell. Johnson and Orbach (1997) found that commercial fishermen in this area had two primary gear types, pots and gill nets. They also concluded that fishermen here move in and out of gill netting on an annual basis.

Table 5. Population and Economic Information for Counties included in Area 1. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

Area 1-County		1993	1994	1995
Bertie	Population	20,631	20,665	20,745
	Personal Income (Thousands of $)	291,226	303,292	328,227
	Per Capita Pers Income ($)	14,116	14,677	15,822
	Personal Income Fishing (Thousands of $)	71	75	84
Camden	Population	6,211	6,370	6,399
	Personal Income (Thousands of $)	92,875	100,012	105,636
	Per Capita Pers Income ($)	14,953	15,700	16,508
	Personal Income Fishing (Thousands of $)	0	0	0
Chowan	Population	13,815	13,909	13,958
	Personal Income (Thousands of $)	226,563	234,453	247,428
	Per Capita Pers Income ($)	16,400	16,856	17,727
	Personal Income Fishing (Thousands of $)	128	134	151
Currituck	Population	15,215	15,831	16,285
	Personal Income (Thousands of $)	251,885	269,871	291,055
	Per Capita Pers Income ($)	16,555	17,047	17,873
	Personal Income Fishing (Thousands of $)	358	376	423
Pasquotank	Population	33,220	33,488	33,759
	Personal Income (Thousands of $)	510,623	534,860	574,433
	Per Capita Pers Income ($)	15,371	15,972	17,016
	Personal Income Fishing (Thousands of $)	----	----	----
Perquimans	Population	10,644	10,692	10,737
	Personal Income (Thousands of $)	148,365	162,627	160,912
	Per Capita Pers Income ($)	13,939	15,210	14,987
	Personal Income Fishing (Thousands of $)	----	0	----
Tyrell	Population	3,918	3,875	3,846
	Personal Income (Thousands of $)	56,056	58,138	52,738
	Per Capita Pers Income ($)	14,307	15,003	13,712
	Personal Income Fishing (Thousands of $)	476	500	562
Washington	Population	14,136	14,276	14,138
	Personal Income (Thousands of $)	220,429	229,038	238,124
	Per Capita Pers Income ($)	15,593	16,044	16,843
	Personal Income Fishing (Thousands of $)	225	236	266

Using multidimensional scaling, Johnson and Orbach were able to examine the spatial relationship of various types of fishing in each area. For Area 1, crab potting was the most central fishery. In other words most fishermen in the area do some crab potting. Referring to cliques, they found that for this area fishermen who peeler pot, eel pot, crab pot and gill net flounder differ from those that long haul. Fishermen that long haul will crab pot and gill net flounder but do not engage in peeler pots or eel pots.

In examining the categories which would include fishermen for Area 1 (Table 6) there seems to be no trend regarding either those in Farm/Fish/Forest occupations or the Agriculture, Fishing, Mining Industries. There are both increases and decreases in the number of those within each categories from 1970 to 1990 which varies by county.

Table 6. Number within Farm/Fish/Forest Occupation and Agriculture, Fishing, Mining Industry for North Carolina Coastal Counties included in Area 1 for 1970, 1980, and 1990 Census. Source: MARFIN Sociodemographic Database

County	Occupation/Industry	1970	1980	1990
Bertie County	Farm/Fish/Forest	923	1035	839
	Agri.,Fishing,Mining	1050	1038	884
Camden County	Farm/Fish/Forest	203	220	114
	Agri.,Fishing,Mining	220	181	137
Chatham County	Farm/Fish/Forest	740	904	832
	Agri.,Fishing,Mining	927	934	1286
Currituck County	Farm/Fish/Forest	194	247	316
	Agri.,Fishing,Mining	215	296	309
Pasquotank County	Farm/Fish/Forest	444	491	469
	Agri.,Fishing,Mining	552	478	508
Perquimans County	Farm/Fish/Forest	417	513	299
	Agri.,Fishing,Mining	445	524	316
Tyrrell County	Farm/Fish/Forest	197	249	208
	Agri.,Fishing,Mining	225	273	233
Washington County	Farm/Fish/Forest	408	511	551
	Agri.,Fishing,Mining	462	557	526

Area 2 : Dare County

Within Dare county the following communities have been described through recent research of the snapper grouper fishery and might be considered fishing communities: Manns Harbor, Manteo, Wanchese, Hatteras, Stumpy Point (Iverson 1997). Johnson and Orbach (1997) found that commercial fishermen in this area had two primary gear types, pots and gill nets. In their analysis of fishery networks for Area 2 they again found crab pots to be central. Another interesting difference revealed was that fishermen who shrimp trawl in this area will gillnet for sharks but do not engage in crab potting.

Dare County shows a higher personal income from fishing over the three years listed (Table 7) than most other coastal counties in North Carolina.

Table 7. Population and Economic Information for Counties included in Area 2. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

Area 2 County		1993	1994	1995
Dare				
	Population	24,300	25,106	26,074
	Personal Income (Thousands of $)	429,564	465,011	502,474
	Per Capita Pers Income ($)	17,678	18,522	19,271
	Personal Income Fishing (Thousands of $)	5,426	5,688	6,392

Dare County (Table 8) shows a general increase in the number of individuals in the listed occupations and industries over the twenty years from 1970 to 1990.

Table 8. Number within Farm/Fish/Forest Occupation and Agriculture, Fishing, Mining Industry for Dare County (Area 2) for 1970, 1980, and 1990 Census. Source: MARFIN Sociodemographic Database

County	**Occupation/Industry**	**1970**	**1980**	**1990**
Dare County	Farm/Fish/Forest	11	376	637
	Agri.,Fishing,Mining	181	446	655

Snapper Grouper Fishing

Most of the snapper grouper permit holders in Area 2 work out of Hatteras and only a small portion of their annual commercial fishing activity is devoted to targeting snapper grouper species. Black sea bass, snowy grouper, and blueline tilefish are the most frequently targeted species by commercial snapper grouper fishermen from this area. Surface longlining for tuna and swordfish is apparently the most productive and profitable style of commercial fishing in the area, and the small towns of Manteo and Wanchese serve as refuge for a large number of both local and non-local longlining boats (Iverson, 1997).

Area 3: Southern Area

The Southern Area includes the following counties and communities (in parenthesis): Brunswick (Southport). Pender, New Hanover, Onslow (Sneads Ferry). Johnson and Orbach (1997) found that commercial fishermen in this area had four primary gear types: hook-and-line, gill net, hand harvest of shellfish, and trawling. Pot fishing was classified as secondary gear but they report that increasing usage over time could possibly make it a primary gear. It is interesting to note that they also reported that pot fishing showed an increase in all five areas over time. Area 3 showed much more complexity in annual rounds of fishing than Areas 1 or 2 with shrimp trawling, hand clamming and crab potting all central to the network (Johnson and Orbach 1997).

Table 9. Population and Economic Information for Counties included in Area 3. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

Area 3 County		1993	1994	1995
Brunswick				
	Population	56,350	58,386	60,697
	Personal Income (Thousands of $)	878,453	941,247	1,024,954
	Per Capita Pers Income ($)	15,589	16,121	16,886
	Personal Income Fishing (Thousands of $)	1,595	1,674	1,885
Pender				
	Population	32,554	33,894	33,759
	Personal Income (Thousands of $)	510,623	534,860	574,433
	Per Capita Pers Income ($)	15,681	16,341	17,253
	Personal Income Fishing (Thousands of $)	----	----	----
New Hanover				
	Population	131,091	135,317	139,906
	Personal Income (Thousands of $)	2,620,539	2,800,024	3,036,665
	Per Capita Pers Income ($)	19,990	20,692	21,705
	Personal Income Fishing (Thousands of $)	----	----	693
Onslow				
	Population	145,638	144,951	144,259
	Personal Income (Thousands of $)	1,962,312	2,030,075	2,149,074
	Per Capita Pers Income ($)	13,474	14,005	14,897
	Personal Income Fishing (Thousands of $)	667	700	787

Counties included in Area 3 (Table 10.) show a general increase in numbers of individuals within the selected occupations and industries, with the exception of Pender County which shows a decline from 1970-1990.

Table 10. Number within Farm/Fish/Forest Occupation and Agriculture, Fishing, Mining Industry for North Carolina Coastal Counties included in Area 3 for 1970, 1980, and 1990 Census. Source: MARFIN Sociodemographic Database.

County	Occupation/Industry	1970	1980	1990
Brunswick County	Farm/Fish/Forest	370	668	1028
	Agri.,Fishing,Mining	505	645	971
Pender County	Farm/Fish/Forest	772	562	627
	Agri.,Fishing,Mining	892	669	690
New Hanover County	Farm/Fish/Forest	289	550	782
	Agri.,Fishing,Mining	564	615	984
Onslow County	Farm/Fish/Forest	754	869	996
	Agri.,Fishing,Mining	906	800	987

Snapper Grouper Fishing

For Area 3, the small community of Sneads Ferry, is unique in that the majority of the commercial reef fishermen fish with sea bass pots. According to the 1993 federal permit list for the South Atlantic region, there were 58 permit holders who indicated that sea bass pots were their primary gear type. Of those, 13 permit holders worked out of Sneads Ferry (Iverson, 1997). Overall, 72% of fishermen using sea bass pots as their primary gear work out of home ports in North Carolina.

Area 4: Pamlico Area.

The Pamlico area includes these counties and communities (in parenthesis): Craven, Pamlico (Vandemere, Oriental), Beaufort (Bellhaven, Washington), Hyde (Ocracoke, Swanquarter, Englehard). Johnson and Orbach (1997) found that commercial fishermen in this area had three primary gear types, pots, gill nets, and trawls. In terms of annual fishing rounds Area 4 is the simplest to understand where two strategies are employed: gill netting and crab potting or trawling and crab potting. They go on to note that this simple strategy may signify few choices for fishermen in this area in the case of environmental or regulatory change (Johnson and Orbach 1997). Possible fishing communities within Area 4 might be: Vandemere and Oriental.

Table 11. Population and Economic Information for Counties included in Area 4.
Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

Area 4 County		**1993**	**1994**	**1995**
Craven				
	Population	83,595	83,851	85,163
	Personal Income (Thousands of $)	1,450,296	1,508,353	1,626,657
	Per Capita Pers Income ($)	17,349	17,988	19,101
	Personal Income Fishing (Thousands of $)	386	405	----
Pamlico				
	Population	11,772	11,948	12,064
	Personal Income (Thousands of $)	179,384	186,131	199,576
	Per Capita Pers Income ($)	15,238	15,578	16,543
	Personal Income Fishing (Thousands of $)	2,714	2,851	3,211
Beaufort				
	Population	43,446	43,815	43,998
	Personal Income (Thousands of $)	674,788	711,961	756,048
	Per Capita Pers Income ($)	15,532	16,249	17,184
	Personal Income Fishing (Thousands of $)	1,339	1,406	1,580
Hyde				
	Population	5,374	5,339	5,362
	Personal Income (Thousands of $)	80,982	90,101	80,300
	Per Capita Pers Income ($)	15,069	16,876	14,976
	Personal Income Fishing (Thousands of $)	1,860	1,973	2,215

Pamlico county had the highest personal income from fishing for Area 4 from 1993 to 1995 with a steady increase over those three years (Table 11). Hyde county followed with Beaufort next; both showing an increase over time. For most counties in Area 4 (Table 12) the general trend seems to be an increase from 1970 to 1980 and then a decrease from 1980 to 1990 within these occupation and industry categories. Beaufort County shows an overall decrease from 1970-1990.

Table 12. Number within Farm/Fish/Forest Occupation and Agriculture, Fishing, Mining Industry for North Carolina Coastal Counties included in Area 4 for 1970, 1980, and 1990 Census. Source: MARFIN Sociodemographic Database

County	Occupation/Industry	1970	1980	1990
Craven County	Farm/Fish/Forest	873	1136	832
	Agri.,Fishing,Mining	1129	1222	860
Pamlico County	Farm/Fish/Forest	245	498	442
	Agri.,Fishing,Mining	502	662	477
Beaufort County	Farm/Fish/Forest	1452	1393	1024
	Agri.,Fishing,Mining	2169	2123	1190
Hyde County	Farm/Fish/Forest	295	509	454
	Agri.,Fishing,Mining	442	579	511

Area 5: Carteret County

In Area 5 Johnson and Orbach (1997) found that commercial fishermen had three primary gear types, gill nets, trawls and hand harvest of shell fish. In terms of annual fishing rounds Area 5 did not show the clear gear stratification found in other areas. Shrimp trawling is the most central fishery, but pound netting, crab potting, and mechanized clamming also occur with shrimp trawling. (Johnson and Orbach 1997). Possible fishing communities within Area 5: Morehead City and Beaufort.

Table 13. Population and Economic Information for Counties included in Area 5. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

Area 5		1993	1994	1995
County				
Carteret				
	Population	55,747	56,381	57,690
	Personal Income (Thousands of $)	935,032	985,484	1,076,753
	Per Capita Pers Income ($)	16,773	17,479	18,664
	Personal Income Fishing (Thousands of $)	2,783	2,871	3,207

Among North Carolina's coastal counties, Carteret county was second to Dare county (Table 13) in terms of personal income from fishing. In addition, Carteret County (Table 14) shows an marked increase from 1970 to 1980, then a decrease from 1980 to 1990, within the occupations of Farm/Fish/Forest and an overall increase in the number of Agriculture, Fishing and Mining industries.

Table 14. Number within Farm/Fish/Forest Occupation and Agriculture, Fishing, Mining Industry for Carteret County (Area 5) for 1970, 1980, and 1990 Census. Source: MARFIN Sociodemographic Database.

County	Occupation/Industry	1970	1980	1990
Carteret County	Farm/Fish/Forest	225	1200	1158
	Agri.,Fishing,Mining	731	1234	1260

In a recent report on the importance of commercial fishing in Carteret county, Diaby (1997) found that Carteret county ranked first in poundage (96,652,314 lb) and second in dockside value ($20,618,486) in terms of commercial landings for North Carolina coastal counties. Finfish represented the 91% of total landings and 46% of total ex-vessel value. The most important species of finfish were: menhaden, flounder, croaker, weakfish and spot. Shellfish and crustaceans accounted for only 9% of all commercial landings but, represented over half of the value of landings during the period from 1974-1994. Employment by the commercial fishing industry, both full and part time for Carteret county was estimated to be 3,232 people for 1994 (Diaby, 1997). This number varies from those reported in the census data and emphasizes the problems in comparing these types of data. Since 1981 there have been about 105 to 140 licensed seafood dealers in Carteret county. The value of processed seafood peaked for the county in 1981 when scallops accounted for almost half of the value with a total value of $19,737,126. Since that time there has been a general decline in total value of processed seafood attributable to a decline in scallop landings. Menhaden was the most important single processed product over a fifteen year period from 1980 to 1994 (Diaby, 1997).

In estimating the economic impact of Carteret county commercial harvesting sector Diaby (1997) estimated $27 million in sales of goods and services and $11.66 million in value added. Total employment from commercial harvesting activities was estimated to be 3,371.

Sales of goods and services for the wholesaling and processing sector were estimated at $19 million, with $11 million n value added. There were an estimated 1,563 full and part time jobs created earning $6.55 million in wages (Diaby, 1997).

Overall, the activities of the commercial fishing industry created $46 million in sales of goods and services and $24 million in value added. There were 4,934 full and part time jobs which earned $14 million in wages (Diaby, 1997).

The recreational fishery spent approximately $70 million on fishing trips in Carteret county with $25.23 million in employ compensation and $47.61 in value added. There were 1,821 full and part time jobs associated with the recreational fishing industry in Carteret County.

The total impact of the coastal fishing industry on the economy of Carteret County was estimated to be $120.74 million with $71.32 million in value added. The total number of full and part time jobs was estimated at 6,755 with earnings of $38.94 (Diaby, 1997).

Snapper Grouper Fishing

The Morehead City/Beaufort area is located approximately 50 miles south of Ocracoke in Carteret County. This area is known for its sportfishing activity including several major tournaments each year. There is a small population of full time commercial reef fishermen in Morehead, however the majority of fishermen holding commercial permits are primarily part timers. Many of these fishermen divide their time between charter fishing during the peak tourist season (April through September) and commercial fishing in the winter months. Full time fishermen in this area reported fishing approximately 50 miles straight offshore and fishing from Hatteras to as far south as the South Carolina/Georgia line. Trip lengths vary with the size of the vessel, but the average trip length is 7 days and the larger boats carried up to 3 crew members (Iverson, 1997).

King Mackerel Fishery

The king mackerel fishery in North Carolina has grown steadily since 1980 and has leveled with catches repeatedly around one million pounds in recent years. From 1986 to 1990 the number of permits for Atlantic group king mackerel issued in North Carolina ranged from a low of 325 in 1987/88 to a high of 533 in 1989/90. Again, the majority of those permits were granted to hook and line fishermen. Present data indicates there were 448 commercial vessels permitted for king and Spanish mackerel in North Carolina (Vondruska, 1997).

4.3.3.1.3 South Carolina

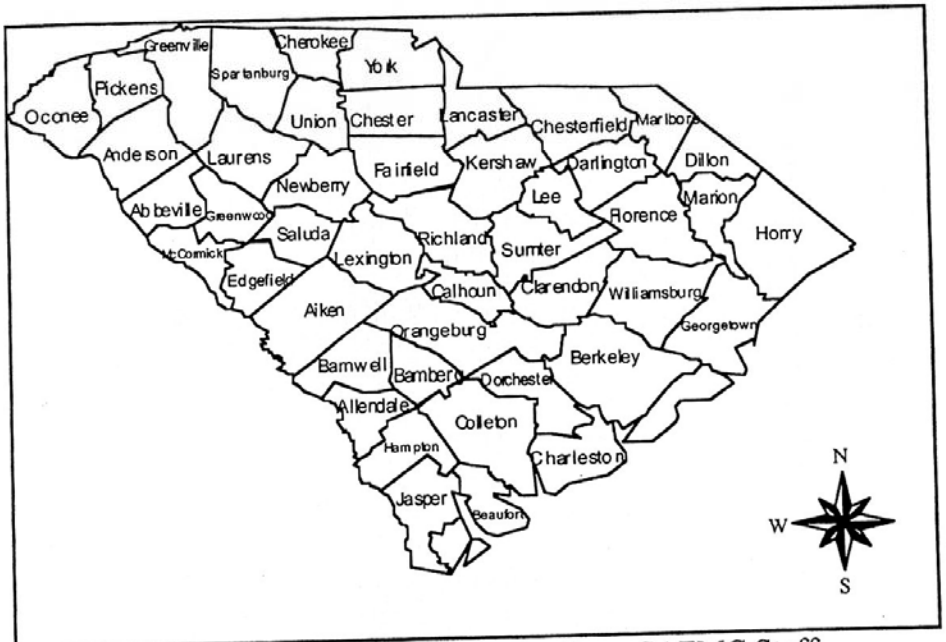


Figure 3. South Carolina Counties Source: Roger Pugliese, SAFMC Staff.

The 1990 Census of Population and Housing provides the following information for South Carolina regarding individuals who reported their occupation as fisher in Table 15. A total of 401 individuals claimed Fisher as their occupational title with less than half indicating it was a year round full time employment. There were few females who indicated such and they had a far lower mean annual income than males in this occupation.

Table 15. Number of Fishers and Mean Annual Income for South Carolina Fishers in 1990. Source: U.S. Bureau of the Census.

	Year Round/Full Time	Other	Total
Number of fishers			
Male	188	193	381
Female	6	14	20
Total	194	207	401
Mean Annual Income ($)			
Male	28,842	14,489	18,946
Female	750	5,000	2,403
Total	23,710	14,269	18,390

There were a total of 69 individuals who indicated their occupation as captain of a fishing vessel in the 1990 census of population and housing. and 7 of them were female according to Table 16 Again, females had a much lower mean annual income when compared to males.

Table 16. Number of Captains of Fishing Vessels and other officers and Mean Annual Income for South Carolina in 1990. Source: U.S. Bureau of the Census

	Year Round/Full Time	Other	Total
Number of Captains			
Male	17	45	62
Female	7	0	7
Total	24	45	69
Mèan Annual Income ($)			
Male	18,765	15,022	16,048
Female	9,000	0	9,000
Total	15,917	15,022	15,333

Horry County

The following descriptions for fishing communities in South Carolina are notes from Kim Iverson of South Carolina Department of Natural Resources. Kim has spent many months interviewing both commercial and recreational fishermen in South Carolina and other parts of the South Atlantic region as part of several research projects. Although the research was not intended to identify fishing communities, her notes represent the best available information on fishing communities for South Carolina.

Little River has a long history of fishing activity, both commercial and recreationally. The headboat operations date back to the 1940's. As of 1996, there were headboats operating in Little River. There are approximately 4 vessels that actively run charters and also commercial fish. Several full time snapper/grouper vessels operate out of the area. Little River also hosts an annual Blue Crab Festival each spring (Kim Iverson, SCDNR pers. comm., 1998).

Murrells Inlet has a large fleet of charter and headboats, with one marina hosting one of the Governor's Cup Billfishing Tournaments. There are several smaller fishing tournaments held in the area. There are fish houses in the community that deal primarily with finfish. There are no shrimp dealers. This area is also noted for it's large number of seafood restaurants that target the tourist market from Myrtle Beach (Kim Iverson, SCDNR pers. comm., 1998).

Major fishing tournaments held in Murrells Inlet are: March of Dimes Annual Flounder Tournament - Voyagers View Marina. Registration was by angler with approximately 200 anglers participating. Local tournament with many family participants. Primarily smaller boats < 25' participating. Tournament date May 17.; and the Marlin Quay Governor's Cup Billfish Tournament - Marlin Quay Marina. The last in the series of SC Gov. Cup. Total of 31 boats registered. July 23-26 (Kim Iverson, SCDNR pers. comm., 1998).

Major tournaments in North Myrtle Beach: Dock Holidays Governor's Cup Billfish Tournament - Dock Holiday's Marina. The first tournament in a series of 6 for the SC Governor's Cup. April 30 - May 3. Total of 25 boats entered; Frantic Atlantic King Mackerel Tournaments - North Myrtle Beach - Blue Marlin Yacht & Fishing Club. A two tournament series consisting of the Spring and Fall Classics. Total purse of $250,000 for the series. Total of 392 paid boat entries with an average of 4.09 anglers per boat. Tournament dates May 9-11, September 26-28; Evinrude Outboard King Mackerel Tournament - Oct. 11-12, Weigh-in stations at Dock Holidays Marina, Marlin Quay Marina and Georgetown Landing. 147 boats were registered; Yamaha Contender King Mackerel Classic - Weigh in stations at Dock Holidays Marina, Marlin Quay Marina and Georgetown Landing. 125 boats registered; Fall Pier King Tournament - September 19-21 (Kim Iverson, SCDNR pers. comm., 1998).

One of the largest concentration of snapper grouper vessels is located in Murrells Inlet, SC. Most of the reef fishermen in this area are full time commercial fishermen and consider bandit reels to be the most effective way of catching snapper grouper. There is a wide variety of snapper grouper species off of Murrells Inlet, with gag grouper, scamp grouper and vermilion snapper being highly targeted. The average trip length is 5 days with some of the larger boats (>40 ft.) fishing up to 10 days. A few smaller bandit boats may stay out for 2-3- days. The Gulf Stream is approximately 62 miles offshore from Murrells Inlet. Most bandit boats fish between the 20-50 fathom line, concentrating on the 25 fathom curve. Winter weather dictates that fishermen fish shallow, in waters 60-90' deep. Several fishermen switch to sea bass trapping during the winter months (Iverson, 1997).

Horry County has shown a small increase in personal income from fishing that follows the general increase in personal income overall (Table 17).

Table 17. Population and Economic Information for Horry County, South Carolina. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Horry				
	Population	148,385	152,435	157,834
	Personal Income (Thousands of $)	2,543,793	2,744,260	3,013,059
	Per Capita Pers Income ($)	17,143	18,177	19,220
	Personal Income Fishing (Thousands of $)	81	129	169

Vessels in Murrells Inlet will fish an area from Frying Pan Shoals off southern NC, south to Savannah. The average boat has two crew members. It is interesting to note that fishermen stated a crew of 3 plus the captain was ideal for this area, but decreasing catches and increased costs have made it necessary to cut back on crew members (Iverson, 1997).

<u>Georgetown County</u>

The community of Georgetown has shrimp dealers who also deal in finfish and shellfish. Georgetown is host to the one of the SC Governor's Cup Billfish Tournaments along with several other smaller fishing tournaments. There are no headboats operating from the area and charter activity is limited. Georgetown is known for it's historic waterfront district (Kim Iverson, SCDNR pers. comm., 1998).

Major fishing tournaments in Georgetown County: Georgetown Landing Governor's Cup Billfishing Tournament - May 21-24, Georgetown Landing Marina. The oldest of the series tournaments with 45 boats participating.

Georgetown County shows an increasing personal income from fishing like Horry County in Table 18 but, personal income from fishing tends to be a larger percentage of overall personal income than in Horry County.

Table 18. Population and Economic Information for Georgetown County, South Carolina. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Georgetown				
	Population	49,371	49,966	50,835
	Personal Income (Thousands of $)	822,317	885,024	946,898
	Per Capita Pers Income ($)	16,656	17,713	18,627
	Personal Income Fishing (Thousands of $)	246	388	399

Charleston County

McClellanville is a small community with a long history of commercial shrimping. McClellanville has a large shrimp fleet. At any given time (dependent upon the season) there can be as many as 20 shrimp boats at the docks. Shrimp wholesale dealers are also present within the community. McClellanville hosts an annual Blessing of the Fleet Festival each spring. Shem Creek (Mt. Pleasant) hosts a mixture of commercial and recreational fishing activity along with a number of seafood restaurants, a retail seafood market and a waterfront hotel. There are also headboats operating out of Shem Creek along with charter operations. There is a large permanent shrimp fleet and many shrimp boats visit seasonally. At any give time there are an average of 30 shrimp boats along the creek. Shrimp dealers along the creek also buy and sell finfish from the trawlers. There are several offshore fishing boats including longline and snapper/grouper boats. Several shellfishermen and crabbers do business along the creek. Each spring, Mt. Pleasant hosts an Annual Blessing of the Fleet for the shrimp boats.

In Folly Beach there is a concentration of commercial fishing vessels and several fish houses who handle offshore finfish, shellfish, shrimp and crabs. Rockville is a historical small community located at the south end of Wadmalaw Island. There are commercial dealers who handle shrimp, inshore fish, offshore finfish and some shellfish. On Edisto Island there are several commercial seafood dealers. There are approximately 10 shrimp boats that operate there, fluctuating with the season. The dealers handle primarily shrimp and in-shore species along with shellfish and blue crabs. There is also a large "harvest" of horseshoe crabs. These crabs are "bled" for their blood that is used in cancer research and returned to the water. Edisto Island is also host to the annual SC Governor's Cup Billfish Tournament. Charter activity here is limited. Bennett's Point is a small community south of Edisto with shrimping operations in the community. There are 10-15 small boat shrimpers that live in Walterboro and fish out of Bennett's Point (Kim Iverson, SCDNR pers. comm., 1998).

Table 19. Population and Economic Information for Charleston County, South Carolina. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Charleston	Population	297,888	287,139	281,068
	Personal Income (Thousands of $)	5,653,489	5,879,506	6,083,636
	Per Capita Pers Income ($)	18,979	20,476	21,645
	Personal Income Fishing (Thousands of $)	3,188	3,809	- - - -

Charleston County (Table 19) has a higher personal income from fishing than the previous two counties, but has a much larger overall dollar value for personal income overall.

Major fishing tournaments in the Charleston County area: SCSSA (South Carolina Saltwater Sportfishing Assoc.) Early Bird - Ashley Marina. Approximately 25 registered boats. April 19. Multi-species tournament; James Island King Mackerel Tournament - James Island Yacht Club, May 24; Wild Dunes Governor's Cup Billfish - June 11-14. Total of 46 registered boats; Bohicket Invitational Governor's Cup Billfish - June 25-28. Total of 48 registered boats. Bohicket Marina on John's Island; Lowcountry Angler's Inshore Tournament - June 28. Multi-species tournament held at the East Cooper Outboard Motor Club on Gold Bug Island in Mt. Pleasant. Registration by angler, with approximately 200 anglers registered; SCSSA Sailfish XV - Ashley Marina in Charleston. Club sponsored tournament with approximately 25 boats registered. Sailfish, tuna, dolphin & wahoo. August 8-10; Fishing For Miracles King Mackerel

Tournament - Ripley's Light Marina. Large King tournament with over 200 boats entered. August 14-16; Alison Oswald, Sr. Memorial Tournament - James Island Yacht Club. Local tournament with approximately 75 boats participating. Multi-species. Aug. 23; Edisto Marina Governor's Cup Billfish Tournament - July 16-19. One of the oldest and largest of the Billfish Series. 46 Boats registered. Edisto Island (Kim Iverson, SCDNR pers. comm., 1998).

Beaufort County

In Frogmore there are 8 commercial dealers which are home to over 50 shrimpers. This does not include the many individuals with shrimp boats in their back yards. The dealers primarily handle shrimp but others may also handle crabs and shellfish. There is a large blue crab industry on nearby Lady's Island. There are several commercial seafood dealers in the Port Royal area with over 30 shrimp boats. There are also commercial crabbers, shad fishermen and offshore finfishermen here. There are a small number of charter vessels operating out of this area also. Hilton Head Island primarily caters to the tourist trade. There are several headboats operating on Hilton Head. These boats make half-day trips and night trips for shark fishing. There are four major marinas that offer charter fishing. Commercially, Hilton Head had 4 seafood dealers and approximately 12-15 shrimp boats (Kim Iverson, SCDNR pers. comm., 1998).

Data on personal income from fishing in Table 20 for Beaufort County may have been excluded due to confidentiality issues.

Table 20. Population and Economic Information for Beaufort County, South Carolina. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

		1993	1994	1995
County				
Beaufort				
	Population	94,375	97,293	100,017
	Personal Income (Thousands of $)	2,057,250	2,194,774	2,373,921
	Per Capita Pers Income ($)	21,799	22,558	23,774
	Personal Income Fishing (Thousands of $)	----	----	----

Major fishing tournaments in Beaufort County: 42nd Annual Beaufort County Water Festival Fishing Tournament - June 28. Held in conjunction with the annual Beaufort Water Festival; Hilton Head Kingfish Classic - Schillings Marina, Hilton Head Island. July 10-12. Registration by angler with a total of 49 registered; Dottie Dunbar Women's Tournament - Palmetto Bay Marina, Hilton Head. Women's only multi-species inshore tournament. Total of 49 anglers registered. October 4 (Kim Iverson, SCDNR pers. comm., 1998).

Possible fishing communities in South Carolina: Charleston, Mt. Pleasant, Hilton Head, Port Royal, Frogmore (St. Helena), Bennett's Point, Edisto Beach, Rockville, Folly Beach, Shem Creek, McClellanville, Georgetown Waterfront, Murrell's Inlet, Little River (most of these locations are designated ports of landing)

Counties in South Carolina have seen a general increase in these occupations and industries over the past three decades (Table 21), with the exception of Horry County which has seen a slight decreasing trend.

Table 21. Number within Farm/Fish/Forest Occupation and Agriculture, Fishing, Mining Industry for South Carolina Coastal Counties for 1970, 1980, and 1990 Census. Source: MARFIN Sociodemographic Database

County	**Occupation/Industry**	**1970**	**1980**	**1990**
Horry County	Farm/Fish/Forest	2627	2542	2310
	Agri.,Fishing,Mining	2843	2653	2110
Georgetown County	Farm/Fish/Forest	403	558	597
	Agri.,Fishing,Mining	552	856	690
Charleston County	Farm/Fish/Forest	810	1697	2056
	Agri.,Fishing,Mining	1256	1938	2316
Beaufort County	Farm/Fish/Forest	436	938	966
	Agri.,Fishing,Mining	698	1087	1111
Colleton County	Farm/Fish/Forest	532	614	730
	Agri.,Fishing,Mining	787	705	782

For the Charleston, South Carolina MSA (Table 22) there are 113 individuals who indicated fishing as their year round occupation . Another 102 individuals indicated that it is a part time or seasonal occupation for them. This represents over half of those individuals in South Carolina who indicated the occupation as fishing from Table 15. The Charleston, SC MSA includes Berkely, Charleston and Dorchester counties.

Table 22. Number of Individuals in Occupation of Fishing By Work Status and Gender for the Charleston, SC MSA in 1989. Source: 1990 Census Of Population And Housing.

	Year Round Full Time	Other	Total
Male	102	102	204
Female	11	0	11
Total	113	102	215

4.3.3.1.4 Georgia

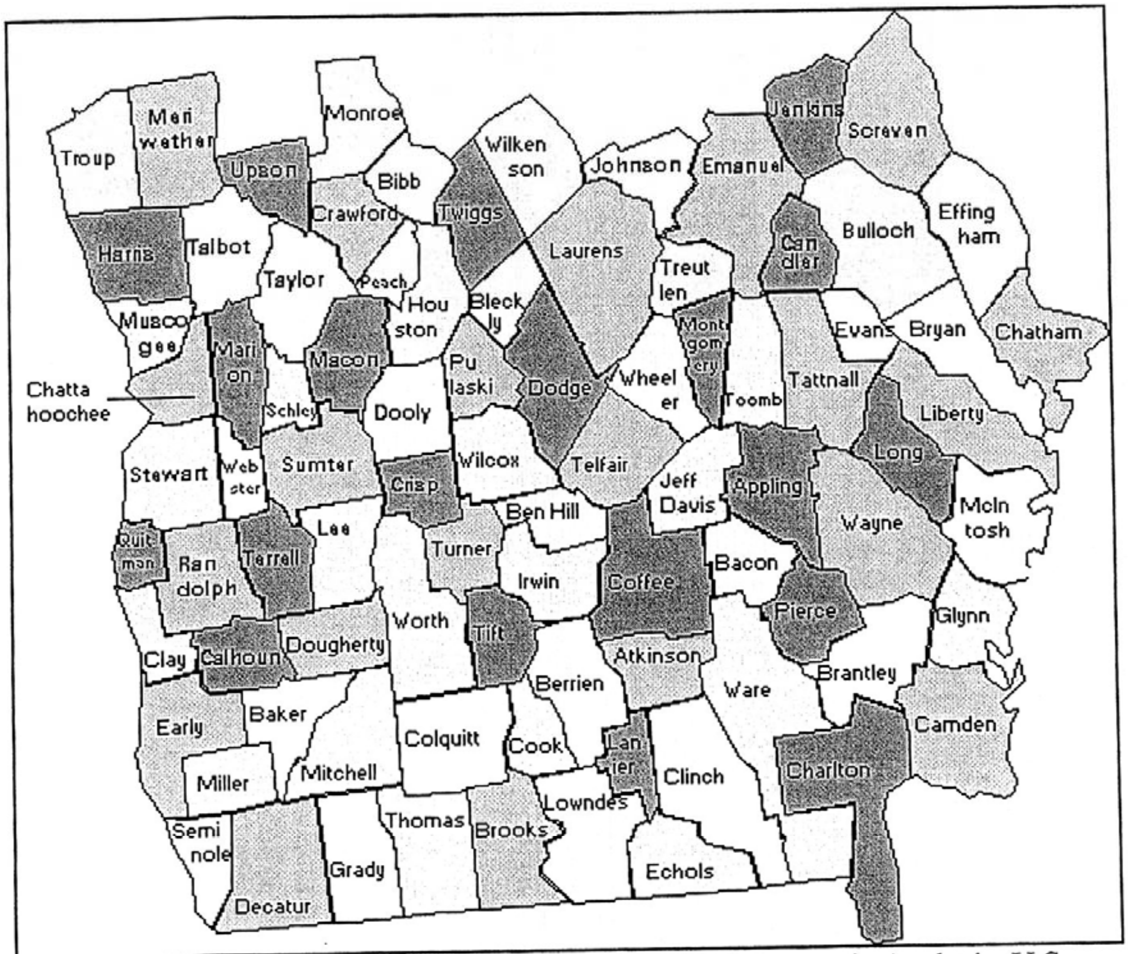


Figure 4. Georgia Coastal Counties. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

The 1990 Census of Population and Housing provides the following information for Georgia regarding individuals who reported their occupation as fisher in Table 23. A total of 536 individuals claimed Fisher as their occupational title with less than half indicating it was a year round full time employment. There were few females who indicated such and they had a far lower mean annual income than males who indicated it was a full time occupation. However, females who indicated it was other than full time had a much higher mean income than any other category. This may be due to a low sample size, however.

Table 23. Number of Fishers and Mean Annual Income for Georgia in 1990. Source: U.S. Bureau of the Census.

	Year Round/Full Time	Other	Total
Number of fishers			
Male	222	295	518
Female	11	7	18
Total	234	302	536
Mean Annual Income ($)			
Male	19,139	11,082	15,058
Female	8,600	25,000	20,080
Total	18,813	12,024	15,308

Shrimping

In their 1975 report, Nix et. al., found a total of 32 commercial docks in six Georgia coastal counties. Those docks and shrimp trawlers were distributed as follows: Camden Co. - 5 docks and 33 trawlers; Glynn Co. - 5 docks and 74 trawlers; McIntosh Co. - 12 docks and 111 trawlers; Liberty Co. - 1 dock and 18 trawlers; Bryan Co. - 1 dock and 2 trawlers; and finally Chatham Co. - 8 docks and 69 trawlers. This information is outdated and certainly does not represent the current status and location of shrimp trawlers in Georgia. However, the report does represent the kinds of information that can be extremely helpful in identifying fishing communities.

Snapper Grouper Fishing

The coast of Georgia contains a small concentration of full-time reef fishermen that fish primarily with bandit reels. Their fishing patterns are similar to those found in SC with vessels fishing from northern Florida north to the SC/NC line (Iverson, 1997).

Possible fishing communities in Georgia: Savannah, Brunswick, St. Marys, Jekyll Island, and Darien.

Table 24. Number of Captains of Fishing Vessels and other officers and Mean Annual Income for Georgia in 1990. Source: U.S. Bureau of the Census.

	Year Round/Full Time	Other	Total
Number of Captains			
Male	17	21	38
Female	0	0	0
Total	17	21	38
Mean Annual Income ($)			
Male	25,706	1,976	12,592
Female	0	0	0
Total	25,706	1,976	12,592

Table 25. Population and Economic Information for Chatham County, Georgia. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Chatham	Population (number of persons)	224,050	225,779	226,554
	Personal income (thousands of dollar	4,569,113	4,810,530	5,087,638
	Per capita personal income (dollars)	20,393	21,306	22,457
	Personal Income Fishing (Thousands of $)	650	(D)	25

Table 26. Population and Economic Information for Bryan County, Georgia. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Bryan				
	Population	18,827	20,008	21,212
	Personal Income (Thousands of $)	274,738	307,258	342,128
	Per Capita Pers Income ($)	14,593	15,357	16,129
	Personal Income Fishing (Thousands of $)	251	359	- - - -

Table 27. Population and Economic Information for Liberty County, Georgia. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Liberty				
	Population	56,625	58,827	58,571
	Personal Income (Thousands of $)	636,042	669,454	709,468
	Per Capita Pers Income ($)	11,233	11,380	12,113
	Personal Income Fishing (Thousands of $)	- - - -	90	97

Table 28. Population and Economic Information for McIntosh County, Georgia. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
McIntosh				
	Population	8,985	9,153	9,372
	Personal Income (Thousands of $)	110,187	116,171	125,645
	Per Capita Pers Income ($)	12,263	12,692	13,406
	Personal Income Fishing (Thousands of $)	3,619	4,486	- - - -

Table 29. Population and Economic Information for Glynn County, Georgia. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Glynn				
	Population	64,759	64,956	65,450
	Personal Income (Thousands of $)	1,322,745	1,400,544	1,505,337
	Per Capita Pers Income ($)	20,426	21,558	23,000
	Personal Income Fishing (Thousands of $)	328	343	351

Table 30. Population and Economic Information for Camden County, Georgia. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Camden				
	Population	39,712	41,262	40,819
	Personal Income (Thousands of $)	502,639	542,385	556,622
	Per Capita Pers Income ($)	12,657	13,145	13,636
	Personal Income Fishing (Thousands of $)	1,889	2,431	2,484

Georgia coastal counties have seen a general increase in these occupations and industries with the exception of Liberty County which has shown a decrease from 1970-1990.

Table 31. Number within Farm/Fish/Forest Occupation and Agriculture, Fishing, Mining Industry for Georgia Coastal Counties for 1970, 1980, and 1990 Census. Source: MARFIN Sociodemographic Database

County	Occupation/Industry	1970	1980	1990
Bryan County	Agri.,Fishing,Mining	161	100	200
	Farm/Fish/Forest	121	135	136
Chatham County	Agri.,Fishing,Mining	558	686	1103
	Farm/Fish/Forest	228	704	1062
Liberty County	Agri.,Fishing,Mining	332	146	152
	Farm/Fish/Forest	242	205	157
McIntosh County	Agri.,Fishing,Mining	233	266	169
	Farm/Fish/Forest	27	260	193
Glynn County	Agri.,Fishing,Mining	261	482	593
	Farm/Fish/Forest	84	581	712
Camden County	Agri.,Fishing,Mining	209	126	176
	Farm/Fish/Forest	106	110	205

4.3.3.1.5 Florida

Florida's eastern coastline is made up largely of metropolitan counties. This is primarily due to the increases in population for Florida's coastal counties over the past 50 years. Florida's coastline has become a very popular retirement destination and tourist attraction. Because they are largely metropolitan, fishing communities here may be subsumed into these larger metropolitan areas and difficult to identify. Data presented from the most recent Census will also show that in relation to the larger economy, fishing will contribute very little at the county level for most coastal counties. Over the years, with the demographic changes following the inmigration of retirees and tourists and the subsequent economic transition, few fishing communities will have survived as distinct communities.

The data presented in Table 32 shows Florida as having almost 6,000 individuals claiming fisher as their occupation in the 1990 census; 381 of those individuals were female. Mean annual income is highest for those reporting fishing as a full time occupation with women reporting a lower mean annual income in all categories.

Table 32. Number of Fishers and Mean Annual Income for Florida in 1990. Source: U.S. Bureau of the Census.

	Year Round/Full Time	Other	Total
Number of fishers			
Male	2,698	2,844	5,544
Female	111	270	381
Total	2,809	3,116	5,925
Mean Annual Income ($)			
Male	23,288	11,794	17,388
Female	17,285	11,511	13,193
Total	23,051	11,770	17,118

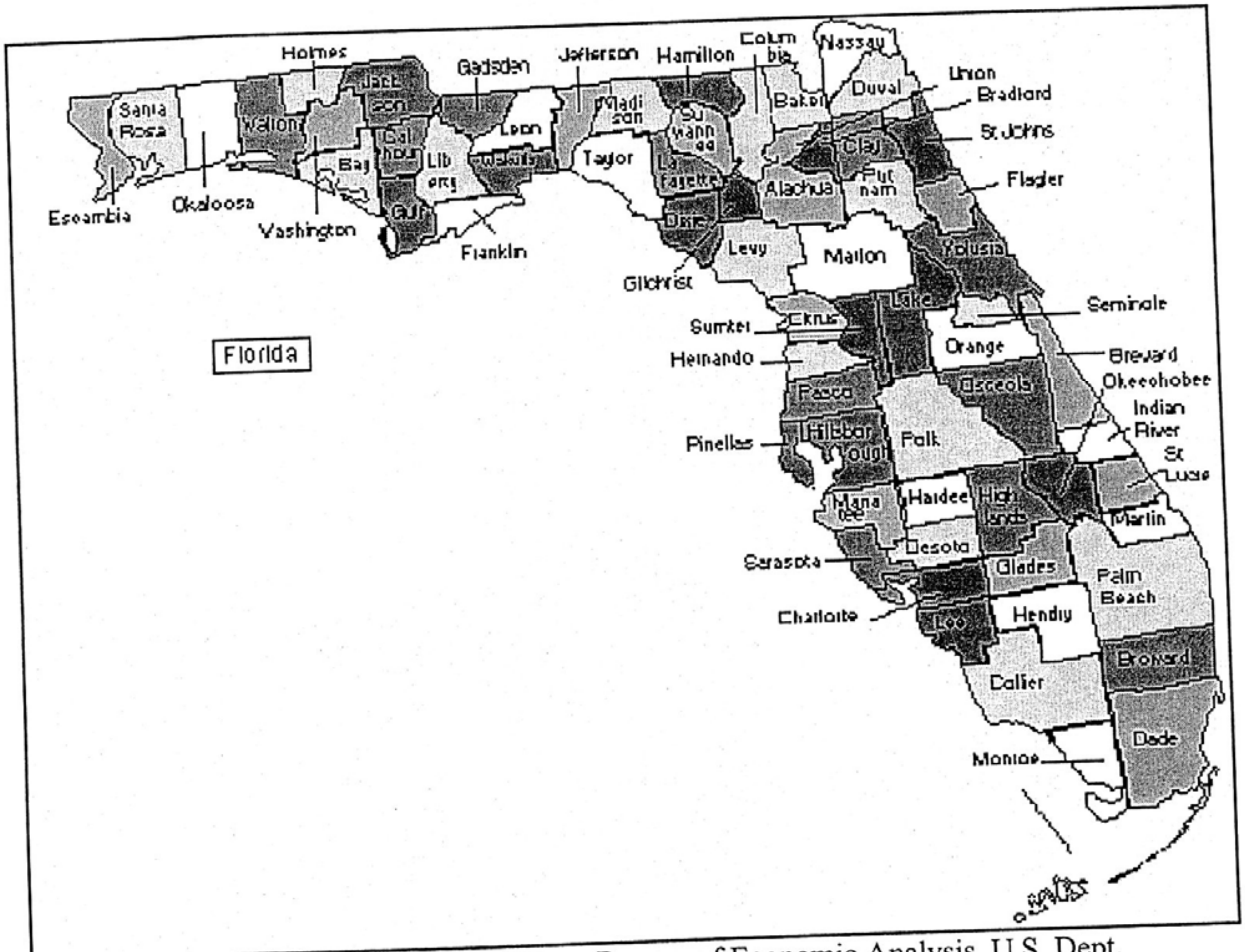


Figure 5. Florida Coastal Counties. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

There were over 1100 individuals from Florida who reported their occupation as captain of a fishing vessel during the 1990 census, with 51 of them being female (Table 33). Again, mean annual income was highest for full time workers and females reported lower mean annual income for both full time and other work.

Table 33. Number of Captains of Fishing Vessels and other officers and Mean Annual Income for Florida in 1990 Source: U.S. Bureau of the Census.

	Year Round/Full Time	Other	Total
Number of Captains			
Male	430	633	1,063
Female	26	25	51
Total	456	658	1,114
Mean Annual Income ($)			
Male	25,993	21,274	23,183
Female	8,487	15,420	11,885
Total	24,995	21,052	22,666

Nassau County (Table 34) showed an increase in personal income from fishing over the time period from 1993 to 1995 which reflects the general increase in population and personal income overall for the county.

Table 34. Population and Economic Information for Nassau County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Nassau				
	Population	48,355	49,565	50,717
	Personal Income (Thousands of $)	954,342	1,003,920	1,089,793
	Per Capita Pers Income ($)	19,736	20,255	21,488
	Personal Income Fishing (Thousands of $)	1,540	1,918	2,068

Duval County (Table 35) shows slow growth in population over the three years listed, but does show growth in personal income from fishing from 1993 to 1994. There was a slight decrease in personal income from fishing reported from 1994 to 1995.

Table 35. Population and Economic Information for Duval County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Duval				
	Population	701,267	703,152	705,014
	Personal Income (Thousands of $)	14,111,822	14,724,897	15,748,121
	Per Capita Pers Income ($)	20,123	20,941	22,337
	Personal Income Fishing (Thousands of $)	2,272	3,658	3,335

St John's County (Table 36) had some growth in personal income from fishing from 1993 to 1994 but no data were available for 1995 to indicate whether that trend continued.

Table 36. Population and Economic Information for St. John's County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
St. Johns				
	Population	94,480	98,377	101,966
	Personal Income (Thousands of $)	2,394,764	2,612,557	2,869,300
	Per Capita Pers Income ($)	25,347	26,557	28,140
	Personal Income Fishing (Thousands of $)	432	502	----

According to Table 37, Flagler County had no individuals reporting personal income from fishing for the time period 1993 to 1995. Volusia County also has no personal income from fishing listed in Table 38, but data were not included due to confidentiality issues.

Table 37. Population and Economic Information for Flagler County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Flagler				
	Population	35,868	37,894	40,260
	Personal Income (Thousands of $)	571,528	631,959	692,269
	Per Capita Pers Income ($)	15,934	16,677	17,195
	Personal Income Fishing (Thousands of $)	0	0	0

Table 38. Population and Economic Information for Volusia County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Volusia				
	Population	397,372	405,515	410,115
	Personal Income (Thousands of $)	6,845,402	7,235,060	7,772,063
	Per Capita Pers Income ($)	17,227	17,842	18,951
	Personal Income Fishing (Thousands of $)	----	----	----

Indian River County saw an increase in personal income from fishing from 1993 to 1994 according to Table 39, but saw a decrease from 1994 to 1995. St. Lucie County (Table 40) may have had a similar trend although data from 1993 are missing and the trend is not clear.

Table 39. Population and Economic Information for Indian River County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Indian River				
	Population	94,184	95,374	96,263
	Personal Income (Thousands of $)	2,686,514	2,827,427	3,065,533
	Per Capita Pers Income ($)	28,524	29,646	31,845
	Personal Income Fishing (Thousands of $)	1,340	1,826	1,707

Table 40. Population and Economic Information for St. Lucie County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
St. Lucie				
	Population	165,120	169,284	171,914
	Personal Income (Thousands of $)	2,719,602	2,840,752	3,051,018
	Per Capita Pers Income ($)	16,470	16,781	17,747
	Personal Income Fishing (Thousands of $)	----	1,855	1,303

Table 41. Population and Economic Information for Broward County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce

County		1993	1994	1995
Broward				
	Population	1,353,279	1,358,585	1,412,942
	Personal Income (Thousands of $)	32,716,045	34,273,950	37,007,667
	Per Capita Pers Income ($)	24,175	24,736	26,192
	Personal Income Fishing (Thousands of $)	658	816	- - - -

The trend in personal income from fishing for Broward County is not clear as data from 1995 are missing from Table 41 because of confidentiality. Brevard County (Table 42) shows a decrease in personal income from fishing during 1994 to 1995, but overall shows a much larger percentage of personal income coming from fishing than most counties previous.

Table 42. Population and Economic Information for Brevard County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Brevard				
	Population	435,546	443,337	450,238
	Personal Income (Thousands of $)	8,564,204	8,938,218	9,341,030
	Per Capita Pers Income ($)	19,663	20,161	20,747
	Personal Income Fishing (Thousands of $)	3,600	4,690	3,797

Martin County has one of the highest per capita incomes reported over the three year period according to Table 43. There was also a significant increase in personal income from fishing from 1993 to 1994 which decreased in 1995. Palm Beach County, with an even higher per capita income, showed an increase in personal income from fishing from 1993 to 1994 with no data available for 1995 (Table 44).

Table 43. Population and Economic Information for Martin County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Martin				
	Population	107,238	109,194	110,495
	Personal Income (Thousands of $)	3,406,064	3,521,665	3,815,294
	Per Capita Pers Income ($)	31,762	32,251	34,529
	Personal Income Fishing (Thousands of $)	270	1,658	819

Table 44. Population and Economic Information for Palm Beach County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Palm Beach				
	Population	933,644	957,522	976,358
	Personal Income (Thousands of $)	30,994,531	32,423,719	35,204,121
	Per Capita Pers Income ($)	33,197	33,862	36,057
	Personal Income Fishing (Thousands of $)	1,464	1,902	- - - -

Dade County shows a steady growth in personal income from fishing for the time period listed in Table 45. Monroe County shows, by far, the highest personal income from fishing for any Florida county and most likely any county in the South Atlantic according to Table 46.

Table 45. Population and Economic Information for Dade County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Dade				
	Population	1,985,373	2,011,571	2,046,078
	Personal Income (Thousands of $)	39,110,301	40,344,476	43,087,320
	Per Capita Pers Income ($)	19,699	20,056	21,058
	Personal Income Fishing (Thousands of $)	1,247	1,479	1,897

Table 46. Population and Economic Information for Monroe County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Monroe				
	Population	81,737	81,461	81,152
	Personal Income (Thousands of $)	1,982,209	2,054,326	2,208,152
	Per Capita Pers Income ($)	24,251	25,219	27,210
	Personal Income Fishing (Thousands of $)	13,506	15,558	16,723

Recently, data were compiled from the last three census and placed into a user friendly interface through a MARFIN grant by the Louisiana Population Data Center, Louisiana State University (C. M. Tolbert, et al. 1998). Those data provide a time series of information from the last three census with the ability to compare several variables at the state,. county and place level. Census places are incorporated and Census designated places of 2500 or more persons. The tables presented below incorporate the data included in the MARFIN SocioDemographic Database for the coastal counties outlined above with a focus on the occupational classification of Farm/Fish/Forest and the industry classification of Agriculture, Fishing, and Mining. These classifications are inclusive of those within the occupation and industry of fishing, but not exclusive of others, therefore it is difficult to know the exact number of individuals who have indicated their occupation or business is fishing. We can only assume that whatever trend appears over the time corresponds to the occupation of fishing as well as the others.

Data covering Metropolitan Statistical Areas are provided because it includes a more detailed occupational breakdown, but unfortunately geographic boundaries expand as most MSAs encompass more than one county. In some cases, MSAs were not used because the area covered did not correspond with the coastal areas within the South Atlantic region. As mentioned earlier, these data are what is currently available. Further analysis is constrained by variety of issues relating to data computability and availability at each place level of analysis. As mentioned before more research on fishing communities will be required before a more complete definition and identification can be accomplished.

Examining census data at the level of Metropolitan Statistical area reveals greater detail for occupation, but the scale changes as MSAs often times encompass more than one county. Metropolitan area (MA) is a large population nucleus, together with adjacent communities that have a high degree of economic and social integration with that nucleus. Metropolitan Areas must contain either a place with a minimum population of 50,000 or a Census Bureau-defined urbanized area and a total MA population of at least 100,000. An MA comprises one or more central counties and also may include one or more outlying counties that have close economic and social relationships with the central county. Metropolitan statistical areas (MSA's) are relatively freestanding MA's and are not closely associated with other MA's. These areas typically are surrounded by nonmetropolitan counties. See Appendix ?? for details on the parameters for the coastal MSAs included in this discussion.

When you look at the occupations of farming, fishing and forestry for Florida coastal counties in Table 47, over the past 20 years there is, in general, a steady increase in the number of individuals within these occupations and industries.

Table 47. Number within Farm/Fish/Forest Occupation and Agriculture, Fishing, Mining Industry for East Florida Coastal Counties from 1970, 1980, and 1990 Census. Source: MARFIN Sociodemographic Database

County	Occupation/Industry	1970	1980	1990
Nassau County	Farm/Fish/Forest	371	427	559
	Agri.,Fishing,Mining	501	462	606
Duval County	Farm/Fish/Forest	1237	2782	3729
	Agri.,Fishing,Mining	2536	2959	4324
St.Johns County	Farm/Fish/Forest	794	813	1002
	Agri.,Fishing,Mining	1012	883	976
Flagler County	Farm/Fish/Forest	145	314	408
	Agri.,Fishing,Mining	186	298	403
Volusia County	Farm/Fish/Forest	1308	3150	4917
	Agri.,Fishing,Mining	2511	3407	5606
Indian River County	Farm/Fish/Forest	991	1907	2042
	Agri.,Fishing,Mining	1454	2361	2217
St. Lucie County	Farm/Fish/Forest	2602	2710	3147
	Agri.,Fishing,Mining	3253	3252	3342
Broward County	Farm/Fish/Forest	1982	7358	9425
	Agri.,Fishing,Mining	5354	7756	10317
Brevard County	Farm/Fish/Forest	764	1772	3369
	Agri.,Fishing,Mining	1394	2279	3585
Martin County	Farm/Fish/Forest	964	1838	1983
	Agri.,Fishing,Mining	1268	2032	2086
Palm Beach County	Farm/Fish/Forest	6552	9676	13261
	Agri.,Fishing,Mining	9791	11780	15155
Dade County	Farm/Fish/Forest	4804	11257	14894
	Agri.,Fishing,Mining	9682	13708	16926
Monroe County	Farm/Fish/Forest	163	1769	1729
	Agri.,Fishing,Mining	920	1932	1860

The following table includes only those individuals who reported their occupation as fishing for the following Metropolitan Statistical Areas (MSA) within Florida.

Table 48. Number of Individuals in Occupation of Fishing By Work Status and Gender for Florida MSA in 1989. Source: 1990 Census Of Population And Housing.

Jacksonville		Year Round Full Time	Other	Total
	Male	151	210	361
	Female	15	49	64
	Total	166	259	425
West Palm Beach		Year Round Full Time	Other	Total
	Male	94	47	141
	Female	0	0	0
	Total	94	47	141
Miami		Year Round Full Time	Other	Total
	Male	254	254	508
	Female	0	30	0
	Total	254	284	538

Snapper Grouper Fishery Profile

Concentrations of reef fishermen can be found in the communities of Mayport, Port Orange and New Smyrna, north of Cape Canaveral. Bandit reels are the primary gear used for reef fishing in these areas, although a few bottom longline vessels are present. In northern Florida, bandit fishermen report trips lasting 5-6 days and fish 30-50 miles offshore. They average between 2 to 3 crew members depending on vessel size and gear. Vessels from the Mayport area reported fishing from the Georgia line south to the Daytona area. The larger longline vessels are required by regulations to fish past the 50 fathom line and reported trip lengths of up to 10 days, fishing as far as 100 miles from shore. These bottom long line vessels fish for deep water species such as tilefish in water 600 - 900' deep (Iverson, 1997).

King Mackerel Fishery Profile

McKenna (1994) identified the number of fishermen in Florida reporting landings of king mackerel (based on Saltwater Products Licenses) from 1987 to 1993 as varying from 1,500 to 2,222. From 1986 to 1990 the number of commercial permits for Atlantic migratory group king mackerel ranged from a high of 888 in 1989/90 fishing season to low of 785 in the 1987/88 fishing year. The percentage of those permits which were hook and line fishermen for those years ranged from 89% in 86/87 to 78% in 1990. There were 1654 vessels permitted for commercial king mackerel and Spanish mackerel in Florida for the 1993-94 fishing year. The number of permitted vessels was divided with 846 and 808 allocated to the East and West coasts respectively. How many of those vessels landed king mackerel is unknown at this time. Catch per unit of effort data seems fairly consistent for the southeastern region of the Atlantic group king mackerel with an average CPUE of between 200-300 lbs/trip (McKenna, 1994). Most of the commercial landings of Atlantic group king mackerel are made by hook and line fishermen. In addition, because most landings of Atlantic group king mackerel are in Florida and the most information that exists is on the Florida fishery, the following description will focus primarily on the Florida fishery unless noted otherwise.

King Mackerel Hook and Line Fleet

There were approximately 203 full and part time vessels in the hook and line mackerel fleet in 1980. Vessel size ranged from 22-44 feet in length. Today, the Florida South Atlantic troll fishery is composed of about 100 full-time and 100 part-time operations, about 150 of them are dependent upon king mackerel. Full-time fishermen operate primarily out of Jupiter, Port Salerno, Fort Pierce, Sebastian, and Rivera Beach. Normally, there is one fisherman to a boat. Part-time fishermen operate mostly out of Palm Beach, frequently two or three fishermen per boat. Approximately 40 percent of the full time trollers switch to bottom fishing for various reef fish after the Gulf king mackerel season. The remainder of these full time trollers tie up their boats when the Gulf king mackerel season ends. Some engage in various non-fishing jobs, while the majority reportedly wait for the opening of the Atlantic king mackerel season (GMFMC & SAFMC, 1994).

During the peak season about 75 to 100 troll vessels and 16 to 20 net vessels target king mackerel in the Keys. Net vessels usually start fishing late December, although some of these vessels troll for mackerel before net fishing becomes more practicable. Most king mackerel fishermen in the Keys target other species such as stone crab, spiny lobster, and reef fish throughout the year.

King Mackerel Net Fishing Fleet

There were approximately 89 large gill net vessels in Florida including full and part time in 1980. The vessels ranged in size from 30-65 feet. These vessels fished Spanish and king mackerel during the winter, but also targeted lobster, swordfish and bait fish during other times of the year. Vessels over 40 feet usually employed a power roller to haul nets. The large gill net fleet was primarily located from Florida's central east coast in Ft. Pierce, throughout the Florida Keys to the central west coast as far north as Cortez. There were also a few large boats in the Panhandle area of Port St. Joseph (Centaur Associates, 1981).

Approximately 87% of captains in the large gill net fleet at that time depended entirely upon fishing for their income. Net fishermen, then as they do today, have the options of participating in the Spanish mackerel fishery, trolling for king mackerel, and fishing with nets or hook and line for Atlantic group king mackerel after March (Centaur Associates 1981).

Today, there are twelve large net boats located in the Keys that may fish Atlantic group king mackerel occasionally. These vessels have a capacity of up to 40,000 pounds per trip and have had large catches of king mackerel in the past. There does not seem to be a small gill net boat sector for Atlantic king mackerel. In Monroe County there are 16 to 20 large net boats currently participating in the king mackerel fishery, some with capacity to land up to 50,000 pounds. There are another 6 to 12 small net boats in south-west Florida ready to enter the fishery when the opportunity arises. These vessels are 30 to 40 feet in length with capacities of 5,000 to 10,000 pounds.

There has been a general decline in net catches along the Florida east coast. This may be attributed to regulations like the prohibition of drift nets and purse seines, but also stems from the recent net ban in Florida state waters.

King Mackerel Dealers

McKenna (1994) identified over 200 dealers in Florida who had handled king mackerel since 1987. In 1992 there were 240 who reported landings of king mackerel. Most of those dealers purchased king mackerel ten or fewer times per season and handled less than 5000 pounds. There were over twenty dealers who handled 100,000 pounds or more during the 1992 season (McKenna, 1994) .

Possible fishing communities in Florida: Mayport, Port Orange, New Smyrna, Sebastian, Port Salerno, Rivera Beach, Ft. Pierce, Jupiter, West Palm Beach, Boyton Beaches, The Keys -- Upper Keys: Key Largo, Tavernier; Middle Keys - Islamorada, Marathon; Lower Keys; and Key West.

4.3.3.1.6 Other Community related Analysis

In a recent survey of snapper grouper fishermen in the South Atlantic questions were posed concerning a fishermen's tenure within a community and attitudes towards community change. The results in Table 49 show that the majority of fishermen feel their community has stayed the same or has changed for the better. A larger percentage of inactive than active snapper grouper fishermen feel that their community has changed for the worse. Well over half of fishermen interviewed had been in their present community for twenty years or more. Over sixty percent of inactive fishermen have lived in their community for twenty years or more, while over fifty percent of active fishermen have lived in their communities for 19 years or less. The mean number of years a fishermen had resided in their present community was twenty years or more for North Carolina, South Carolina and Florida. In comparison Georgia snapper grouper fishermen had an average tenure in their communities of 6.5 years. This may be an artifact of the small sample size in Georgia as only seven fishermen from that state were interviewed, but could also be reflective of the nature of snapper grouper fishing in Georgia (Rhodes et al., 1997).

Table 49. Snapper Grouper Fishermen's Tenure and Attitude toward Change in their Present Community. Source: Socio-demographic Assessment of Commercial Reef Fishermen in the South Atlantic Region. 1997.

	Active (%)	Inactive (%)
Feel Your Community has changed?	(N=201)	(N=26)
For the better	41.8	30.8
For the worse	32.1	46.2
Stayed the same	25.9	23.1
	Active (Yrs)	Inactive (Yrs)
Number of Years in Present Community?	(N=201)	(N=26)
2-12	27.6	25.9
13-19	32.0	11.1
20-35	19.5	33.4
36 <	20.9	29.6

These perspectives on an individual's feelings toward a community become important when that person must face significant changes regarding his/her occupation, as is often the case when limited entry or some other form of fisheries management is implemented. An individual's commitment toward their community and sense of belonging will influence decisions on whether to stay in fishing or within a particular community. The impacts become important for the community if many individuals face the same decision. When active fishermen were asked what is the likelihood of moving to a new town in the next 2-3 years most responded that it is was unlikely, however, over 27% indicated they were not sure or it was likely. When both inactive and active fishermen were asked the likelihood of leaving commercial fishing altogether 46% of inactive fishermen said it was likely or very likely, while only 11% of active fishermen indicated such a likelihood. (Rhodes et al., 1997). These type of data at the community level would contribute much to the understanding of possible impacts of future fisheries management.

4.3.3.1.7 Data Needs

As mentioned earlier, the data presented here is what is currently available and readily accessible. It is very limiting and does not provide a sufficient amount of detail needed to define and identify fishing communities. Therefore, the likelihood of realistic impact assessment of future fishing regulations on fishing communities is not good.

At the present the NMFS does not collect data on fishing communities. Therefore, it is impossible to realistically identify fishing communities in this amendment. There is a tremendous need for research to be conducted on a continuous basis to collect this information. Both state and federal government agencies have access to current information which can inform the process of identifying fishing communities. Permit databases for fishing licenses, wholesale and retail licenses, boat registrations, marina permits, boat landing locations, and many others exist now. Putting that information into one database is a monumental task, but should be undertaken soon. Geographic Information System software is now available and being used to compile much of the data regarding habitat. The same type of databases need to be created regarding fishing communities. Spatial analysis of the variables that help identify and define fishing communities can give useful insight into the changes that affect these coastal communities.

It is unlikely that Council Staff would be able to gather these data. Council staff have in the past, with the cooperation of industry, been able to gather important information about a particular fishery, but were criticized for not following OMB guidelines. The difficulty with following OMB guidelines is that approval of data gathering tools is too time consuming. Councils are often on a timeline to develop FMPs which does not allow for a lengthy approval process. The South Atlantic Council staff has sufficient expertise with this type of data collection that design, implementation and analysis can often take place during an extremely short time period with little burden upon the public. In fact, industry is often eager to provide these type of data for consideration during development of an FMP, but don't have the expertise to offer data a form that can be used by Council staff.

Data collection is critical to the future of impact assessment of fishing communities. Standards must be set and data need to be collected. At present, the ACCSP is attempting to set those standards and has included social and economic data in that program. The ACCSP Technical Source Document IV contains detailed social and economic data needs and draft survey instruments. Social and economic data collection projects should at least collect the minimum data elements. Support of ACCSP can be an important step in meeting the future needs of the councils with regard to fishing communities. In addition, another guideline for the types of data needed can be found in the Southeast Social and Cultural Data Analysis Plan (NMFS, 1994). The plan was designed to address many of the current social and cultural information needs for the three councils in the Southeast."

4.0 ECOSYSTEM CONSIDERATIONS

4.1 Introduction

As a result of the Sustainable Fisheries Act Amendment to the Magnuson-Stevens Fishery Conservation and Management Act in 1996 the Councils and the NMFS have been mandated to use an ecosystem approach in managing the Nation's Fisheries. The Council has taken the first step with the submission of the Habitat Plan identifying and describing in detail essential fish habitat (EFH) for species managed throughout the South Atlantic and with the submission of the Comprehensive Habitat Amendment amending all existing FMP's to include descriptions of EFH and EFH-habitat areas of particular concern (EFH-HAPCs). By including an Ecosystems Considerations section in the required SAFE reports, existing data regarding the effects of a fishery on the ecosystem will be provided to the Council on a species by species basis while emphasizing the need for a new level of information. This section will also provide a forum in which to express ecosystem concerns for a specific fishery. In addition to receiving information from the National Marine Fisheries Service and Habitat Advisory Panel, anecdotal information concerning ecosystem issues has also been gathered through discussions with the Dolphin and Wahoo Advisory Panel and other people familiar with the fishery and has been included in this section.

While incorporating ecosystem concerns into stock assessment reports is a new approach for this Council, this approach has been taken by the North Pacific Fishery Management Council for several years. A copy of their ecosystems chapter has been included as Appendix E and is an example of the way the ecosystem approach can be used in annual SAFE reports. Another supporting document detailing new ideas and approaches to holistic management is the report to Congress from the Ecosystem Principles Advisory Panel of the NMFS (Appendix F), appointed by the National Academy of Sciences. Congress charged NMFS with establishing this panel to assess the extent that ecosystem principles are used in fisheries management and research and to recommend how such principles can be used to improve our Nation's management of living marine resources.

Ecosystem considerations presented in the interim final rule to implement the essential fish habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act).

Overview of EFH FMP Amendment Guidelines

The themes of sustainability and risk-averse management are prevalent throughout the Magnuson-Stevens Act, both in the management of fishing practices (e.g., reduction of bycatch and overfishing and consideration of ecological factors in determining optimum yield [OY]) and in the protection of habitats (i.e., prevention of direct and indirect losses of habitats, including EFH). Management of fishing practices and habitat protection are both necessary to ensure long-term productivity of our Nation s fisheries. Mitigation of EFH losses and degradation will supplement the traditional management of marine fisheries. Councils and managers will be able to address a broader range of impacts that may be contributing to the reduction of fisheries resources. Habitats that have been severely altered or impacted may be unable to support populations adequately to maintain sustainable fisheries. Councils should recognize that fishery resources are dependent on healthy ecosystems; and that actions that alter the ecological structure and/or functions within the system can disturb the health or integrity of an ecosystem. Excess disturbance, including over-harvesting of key components (e.g., managed species) can alter ecosystems and reduce *their productive capacity. Even though traditional fishery management and FMPs have been mostly based on yields of single-species or multi-species stocks, these regulations encourage a broader, ecosystem approach to meet the EFH requirements of the Magnuson-Stevens Act. Councils should strive to understand the ecological roles (e.g., prey, competitors, trophic links within food webs, nutrient transfer between ecosystems, etc.) played by managed species within their ecosystems. They should protect, conserve, and enhance adequate quantities of EFH to support a fish population that is capable of fulfilling all of those other contributions that the managed species makes to maintaining a healthy ecosystem as well as supporting a sustainable fishery. Councils must identify in FMPs the habitats used by all life history stages of each managed species in their fishery management units (FMUs). Habitats that are necessary to the species for spawning, breeding, feeding, or growth to maturity will be described and identified as EFH. These habitats must be described in narratives (text and tables) and identified geographically (in text and maps) in the FMP. Mapping of EFH maximizes the ease with which the information can be shared with the public, affected parties, and Federal and state agencies to facilitate conservation and consultation. EFH that is judged to be particularly important to the long-term productivity of populations of one or more managed species, or to be particularly vulnerable to degradation, should be identified as "habitat areas of particular concern" (HAPC) to help provide additional focus for conservation efforts. After describing and identifying EFH, Councils must assess the potential adverse effects of all fishing-equipment types on EFH and must include management measures that minimize adverse effects, to the extent practicable, in FMPs. Councils are also directed to examine non-fishing sources of adverse impacts that may affect the quantity or quality of EFH and to consider actions to reduce or eliminate the effects.*

(ii) EFH determination.
(E) Ecological relationships among species and between the species and their habitat require, where possible, that an ecosystem approach be used in determining the EFH of a managed species or species assemblage. The extent of the EFH should be based on the judgment of the Secretary and the appropriate Council(s) regarding the quantity and quality of habitat that is necessary to maintain a sustainable fishery and the managed species' contribution to a healthy ecosystem.

(11) Review and revision of EFH components of FMPs.
This information should be reviewed as part of the annual Stock Assessment and Fishery Evaluation (SAFE) report prepared pursuant to § 600.315(e).

4.2. Essential Fish Habitat and Essential Fish Habitat -Habitat Areas of Particular Concern Designations

Essential Fish for Coastal Migratory Pelagics:

Essential fish habitat for coastal migratory pelagic species includes sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, but from the Gulf stream shoreward, including *Sargassum*. In addition, all coastal inlets, all state-designated nursery habitats of particular importance to coastal migratory pelagics (for example, in North Carolina this would include all Primary Nursery Areas and all Secondary Nursery Areas).

For Cobia essential fish habitat also includes high salinity bays, estuaries, and seagrass habitat. In addition, the Gulf Stream is an essential fish habitat because it provides a mechanism to disperse coastal migratory pelagic larvae.

For king and Spanish mackerel and cobia, essential fish habitat occurs in the South Atlantic and Mid-Atlantic Bights.

Essential Fish Habitat - Habitat Areas of Particular Concern for Coastal Migratory Pelagics

Areas which meet the criteria for essential fish habitat-habitat areas of particular concern (EFH-HAPCs) include sandy shoals of Cape Lookout, Cape Fear, and Cape Hatteras from shore to the ends of the respective shoals, but shoreward of the Gulf stream; The Point, The Ten-Fathom Ledge, and Big Rock (North Carolina); The Charleston Bump and Hurl Rocks (South Carolina); The Point off Jupiter Inlet (Florida); *Phragmatopoma* (worm reefs) reefs off the central east coast of Florida; nearshore hard bottom south of Cape Canaveral; The Hump off Islamorada, Florida; The Marathon Hump off Marathon, Florida; The "Wall" off of the Florida Keys; Pelagic *Sargassum*; and Atlantic coast estuaries with high numbers of Spanish mackerel and cobia based on abundance data from the ELMR Program. Estuaries meeting this criteria for Spanish mackerel include Bogue Sound and New River, North Carolina; Bogue Sound, North Carolina (Adults May-September salinity >30 ppt); and New River, North Carolina (Adults May-October salinity >30 ppt). For Cobia they include Broad River, South Carolina; and Broad River, South Carolina (Adults & juveniles May-July salinity >25ppt).

These areas include spawning grounds and habitats where eggs and larvae develop. In addition, the estuarine habitats also provide prey species along migration pathways.

4.3 Description of Habitat

Description of the Species and Distribution

Dolphin are fast aggressive predators that feed on actively swimming fish (MMS 1990). Fish are the most important items in the diet, becoming increasingly important as dolphin grow from 300 mm (12 in) to 1,500 mm (59 in). Flyingfish are important in the diet of adult common dolphin. Flyingfishes appear to be especially important in the diet of large dolphin; fish and invertebrates on *Sargassum* appers to be most important to small female dolphin. In general, many dolphin prey are associated with *Sargassum*, and most of the fishes that were found associated with *Sargassum* in the Florida Current are eaten by dolphin (MMS 1990). Dolphin probably spend a relatively large amount of time feeding on small animals associated with *Sargassum* because, although adapted for fast short-range pursuit, dolphin lack the adaptation of fishes such as tunas for long-range pursuit of prey. Dolphin in the Gulf Stream ate 32 species of fishes. Additional food included the crab *Portunis sayi* (common in *Sargassum*), shrimp, and cephalopods. Although *Sargassum* appears frequently in dolphin stomachs, it is probably ingested incidentally with assiciated small fishes and crustaceans. Off Cape Hatteras, most fish in the diet were those typically associated with *Sargassum*. The most frequently found genera wre *Hippocampus* (seahorse), *Monacanthus* (filefish), and *Aluterus* (filefish). Other prey of dolphin include balistids and fast moving fishes such as Spanish mackerel and carangids, and at night perhaps mesopelagic fishes. The presence of other smaller dolphins in the diet indicates cannibalism, and smaller dolphin may find shelter in *Sargassum* from predators, including their own species (MMS 1990).

Wahoo

Habitats Identified in the Habitat Plan Which Constitute the Ecosystem Used by Managed Species including Dolphin and Wahoo

A. Marine/Offshore Essential Fish Habitat

"3.2.3 Pelagic Habitat

3.2.3.1 Sargassum Habitat

3.2.3.1.1 Description of Sargassum Habitat

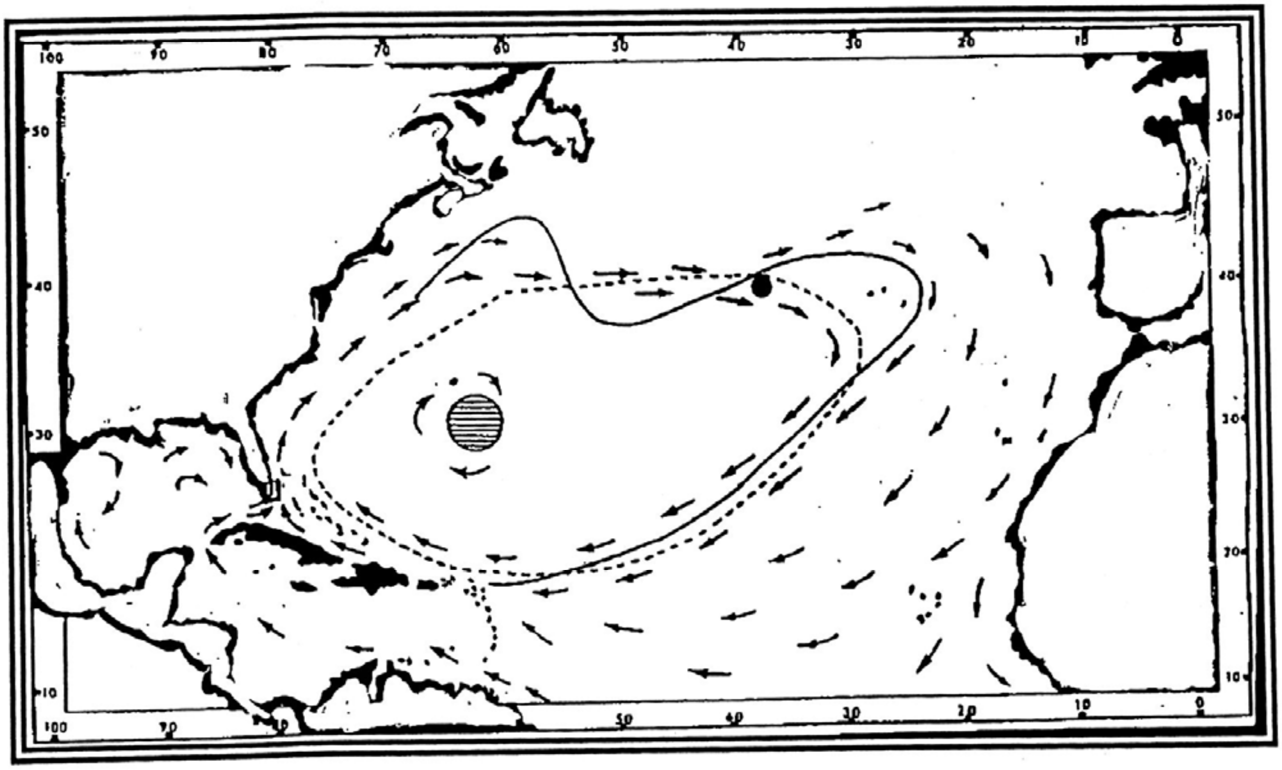
Within warm waters of the western North Atlantic, pelagic brown algae *Sargassum natans* and *S. fluitans* (Phaeophyta: Phaeophyceae: Fucales: Sargassaceae) form a dynamic structural habitat. These holopelagic species are believed to have evolved from benthic ancestors at least 40 million years ago. Evidence supporting this contention include: 1) lack of sexual reproduction characteristic of benthic species, 2) absence of a basal holdfast, 3) endemic faunal elements (10 invertebrates and 2 vertebrates), 4) greater buoyancy than benthic forms, and 5) late Eocene to early Miocene fossil remains from the Carpathian basin of the Tethys Sea (Winge, 1923; Parr, 1939; Friedrich, 1969; Butler et al., 1983; Stoner and Greening, 1984, Luning, 1990). *Sargassum natans* is much more abundant than *S. fluitans*, comprising up to 90% of the total drift macroalgae in the Sargasso Sea. Limited quantities of several benthic species, including *S. filipendula, S. hystrix, S. polycertium, S. platycarpum* and *S. pteropleuron*, detached from coastal areas during storms, are also frequently encountered adrift. However, the drifting fragments of these benthic species soon perish (Hoyt, 1918; Winge, 1923; Parr, 1939; Butler et al., 1983).

The pelagic species are golden to brownish in color and typically 20 to 80 cm in diameter. Both species are sterile and propagation is by vegetative fragmentation. The plants exhibit complex branching of the thallus, a lush foliage of lancolate to linear serrate phylloids and numerous berry-like pneumatocysts. Perhaps the most conspicuous features are the pneumatocysts. These small vesicles function as floats and keep the plants positively buoyant. Gas within these bladders is predominately oxygen with limited amounts of nitrogen and carbon dioxide. The volume of oxygen within the pneumatocysts fluctuates diurnally in response, not to diurnal cycles of photosynthesis, but to changes in the partial pressure of oxygen in the surrounding medium (Woodcock, 1950; Hurka, 1971). There are generally a large number of pneumatocysts on a healthy plant: up to 80 % of the bladders can be removed and the plants will remain positively buoyant (Zaitsev, 1971). Under calm sea states the algae are at the surface with less than 0.3% of their total mass exposed above the air - water interface. Experiments indicate that an exposure to dry air of 7-10 min. will kill phylloids, whereas, pneumatocysts and thallomes can tolerate exposures of 20-30 min. and 40 min., respectively. Wetting of exposed parts with seawater at 1 min. intervals, however, is enough to prevent tissue damage (Zaitsev, 1971). In nature, such stress is likely encountered only during the calmest seas or when the algae is cast ashore. Illustrations and descriptions of *S. natans* and *S. fluitans* are given in Hoyt (1918), Winge (1923), Parr (1939), Taylor (1960), Prescott (1968), Humm (1979), Littler et al. (1989) and Schneider and Searles (1991).

Most pelagic *Sargassum* circulates between 20°N and 40°N latitudes and 30°W longitude and the western edge of the Florida Current/Gulf Stream (Figure 10a). The greatest concentrations are found within the North Atlantic Central Gyre in the Sargasso Sea (Winge, 1923; Parr, 1939; Ryther, 1956; Dooley, 1972; Butler et al., 1983; Butler and Stoner, 1984; Nierman et al., 1986). Total biomass is unknown, but, estimates obtained from net tows range from 800 - 2000 kg wet weight km^{-2}. Within the Sargasso Sea, this translates into a standing crop of 4 to 11 million metric tons (Parr, 1939; Zaitzev, 1971; Peres, 1982; Butler et al., 1983; Butler and Stoner, 1984; Nierman et al., 1986; Luning, 1990). Stoner (1983) suggested that there had been a significant decline in biomass this century, but later recanted (Butler and Stoner, 1984). Nierman et al. (1986) also calculated that no apparent decline had occurred.

Pelagic *Sargassum* contributes a small fraction to total primary production in the North Atlantic, however, within the oligotrophic waters of the Sargasso Sea, it may constitute as much as 60 % of total production in the upper meter of the water column (Howard and Menzies, 1969; Carpenter and Cox, 1974; Hanson, 1977; Peres, 1982). Estimates of production are typically around 1 mgC m^{-2} d^{-1} with slightly higher values reported from more nutrient rich shelf waters. Production has been shown to double under conditions of nitrogen and phosphorus enrichment (Lapointe, 1986; 1995). Hanisak and Samuel (1984) found *Sargassum* to have low nitrogen and phosphorus requirements, and optimal growth at water temperatures of 24 - 30° C and salinity of 36 ppt. Nitrogen fixation by epiphytic cyanobacteria of the genera *Dichothrix, Trichodesmium,* and *Synechococcus* may enhance production (Carpenter 1972; Carpenter and Cox, 1974; Phlips and Zeman, 1990; Spiller and Shanmugam, 1987). Photosynthesis in both *Sargassum* and the blue-green epiphytes is not inhibited at high light intensities (Hanisak ans Samuel, 1984; Phlips et al., 1986): not surprising in view of the neustonic niche they occupy.

Large quantities of *Sargassum* frequently occur on the continental shelf off the southeastern United States. Depending on prevailing surface currents, this material may remain on the shelf for extended periods, be entrained into the Gulf Stream, or be cast ashore (Hoyt, 1918; Humm, 1951; Howard and Menzies, 1969; Carr and Meylen, 1980; Winston, 1982; Haney, 1986; Baugh, 1991). During calm conditions *Sargassum* may form large irregular mats or simply be scattered in small clumps. Langmuir circulations, internal waves, and convergence zones along fronts aggregate the algae along with other flotsam into long linear or meandering rows collectively termed "windrows" (Winge, 1923; Langmuir, 1938; Ewing, 1950, Faller and Woodcock, 1964; Stommel, 1965; Barstow, 1983; Shanks, 1988; Kingsford, 1990). The algae sinks in these convergence zones when downwelling velocities exceed 4.5 cm sec^{-1}. Buoyancy is not lost unless the algae sink below about 100 m or are held under at lesser depths for extended periods (Woodcock, 1950). A time-at-depth relationship exists which affects the critical depth at which bladder failure ensues (Johnson and Richardson, 1977). If buoyancy is lost, plants slowly sink to the sea floor. Schoener and Rowe (1970) indicate that sinking algae can reach 5000 m in about 2 days. Such sinking events contribute to the flux of carbon and other nutrients from the surface to the benthos (Schoener and Rowe, 1970; Pestana, 1985; Fabry and Deuser, 1991). However, the flux of *Sargassum* to the sea floor has not been quantified and there is no information on the fate of this surface export.



Solid line refers to the outer boundary of regular occurrence; dashed line refers to the area in which there is a> 5% probability of encounter within 1° square; hatched circle represents possible center of distribution

Figure 10a. Distribution of pelagic Sargassum in the Northwest Atlantic. (Source: From Dooley 1972.

3.2.3.1.2 Utilization of Sargassum Habitat

Pelagic *Sargassum* supports a diverse assemblage of marine organisms including fungi (Winge, 1923; Kohlmeyer, 1971), micro-and macro-epiphytes (Carpenter, 1970; Carpenter and Cox, 1974; Mogelberg et al., 1983), at least 145 species of invertebrates (Winge, 1923; Parr, 1939; Adams, 1960; Yeatman, 1962; Weis, 1968; Friedrich, 1969; Fine, 1970; Dooley, 1972; Morris and Mogelberg, 1973; Ryland, 1974; Teal and Teal, 1975; Peres, 1982; Butler et al., 1983; Deason, 1983; Andres and John, 1984; Stoner and Greening, 1984; Morgan et al., 1985; Nierman, 1986; see Table 1 in Coston-Clements et al., 1991), over 100 species of fishes (Table 1), four species of sea turtles (Smith, 1968; Fletemeyer, 1978; Carr and Meylan, 1980; Redfoot et al., 1985; Ross, 1985; Carr, 1986; 1987a; 1987b; Schwartz, 1988; 1989; Witham, 1988;

Manzella and Williams, 1991; Richardson and McGillivary, 1991), and numerous marine birds (Haney, 1986). Many of the organisms most closely associated with *Sargassum* have evolved adaptive coloration or mimic the algae in appearance (Crawford and Powers, 1953; Adams, 1960; Teal and Teal, 1975; Gorelova and Fedoryako, 1986; Hacker and Madin, 1991).

The fishes associated with pelagic *Sargassum* in the western North Atlantic have been studied by a number of investigators (Adams, 1960; Parin, 1970; Zaitzev, 1971; Dooley, 1972; Bortone et al., 1977; Fedoryako, 1980, 1989; Gorelova and Fedoryako, 1986; Settle, 1993; Moser et al., in press). Similar research has also addressed the ichthyofauna of drift algae in the Pacific (Uchida and Shojima, 1958; Besednov, 1960; Hirosaki, 1960b; Shojima and Ueki, 1964; Anraku and Azeta, 1965; Kingsford and Choat, 1985; Kingsford and Milicich, 1987; Nakata et al., 1988). In all cases, juvenile fishes were numerically dominant. Sampling designs and gear avoidance have no doubt contributed to the poorly described adult fish fauna. However, studies by Gibbs and Collette (1959), Beardsley (1967), Parin (1970), Manooch and Hogarth (1983), Manooch and Mason (1983), Manooch et al. (1984; 1985), and Fedoryako (1989) clearly indicate that large pelagic adult fishes utilize *Sargassum* resources. This becomes even more evident when one observes the efforts of fishermen targeting "weedlines".

Many of the fishes found in association with *Sargassum* are not restricted to that habitat and are known to frequent various types of drift material and fish aggregating devices (Besednov, 1960; Mansueti, 1963; Hunter and Mitchell, 1967; Kojima, 1966; Kulczycki et al., 1981; Lenanton et al., 1982; Robertson, 1982; Nakata et al., 1988; Fedoryako, 1989; Rountree, 1989; 1990). Protection, feeding opportunity, cleaning, shade, structural affinity, visual reference, tactile stimulation, historical accident, passive drift and use as a spawning substrate have all been postulated as reasons for such associations (Hirosaki, 1960a; Hunter and Mitchell, 1968; Senta, 1966a; 1966b; 1966c; Dooley, 1972; Helfman, 1981).

The surface residence time, season and geographic location of *Sargassum* affect the species composition and abundance of fishes associated with it. Most of the young fishes that associate with the algae are surface forms (Fahay, 1975; Powles and Stender, 1976) and it is not known if they remain near the alga when it is submerged. Recruitment of fishes to drift algae and flotsam is initially rapid and continues to increase over time (Senta, 1966a; Hunter and Mitchell; 1968; Kingsford and Choat, 1985; Kingsford, 1992). The abundance of larval and juvenile fishes varies seasonally and regionally, both in terms of numbers of fish and fish biomass (Dooley, 1972; Settle, 1993). The invertebrate fauna is similarly variable (Weis, 1968; Fine, 1970; Stoner and Greening, 1984). Regional trends in the mean abundance and biomass of young fish show decrease in abundance across the continental shelf and into the Gulf Stream and Sargasso Sea, and a decrease from spring through winter (Settle, 1993). Species richness is generally highest on the outer shelf during spring and summer and further offshore during the fall and winter. Overall, diversity is greatest in offshore waters (Bortone et al., 1977; Fedoryako, 1980; 1989; Settle, 1993).

The types of *Sargassum* habitats (e.g., individual clumps, small patches, large rafts, weedlines) and the "age" (i.e., growth stage and degree of epibiont colonization) also affects the distribution and abundance of associated fishes. Ida et al.(1967b), Fedoryako (1980), Gorelova and Fedoryako (1986) and Moser et al. (in press) described the spatial distribution of fishes in and around clumps and rafts of *Sargassum*. Juvenile *Diodon, Coryphaena, Lobotes* and the exocoetids occupy the outer periphery, whereas *Canthidermis, Balistes, Kyphosus, Abudefduf, Caranx* and *Seriola* are distributed below the algae. Other species such as *Histrio* and *Syngnathus* are typically hidden within the foliage. Larger juveniles and adults occupy nearby waters out to several 10's of meters from the patches. With regard to algal age, Conover and

Sieburth (1964) and Sieburth and Conover (1965) suggest that the community could be significantly controlled by the effects of exogenous metabolites on algal epibionts. These substances, which are released during periods of new algal growth, inhibits epibiotic colonization, and could alter the trophic resources available to associated macrofauna, including fish (Gorelova and Fedoryako, 1986). Stoner and Greening (1984) concluded that algal age did affect the macrofaunal composition, but the abundance of carnivores remained stable. However, since their study dealt primarily with the invertebrate fauna, the effects of these substances on other trophic links remains unknown, although similar compounds are known to deter some herbivores (Paul, 1987; Hay and Fenical, 1988; Hay et al., 1988; Steinberg, 1988).

Fish abundance has been found to be positively correlated with *Sargassum* biomass. Correlations were significant over the middle shelf throughout the year. Fish biomass was also positively correlated over the outer shelf during the fall (Settle, 1993). No correlation was observed in the Gulf Stream or Sargasso Sea (Dooley, 1972; Fedoryako, 1980; Settle, 1993). The abundance of motile macrofauna (mostly invertebrates) has also been shown to be related to *Sargassum* biomass (Stoner and Greening, 1984).

There have been well over 100 species of fishes collected or observed associated with the *Sargassum* habitat (Table 17). The carangids and balistids are the most conspicuous, being represented by 21 and 15 species respectively. The planehead filefish, *Monacanthus hispidus*, is clearly the most abundant species in shelf waters off the southeastern U.S. and in the Gulf of Mexico (Dooley, 1972; Bortone et al., 1977; Settle, 1993; Moser et al., in press).

A number of species have direct fisheries value although not all of them are common. However, the seasonal abundances of *Caranx* spp., *Elagatis bipinnulata*, *Seriola* spp., *Coryphaena hippurus*, *Pagrus pagrus*, *Mugil* spp., *Peprilus triacanthus*, and *Balistes capriscus* illustrates the importance of the habitat to the early-life-stages of these species.

The relationships between of a number of fishes and the *Sargassum* habitat remains problematic. The muraenids, gonostomatids, myctophids, apogonids, serranids, gerreids, scarids, lutjanids, chaetodontids, acanthurids, istiophorids, scorpaenids, bothids and several other taxa have been collected in limited numbers. It is likely that many of these fishes are found in convergence zones even in the absence of *Sargassum.*

3.2.3.1.3 Measuring Sargassum Distribution and Abundance

Our current understanding of the seasonal distribution and areal abundance (i.e. biomass per unit area) of pelagic *Sargassum* within the EEZ is poor. Gross estimates of the standing stock for the North Atlantic obtained from towed net samples are highly variable and range between 4 and 11 million metric tons. There is a clear need to improve our understanding of the distribution and abundance of this important habitat. Remote technology could aid to that end. Satellite-based Synthetic Aperture Radar (SAR) offers potential for assessing the distribution of large aggregations over broad swaths of the ocean surface. Coincident ship-based ground-truthing would permit an evaluation of the applicability of routine remote measurements of *Sargassum* distribution and abundance.

Table 17. List of fishes collected or observed in association with pelagic *Sargassum* in the North Atlantic Ocean including the Gulf of Mexico and Caribbean Sea. Life-stages are E=egg, L=larva, J=juvenile and A=adult. Nomenclature follows Robins et al. (1991) (Source: NMFS 1997).

Family Genus and species	Common name	Life-stage(s)
Carcharhinidae	requiem sharks	
Carcharhinus falciformis	silky shark	A
C. limbatus	blacktip shark	A
C. longimanus	oceanic whitetip shark	A
Muraenidae	morays	
Unidentified	moray	L
Clupeidae	herrings	
Sardinella aurita	Spanish sardine	J
Gonostomatidae	lightfishes	
Unidentified	lightfish	L
Myctophidae	lanternfishes	
Unidentified	lanternfish	L
Gadidae	cods	
Urophycis chuss	red hake	L, J
U. earlli	Carolina hake	L, J
U. floridana	southern hake	L, J
U. regia	spotted hake	L, J
Antennariidae	frogfishes	
Histrio histrio	sargassumfish	L, J, A
Exocoetidae	flyingfishes	
Cypselurus furcatus	spotfin flyingfish	E, L, J, A
C. melanurus	Atlantic flyingfish	E, L, J, A
Exocoetus obtusirostris	oceanic two-wing flyingfish	J
Hemirhamphus balao	balao	J
H. brasiliensis	ballyhoo	J
Hirundichthys affinis	fourwing flyingfish	E, L, J, A
Hyporhamphus unifasciatus	silverstripe halfbeak	L, J
Paraexocoetus brachypterus	sailfin flyingfish	E, L, J, A
Prognichthys gibbifrons	bluntnose flyingfish	E, L, J, A
Belonidae	needlefishes	
Tylosurus acus	agujon	L, J
Fistulariidae	cornetfishes	
Fistularia tabacaria	bluespotted cornetfish	J
Centriscidae	snipefishes	
Macroramphosus scolopax	longspine snipefish	J
Syngnathidae	pipefishes	
Hippocampus erectus	lined seahorse	J
H. reidi	longsnout seahorse	J
Microphis brachurus	opossum pipefish	J
Syngnathus caribbaeus	Caribbean pipefish	J
S. floridae	dusky pipefish	J
S. fuscus	northern pipefish	J
S. louisianae	chain pipefish	J
S. pelagicus	sargassum pipefish	E, L, J, A
S. scovelli	gulf pipefish	J
S. springeri	bull pipefish	J

Table 17.(cont.) List of fishes collected or observed in association with pelagic *Sargassum* in the North Atlantic Ocean including the Gulf of Mexico and Caribbean Sea.

Family Genus and species	Common name	Life-stage(s)
Dactylopteridae	flying gurnards	
Dactylopterus volitans	flying gurnard	L, J
Scorpaenidae	scorpionfishes	
Unidentified	scorpionfish	L
Serranidae	sea basses	
Epinephelus inermis	marbled grouper	J
Priacanthidae	bigeyes	
Priacanthus arenatus	bigeye	J
Pristigenys alta	short bigeye	L, J
Apogonidae	cardinalfishes	
Apogon maculatus	flamefish	L
Pomatomidae	bluefish	
Pomatomus saltatrix	bluefish	L
Rachycentridae	cobias	
Rachycentron canadum	cobia	E, L, J, A
Echeneidae	remoras	
Phtheirichthys lineatus	slender suckerfish	J
Carangidae	jacks	
Caranx bartholomaei	yellow jack	L, J
C. crysos	blue runner	L, J
C. dentex	white trevally	J
C. hippos	crevalle jack	J
C. latus	horse-eye jack	J
C. ruber	bar jack	L, J
Chloroscombrus chrysurus	Atlantic bumper	L, J
Decapterus macerellus	mackerek scad	J
D. punctatus	round scad	J
D. tabl	redtail scad	J
Elagatis bipinnulata	rainbow runner	L, J, A
Naucrates ductor	pilotfish	J
Selar crumenophthalmus	bigeye scad	L, J
Selene vomer	lookdown	J
Seriola dumerili	greater amberjack	L, J
S. fasciata	lesser amberjack	J
S. rivoliana	almaco jack	L, J, A
S. zonata	banded rudderfish	J
Trachinotus falcatus	permit	L, J
T. goodei	palometa	J
Trachurus lathami	rough scad	L, J
Coryphaenidae	dophins	
Coryphaena equisetis	pompano dolphin	L, J, A
C. hippurus	dolphin	L, J, A
Lutjanidae	snappers	
Lutjanus sp.	snapper	L
Rhomboplites aurorubens	vermillion snapper	L, J
Lobotidae	tripletails	
Lobotes surinamensis	tripletail	L, J, A
Gerreidae	mojarras	
Eucinostomus sp.	mojarra	L

Table 17.(cont.) List of fishes collected or observed in association with pelagic *Sargassum* in the North Atlantic Ocean including the Gulf of Mexico and Caribbean Sea.

Family Genus and species	Common name	Life-stage(s)
Sparidae	porgies	
Pagrus pagrus	red porgy	L, J
Mullidae	goatfishes	
Mullus auratus	red goatfish	L, J
Unidentified	goatfish	L
Kyphosidae	sea chubs	
Kyphosus incisor	yellow chub	L, J
K. sectatrix	Bermuda chub	L, J
Chaetodontidae	butterflyfishes	
Chaetodon ocellatus	spotfin butterflyfish	J
C. striatus	banded butterflyfish	J
Pomacentridae	damselfishes	
Abudefduf saxatilis	sergeant major	L, J
Mugilidae	mullets	
Mugil cephalus	striped mullet	L
M. curema	white mullet	L
Sphyraenidae	barracudas	
Sphyraena barracuda	great barracuda	A
S. borealis	northern sennet	L, J
Polynemidae	threadfins	
Polydactylus virginicus	barbu	J
Labridae	wrasses	
Bodianus pulchellus	spotfin hogfish	J
Thalassoma bifasciatum	bluehead	J
Scaridae	parrotfishes	
Unidentified	parrotfish	L
Uranoscopidae	stargazers	
Unidentified	stargazer	L
Blenniidae	combtooth blennies	
Hypsoblennius hentzi	feather blenny	L
Parablennius marmoreus	seaweed blenny	L
Gobiidae	gobies	
Microgobius sp.	goby	L
Acanthuridae	surgeonfishes	
Acanthurus randalli	gulf surgeonfish	J
Acanthurus sp.	surgeonfish	L
Trichiuridae	snake mackerels	
Unidentified	snake mackerel	L
Scombridae	mackerels	
Acanthocybium solandri	wahoo	J, A
Auxis thazard	frigate mackerel	J, A
Euthynnus alletteratus	little tunny	A
Katsuwonus pelamis	skipjack tuna	A
Scomber japonicus	chub mackerel	J
Scomberomorus cavalla	king mackerel	A
Thunnus albacares	yellowfin tuna	J, A
T. atlanticus	blackfin tuna	A
Xiphiidae	swordfishes	
Xiphius gladius	swordfish	L, J

Table 17.(cont.) List of fishes collected or observed in association with pelagic *Sargassum* in the North Atlantic Ocean including the Gulf of Mexico and Caribbean Sea.

Family Genus and species	Common name	Life-stage(s)
Istiophoidae	billfishes	
Istiophorus platypterus	sailfish	L, J
Makaira nigricans	blue marlin	L, J, A
Tetrapturus albidus	white marlin	L, J, A
Stromateidae	butterfishes	
Ariomma sp.	driftfish	L
Centrolophus sp.	ruff	J
Cubiceps pauciradiatus	bigeye cigarfish	J
Hyperoglyphe bythites	black driftfish	J
H. perciformis	barrelfish	J
Peprilus triacanthus	butterfish	L, J
Psenes cyanophrys	freckled driftfish	J
Bothidae	lefteye flounders	
Bothus sp.	flounder	L
Cyclopsetta fimbriata	spotfin flounder	L
Balistidae	leatherjackets	
Aluterus heudeloti	dotterel filefish	L, J
A. monoceros	unicorn filefish	L, J
A. schoepfi	orange filefish	L, J
A. scriptus	scrawled filefish	L, J
Balistes capriscus	gray triggerfish	J, A
B. vetula	queen triggerfish	J
Cantherhines macrocerus	whitespotted filefish	J
C. pullus	orangespotted filefish	J, A
Canthidermis maculata	rough triggerfish	J
C. sufflamen	ocean triggerfish	J
Monacanthus ciliatus	fringed filefish	J
M. hispidus	planehead filefish	J
M. setifer	pygmy filefish	J
M. tuckeri	slender filefish	J
Xanthichthys ringens	sargassum triggerfish	J
Ostraciidae	boxfishes	
Lactophrys sp.	cowfish	L
Tetraodontidae	puffers	
Chilomycterus antennatus	bridled burrfish	J
C. schoepfi	striped burrfish	J
Diodon holocanthus	ballonfish	J
D. hystrix	porcupinefish	J
Sphoeroides maculatus	northern puffer	L
S. spengleri	bandtail puffer	L
Unidentified	puffer	L
Molidae	molas	
Mola sp.	mola	J

3.2.3.2 Water Column

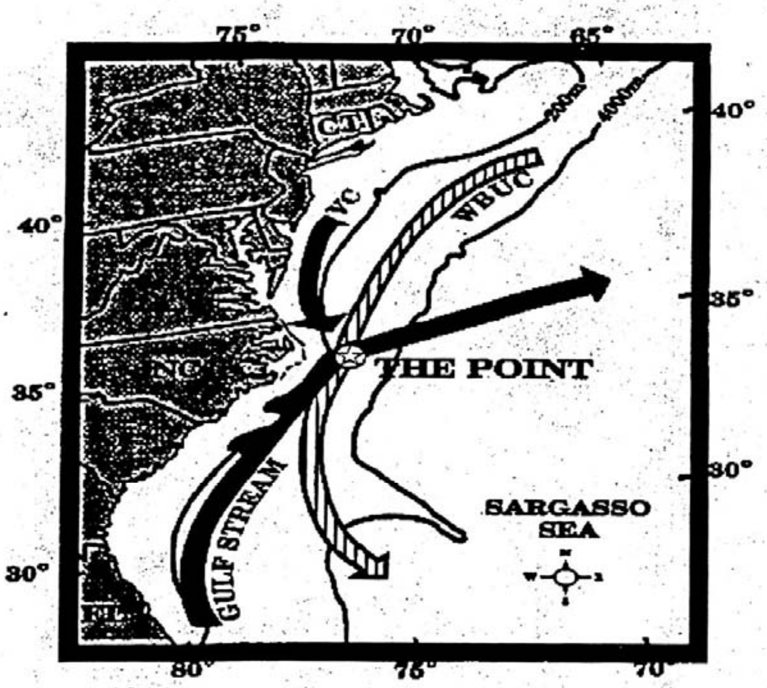
3.2.3.2.1 Description of Water Column Habitats

Specific habitats in the water column can best be defined in terms of gradients and discontinuities in temperature, salinity, density, nutrients, light, etc. These 'structural' components of the water column environment (*sensu* Peters and Cross, 1992) are not static, but change both in time and space. Therefore, there are numerous potentially distinct water column habitats for a broad array of species and life-stages within species.

The continental shelf off the southeastern U.S., extending from the Dry Tortugas to Cape Hatteras, encompasses an area in excess of 100,000 km^2 (Menzel, 1993). Based on physical oceanography and geomorphology, this environment can divided into two regions: Dry Tortugas to Cape Canaveral and Cape Canaveral to Cape Hatteras. The break between these two regions is not precise and ranges from West Palm Beach to the Florida-Georgia border depending on the specific data considered. The shelf from the Dry Tortugas to Miami is ~25 km wide and narrows to approximately 5 km off Palm Beach. The shelf then broadens to approximately 120 km off of Georgia and South Carolina before narrowing to 30 km off Cape Hatteras. The Florida Current/Gulf Stream flows along the shelf edge throughout the region. In the southern region, this boundary current dominants the physics of the entire shelf (Lee et al., 1992; 1994). In the northern region, additional physical processes are important and the shelf environment can be subdivided into three oceanographic zones (Atkinson et al., 1985; Menzel, 1993). The outer shelf (40-75 m) is influenced primarily by the Gulf Stream and secondarily by winds and tides. On the mid-shelf (20-40 m), the water column is almost equally affected by the Gulf Stream, winds and tides. Inner shelf waters (0-20 m) are influenced by freshwater runoff, winds, tides and bottom friction.

Several water masses are present in the region. From the Dry Tortugas to Cape Canaveral, the three water types are: Florida Current Water (FCW), waters originating in Florida Bay, and shelf water. Shelf waters off the Florida Keys are an admixture of FCW and waters from Florida Bay. From Cape Canaveral to Cape Hatteras, four water masses are found: Gulf Stream Water (GSW), Carolina Capes Water (CCW), Georgia Water (GW) and Virginia Coastal Water (VCW). Virginia Coastal Water enters the region from north of Cape Hatteras. Carolina Capes Water and GW are admixtures of freshwater runoff and GSW (Pietrafesa et al., 1985;1994).

Spatial and temporal variation in the position of the western boundary current has dramatic affects on water column habitats. Variation in the path of the Florida Current near the Dry Tortugas, induces formation of the Tortugas Gyre (Lee et al., 1992; 1994). This cyclonic eddy has horizontal dimensions on the order of 100 km and may persist in the vicinity of the Florida Keys for several months. The Pourtales Gyre, which has been found to the east, is formed when the Tortugas Gyres moves eastward along the shelf. Upwelling occurs in the center of these gyres, thereby adding nutrients to the near surface (<100 m) water column. Wind and input of Florida Bay water also influence the water column structure on the shelf off the Florida Keys (Smith, 1994; Wang et al., 1994). Similarly, further downstream, the Gulf Stream encounters the Charleston Bump, a topographic rise on the upper Blake Ridge. Here the current is often deflected offshore, again resulting in the formation a cold, quasi-permanent cyclonic gyre and associated upwelling (Brooks and Bane, 1978). Along the entire length of the Florida Current and Gulf Stream, cold cyclonic eddies are imbedded in meanders along the western front. Three areas of eddy amplification are known: Downstream of Dry Tortugas, downstream of Jupiter Inlet (27°N to 30°N latitude), downstream of the Charleston Bump (32°N to 34°N latitude). Meanders propagate northward (i.e. downstream) as waves. The crests and troughs represent the onshore and offshore positions of the Gulf Stream front. Cross-shelf amplitudes of these waves are on the order 10 to 100 km. Upwelling within meander troughs is the dominant source of 'new' nutrients to the southeastern U.S. shelf and supports primary, secondary and ultimately fisheries production (Yoder, 1985; Menzel 1993). Off Cape Hatteras the Gulf Stream turns offshore to the northeast. Here, the confluence of the Gulf Stream, the Western Boundary Under Current (WBUC), Mid-Atlantic Shelf Water (MASW), Slope Sea Water (SSW), CCW and VCW create a dynamic and highly productive environment, known as the "Hatteras Corner" or "The Point".



A.
WATER MASSES
OFF CAPE HATTERAS

On the continental shelf, offshore projecting shoals at Cape Fear, Cape Lookout and Cape Hatteras affect longshore coastal currents and interact with Gulf Stream intrusions to produce local upwelling (Blanton et al., 1981; Janowitz and Pietrafesa, 1982). Shoreward of the Gulf Stream, seasonal horizontal temperature and salinity gradients define the mid-shelf and inner-shelf fronts. In coastal waters, river discharge and estuarine tidal plumes contribute to the water column structure.

3.2.3.2.2 Use of Water Column Habitats

Coastal waters off the southeastern U.S. are split into two zoogeographic provinces based on shore fishes and continental shelf invertebrate species. The Caribbean Province includes the Florida Keys and extends northward to approximately the Florida-Georgia border, but its northern boundary is not sharp. The Carolinian Province extends from this border, northwards to Cape Hatteras (Briggs 1974). A similar faunal break is evident in mesopelagic fish fauna. The boundary between the North Sargasso Sea Province and the South Sargasso Sea Province occurs approximately parallel with Jupiter Inlet, Florida (Backus et al. 1977).

The water column from Dry Tortugas to Cape Hatteras serves as habitat for many marine fish and shellfish. Most marine fish and shellfish broadcast spawn pelagic eggs and thus, most species utilize the water column during some portion of their early life history (e.g. egg, larvae, juvenile stages). Larvae of shrimp, lobsters, crabs, and larvae of reef, demersal and pelagic fishes are found in the water column (e.g. Fahay, 1975; Powels and Stender, 1976; Leis, 1991; Yeung and McGowan 1991, Criales and McGowan 1994). Problems with species-level identifications prohibits an exact accounting of the number of fishes whose larvae inhabit the water column, but the number of families represented in ichthyoplankton collections ranges from 40 to 91 depending on location, season and sampling method (Table 18a).

Table 18a. Summary of the number of larval fish families identified from studies conducted off the southeastern coast of the United States.

Location	**Season**	**No. Families**	**Study**
Florida Keys	Sp	91	Limouzy-Paris et al. (1994)
Cape Canaveral to Cape Lookout	W	48/60[1]	Powles and Stender (1976)
Cape Canaveral to Cape Lookout	Sp	49/56[1]	Powles and Stender (1976)
Cape Canaveral to Cape Lookout	F	40/55[1]	Powles and Stender (1976)
Cape Fear to Cape Lookout	W	74	Govoni and Spach (submitted)
Cape Fear to Cape Lookout	W	66	Powell and Robbins (1994)
Palm Beach to Cape Lookout	Sp-W	51	Fahay (1975)

1 - bongo / neuston data

There are large number of fishes that inhabit the water column as adults. Pelagic fishes in the region include numerous clupeoids, exocoetids, carangids, *Rachycentron*, *Pomatomus*, coryphaenids, sphyraenids and the scombroids (Schwartz, 1989). Some pelagic species are associated with particular benthic habitats (e.g. *Seriola*, *Sphyraena*), while other species are truly pelagic (e.g. *Thunnus*, *Makaira*). Adult meso- and bathypelagic species inhabit the water column in the Gulf Stream (Figure 10b) and adjacent Sargasso Sea (Backus et al. 1977).

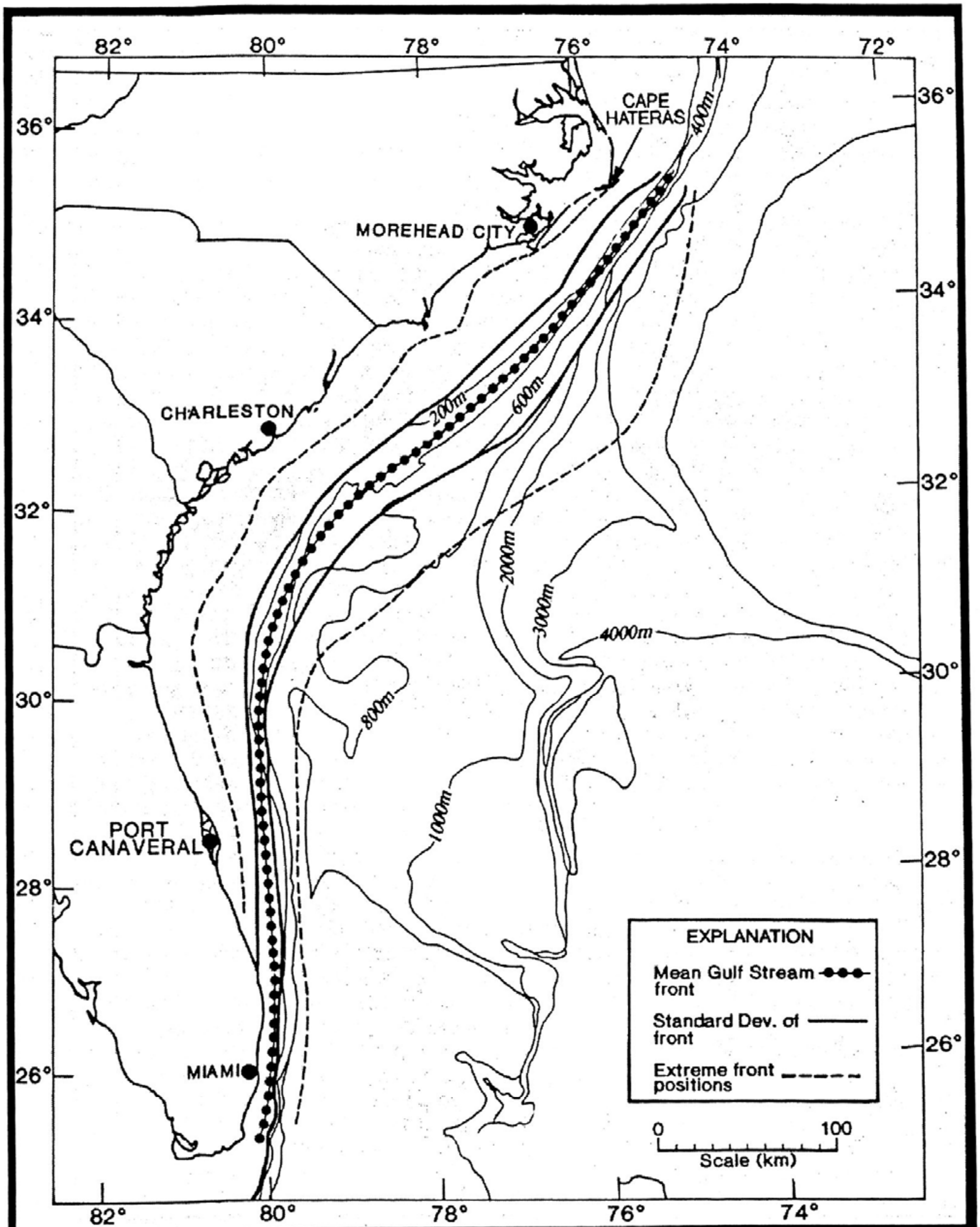


Figure 10b. Gulf Stream front location (Source: MMS 1990).

Species- and life-stage-specific patterns of water column habitat utilization are not well known for most fishes. Some utilize near-shore fronts as feeding or nursery habitats (e.g. *Anchoa*, *Scomberomorus*); others utilize offshore fronts (e.g. *Coryphaena*, *Xiphius*). Important spawning locations include esturaine fronts (e.g. *Cynoscion*, *Sciaenops*), the mid-shelf front (*Micropogonias*, *Leiostomus*, *Paralichthys*), the Gulf Stream front (*Coryphaena*, *Xiphius*). Recent work has shown an accumulation of fish larvae in these shelf fronts (Govoni 1993). Movement of the Gulf Stream front also affects the distribution of adult fishes (Magnuson et al. 1981) and hook and line fisherman and longliners target much of their effort for pelagic species in these frontal zones. In addition, the quasi-permanent gyres which impinge upon the shelf near the Florida Keys and downstream from the Charleston Bump probably serve as important spawning/larval retention habitat for a variety of fishes (Collins and Stender, 1987; Lee et al., 1994). The region known as "Point" off Cape Hatteras supports an unusually high biomass of upper trophic level predators, including many important pelagic fishes. It has been suggested that the area is the most productive sport fishery on the east coast (Ross, 1989).

Due to their important ecological function, at least two offshore pelagic environments discussed above represent essential fish habitat-habitat areas of particular concern (HAPC); the Charleston Bump and The Point. Both regions are productive and highly dynamic oceanic areas. A quasi-permanent, cyclonic eddy with attendant upwelling of nutrient-rich deep water sets-up in the wake of the Charleston Bump. Upwelling results in persistent primary and secondary production that may well result in an important, if not essential feeding environment for the larvae of fishes that congregate to spawn there. The hydrodynamics of the eddy may well serve in the retention of fish propagules that are lost from local populations elsewhere through entrainment into the Gulf Stream. The "Point" off Cape Hatteras is also highly productive due to the confluence of as many as four water masses. Adults of highly migratory species congregate in this area, while the diversity of larval fishes found there is truly astounding (Table 18b).

Table 18b. Taxonomic list of larval and early-juvenile fishes from offshore of Cape Lookout to Cape Hatteras including the region known as "The Point". (Source: Larry Settle pers comm.)

Family Genus and Species	Common name
Elopidae	tarpons
Elops saurus	ladyfish
Megalops atlanticus	tarpon
Albulidae	bonefishes
Albula vulpes	bonefish
Anguillidae	freshwater eels
Anguilla rostrata	American eel
Moringuidae	spaghetti eels
unidentifed	spaghetti eel
Muraenidae	morays
Gymnothorax sp(p).	moray
unidentifed	moray
Serrivomeridae	sawtooth eels
unidentifed	sawtooth eel
Ophichthidae	snake eels
Apterichtus ansp	academy eel
Apterichtus kendalli	finless eel
Callechelys guiniensis	shorttail snake eel
Callechelys sp.	eel
Echiophis intertinctus	spotted spoon-nose eel
Echiophis punctifer	snapper eel
Gordiichthys ergodes	irksome eel
Myrichthys ocellatus	goldspotted eel
Myrichthys sp.	eel
Myrophis punctatus	speckled worm eel
Ophichthus gomesi	shrimp eel
Ophichthus puncticeps	palespotted eel
Ophichthus sp.	eel
unidentifed	snake eel
Nemichthyidae	snipe eels
unidentifed	snipe eel
Nettastomatidae	duckbill eels
Saurenchelys cognita	longface eel
unidentifed	eel
Congridae	conger eels
Ariosoma sp.	conger eel
Paraconger sp.	conger eel
Rhechias dubia	conger eel
Rhynchoconger gracilior/guppyi	conger
unidentifed	conger eel
Clupeidae	herrings
Brevoortia tyrannus	Atlantic menhaden
Etremeus teres	round herring
Sardinella aurita	Spanish sardine
Engrauilidae	anchovies
Anchoa hepsetus	striped anchovy
Engraulis eurystole	silver anchovy
Argentinidae	argentines
unidentifed	argentine
Gonostomatidae	lightfishes
Cyclothone sp.	lightfish
Gonostoma elongatum	lightfish
Vinciguerria nimbaria	lightfish
Vinciguerria poweriae	lightfish
Vinciguerria sp.	lightfish
unidentifed	lightfish

Table 18b (cont.). Taxonomic list of larval and early-juvenile fishes from offshore of Cape Lookout to Cape Hatteras including the region known as "The Point".

Family Genus and Species	Common name
Stomiidae	dragonfishes
Stomias sp.	dragonfish
unidentified	dragonfish
Aulopidae	aulopus
unidentified	aulopus
Chlorophthalmidae	greeneyes
unidentified	greeneye
Scopelarchidae	pearleyes
unidentified	pearleye
Synodontidae	lizardfishes
Trachinocephalus myops	snakefish
unidentified	lizardfish
Evermannellidae	sabertooth fishes
unidentified	sabertooth fish
Paralepididae	barrucudinas
Lestidiops affinis	barracudina
Stemonosudis intermedia	barracudina
unidentified	barracudina
Myctophidae	lanternfishes
Benthosema glaciace	glacier lanternfsh
Benthosema suborbitale	lanternfish
Benthosema sp.	lanternfish
Ceratoscopelus maderensis	lanternfish
Ceratoscopelus warmingii	lanternfish
Diaphus sp.	lanternfish
Diogenichthys atlanticus	Diogenes lanternfish
Electrona risso	lanternfish
Hygophum benoiti	lanternfish
Hygophum hygomii	lanternfish
Hygophum reinhardtii	lanternfish
Hygophum taaningi	lanternfish
Hygophum sp.	lanternfish
Lampadena luminosa	lanternfish
Lampadena sp.	lanternfish
Lampanyctus ater	lanterfish
Lampanyctus cuprarius	lanternfish
Lampanyctus nobilis	lanternfish
Lampanyctus sp.	lanternfish
Lepidophanes sp.	lanternfish
Myctophum affine	metallic lanternfish
Myctophum obtrusiroste	lanternfish
Myctophum selenops	lanternfish
Myctophum sp.	lanternfish
Notolychnus valdiviae	lanternfish
Notoscopelus sp.	lanternfish
unidentified	lanternfish
Moridae	codlings
unidentified	codling
Bregmacerotidae	codlets
Bregmaceros cantori	codlet
Bregmaceros sp.	codlet
unidentified	codlet
Gadidae	cods
Enchelyopus cimbrius	fourbeard rockling
Merluccius bilinearis	silver hake
Urophycis chuss	red hake

Table 18b (cont.). Taxonomic list of larval and early-juvenile fishes from offshore of Cape Lookout to Cape Hatteras including the region known as "The Point".

Family Genus and Species	Common name
Urophycis floridana	southern hake
Urophycis regia	spotted hake
Urophycis sp.	hake
Ophidiidae	cusk-eels
Brotula barbata	bearded brotula
Ophidion beani	longnose cusk-eel
Ophidion selenops	mooneye cusk-eel
Ophidion sp.	cusk-eel
Ophididium osostigmum	polka-dot cusk-eel
unidentified	cusk-eel
Carapidae	pearlfishes
unidentified	pearlfish
Lophiiformes (Order)	anglerfishes
unidentified	anglerfish
Ceratoidei (Suborder)	deepsea anglerfishes
unidentified	deepsea anglerfish
Caulophrynidae	deepsea anglerfishes
Caulophryne jordani	deepsea anglerfish
Lophiidae	goosefishes
Lophius americanus	goosefish
Antennariidae	frogfishes
Antennarius sp.	frogfish
Histrio histrio	sargassumfish
Exocoetidae	flyingfishes
Cypselurus melanurus	Atlantic flyingfish
Hemiramphus brasiliensis	ballyhoo
Hirundichthys affinis	fourwing flyingfish
Hyporhamphus unifasciatus	silverstripe halfbeak
Paraexocoetus brachypterus	sailfin flyingfish
Prognichthys gibbifrons	bluntnose flyingfish
unidentified	flyingfish
Belonidae	needlefishes
Tylosurus acus	agujon
unidentified	needlefish
Scomberesocidae	sauries
Scomberesox saurus	Atlantic saury
Atherinidae	silversides
unidentified	silverside
Trachipteridae	ribbonfishes
unidentified	ribbonfish
Trachichthyidae	roughies
unidentified	roughy
Melamphaidae	scalefishes
Melamphaes simus	scalefish
Holocentridae	squirrelfishes
unidentified	squirrelfish
Caproidae	boarfishes
Antigonia capros	deepbody boarfish
Antigonia sp.	boarfish
Fistulariidae	cornetfishes
unidentified	cornetfish
Centriscidae	snipefishes
Marcoramphosus sp.	snipefish
Syngnathidae	pipefishes
Hippocampus erectus	lined seahorse
Hippocampus reidi	longsnout seahorse

Table 18b (cont.). Taxonomic list of larval and early-juvenile fishes from offshore of Cape Lookout to Cape Hatteras including the region known as "The Point".

Family Genus and Species	Common name
Hippocampus sp.	seahorse
Syngnathus caribbaeus	Caribbean pipefish
Syngnathus floridae	dusky pipefish
Syngnathus pelagicus	sargassum pipefish
Syngnathus scovelli	gulf pipefish
Syngnathus springeri	bull pipefish
Syngnathus sp.	pipefish
unidentified	pipefish
Dactylopteridae	flying gurnards
Dactylopterus volitans	flying gurnard
Scorpaenidae	scorpionfishes
Helicolenus dactylopterus	blackbelly rosefish
unidentified	scorpionfish
Triglidae	searobins
Prionotus carolinus	northern searobin
Prionotus sp(p).	searobin
unidentified	searobin
Chiasmodontidae	swallowers
unidentified	swallower
Serranidae	sea basses
Anthias sp.	sea bass
Centropristis sp.	sea bass
Diplectrum sp.	sea bass
Hemianthias vivanus	red barbier
Liopropoma sp.	sea bass
Plectranthias garrupellus	apricot bass
Psuedgramma gregoryi	reef bass
Rypticus sp.	soapfish
unidentified	sea bass
Priacanthidae	bigeyes
Priancnthus arenatus	bigeye
unidentified	bigeye
Apogonidae	cardinalfishes
unidentified	cardinalfish
Malacanthidae	tilefishes
Lopholatilus chamaeleonticeps	tilefish
Malacanthus plumieri	sand tilefish
Pomatomidae	bluefish
Pomatomus saltatrix	bluefish
Carangidae	jacks
Caranx bartholomaei	yellow jack
Caranx crysos	blue runner
Caranx ruber	bar jack
Caranx spp.	jack
Decapterus macarellus	maclerel scad
Decapterus punctatus	round scad
Decapterus sp.	scad
Elagates bipinnulata	rainbow runner
Hemicaranx amblyrhynchus	bluntnose jack
Selar crumenophthalmus	bigeye scad
Seriola dumerili	greater amberjack
Seriola fasciata	lesser amberjack
Seriola rivoliana	almaco jack
Serioloa zonata	banded rudderfish
Seriola sp(p).	amberjack
Trachinotus carolinus	florida pompano

Table 18b (cont.). Taxonomic list of larval and early-juvenile fishes from offshore of Cape Lookout to Cape Hatteras including the region known as "The Point".

Family Genus and Species	Common name
Trachinotus falcatus	permit
Trachinotus goodei	palometa
Thachurus lathami	rough scad
unidentifed	jack
Coryphaenidae	dolphins
Coryphaena equisetis	pompano dolphin
Coryphaena hippurus	dolphin
Caristiidae	veilfins
Caristius sp.	veilfin
Lutjanidae	snappers
Lutjanus sp(p).	snapper
Rhomboplites aurorubens	vermillion snapper
Lobotidae	tripletails
Lobotes surinamensis	tripletail
Gerreidae	mojarras
Eucinostomus sp.	mojarra
Haemulidae	grunts
unidentifed	grunt
Sparidae	porgies
Lagodon rhomboides	pinfish
Pagrus pagrus	red porgy
unidentifed	porgy
Sciaenidae	drums
Larimus fasciatus	banded drum
Leiostomus xanthurus	spot
Menticirrhus sp(p).	kingfish
Micropogonias undulatus	croaker
Mullidae	goatfishes
Mullus auratus	red goatfish
unidentifed	goatfish
Kyphosidae	sea chubs
Kyphosus sectatrix	Bermuda chub
Chaetodontidae	butterflyfishes
Chaetodon sp(p).	butterflyfish
Pomacentridae	damselfshes
Abudeduf saxatilis	sergeant major
Abudefduf taurus	night sergeant
unidentifed	damselfsh
Mugilidae	mullets
Mugil cephalus	striped mullet
Mugil curema	white mullet
Mugil sp(p).	mullet
Sphyraenidae	barracudas
Sphyraena barracuda	great barracuda
Sphyraena borialis	northern sennet
Sphyraena sp(p).	barracuda
Labridae	wrasses
Hemipteronotus sp(p).	wrass
unidentifed	wrass
Scaridae	parrotfishes
unidentifed	parrotfish
Pholidae	gunnels
Pholis sp.	gunnel
Uranoscopidae	stargazers
unidentifed	stargazer

Table 18b (cont.). Taxonomic list of larval and early-juvenile fishes from offshore of Cape Lookout to Cape Hatteras including the region known as "The Point".

Family Genus and Species	Common name
Percophidae	flatheads
unidentifed	flathead
Blenniidae	combtooth blennies
Parablennius marmorius	seaweed blenny
unidentifed	blenny
Ammodytidae	sand lances
Ammodytes spp.	sand lance
Callionymidae	dragonets
unidentifed	dragonet
Gobiidae	gobies
Isoglossus calliurus	blue goby
Microgobius sp.	goby
unidentifed	goby
Acanthuridae	surgeonfishes
Acanthurus sp(p).	surgeonfish
Trichiuridae	cutlassfishes
unidentifed	cutlassfish
Gempylidae	snake mackerels
Diplosinus multistriates	snake mackerel
Gempylus serpens	snake mackerel
unidentifed	snake mackerel
Scombridae	mackerels
Auxis sp(p).	frigate mackerel
Euthynnus alletteratus	little tunny
Katsuwonus pelamis	skipjack tuna
Sarda sarda	Atlantic bonito
Scomber japonicus	chub mackerel
Scomber scomber	Atlantic mackerel
Scomberomorus cavalla	king mackerel
Thunnus albacares/alalunga	yellowfin tuna/albacore
Thunnus thynnus	bluefin tuna
Xiphiidae	swordfish
Xiphias gladius	swordfish
Istiophoridae	billfishes
unidentifed	billfish
Stromateidae	butterfishes
Ariomma sp.	driffsh
Hyperoglyphe sp.	driffsh
Nomeus gronovii	man-of-war fish
Peprilus triacanthus	butterfish
Psenes cyanophrys	freckled driffish
Psenes maculatus	silver driffish
Psenes pellucidus	bluefin driffish
Psenes sp.	driffsh
unidentifed	butterfish
Bothidae	lefteye flounders
Bothus ocellatus	eyed flounder
Bothus sp(p).	flounder
Citharichthys arctifrons	GulfStream founder
Citharichthys cornutus	horned whiff
Citharichthys gymnorhinus	anglefin whiff
Citharichthys sp(p).	whif
Cyclopsetta fimbriata	spotfin flounder
Engyophrys senta	spiny flounder
Etropus microstomus	smallmouth founder
Etropus sp(p).	flounder

Table 18b (cont.). Taxonomic list of larval and early-juvenile fishes from offshore of Cape Lookout to Cape Hatteras including the region known as "The Point".

Family Genus and Species	Common name
Monolene sessilicauda	deepwater flounder
Paralichthys dentatus	summer flounder
Paralichthys lethostigma	southern flounder
Paralichthys oblongus	fourspot flounder
Paralichthys squamilentus	broad flounder
Scophthalamus aquosus	windowpane
Syacium papillosum	dusky flounder
unidentified	flounder
Pleuronectidae	righteye flounders
Glyptocephalus cynoglossus	witch flounder
Pleuronectes ferrugineus	yellowtail flounder
Soleidae	soles
Symphurus sp(p).	tonguefish
Balistidae	leatherjackets
Aluterus heudeloti	dotterel filefish
Aluterus monoceros	unicorn filefish
Aluterus schoepfi	orange filefish
Aluterus scriptus	scrawled filefish
Balistes capriscus	gray triggerfish
Balistes vetula	queen triggerfish
Cantherhines macrocerus	whitespotted filefish
Cantherhines pullus	orangespotted filefish
Cantheridermis maculata	rough triggerfish
Cantherdermis sufflamen	ocean triggerfish
Monacanthus ciliatus	fringed filefish
Monacanthus hispidus	planehead filefish
Monacanthus setifer	pygmy filefish
Monacanthus tuckeri	slender filefish
Xanthichthys ringins	sargassum triggerfish
unidentified	leatherjacker
Ostraciidae	boxfishes
Lactophrys sp(p).	boxfish
Tetraodontidae	puffers
Diodon holcanthus	ballonfish
Sphoeroides spengleri	bandtail puffer
Sphoeroides sp.	puffer
unidentified	puffers
Molidae	molas
unidentified	mola

4.4 The Effects of Fishing Gear on the Ecosystem and Prior Council Action.

The following summarizes the Council's actions to long-term gains with the effective protection of essential fish habitat and essential fish habitat - habitat areas of particular concern for dolphin and wahoo.

The Council through the Fishery Management Plan for Pelagic *Sargassum* Habitat (SAFMC, 1998b) is proposing to prohibit all harvest and possession of *Sargassum* from the South Atlantic EEZ south of the latitude line representing the North Carolina/South Carolina border. The plan caps harvest at 50,000 pounds wet weight (determined dockside after being off-loaded) in the area bounded by the latitude lines representing the North Carolina/Virginia border and the North Carolina/South Carolina border and the longitude line representing 100 miles seaward from the North Carolina shoreline until January 1, 2001 when all harvest will end. In addition, harvesters will be required to: (a) acquire a federal permit, (b) allow on board observers if requested, (c) maintain logbooks, (d) call into the NMFS Southeast Regional Law Enforcement Office when leaving and returning to port, and (e) require that nets used to harvest *Sargassum* be constructed of four inch stretch mesh or larger. It is the Council's intent to prohibit all harvest and possession of *Sargassum* in or from the South Atlantic EEZ.

This action would immediately prohibit harvest of *Sargassum* (essential fish habitat) south of the North Carolina / South Carolina border and prohibit harvest off North Carolina effective January 1, 2001. The Council is taking this action to prevent the direct removal of this habitat. *Sargassum* serves as an oasis in a media otherwise devoid of structure. While the present level of harvest may be small relative to the unknown biomass of pelagic *Sargassum* in the region, the Council views the total prohibition as a way of ensuring the fishery does not expand. Thus the removal of pelagic essential fish habitat ceases after the phase-out off North Carolina.

The *Sargassum* community represents a highly evolved ecotype with organisms (e.g., *Sargassum* fish, *Sargassum* pipefish, *Sargassum* shrimp, and *Sargassum* crab) which have evolved cryptic coloration and feeding mechanisms to survive and thrive in this habitat. In addition, many organisms (e.g., bryozoans) live attached to the *Sargassum* and feed on phytoplankton in the water column and associated with the habitat. These species would be lost in any removal of this habitat. Recent research indicates the essential nature of the fish and other marine organisms using pelagic *Sargassum* in providing the nutrients for growth of the algae. Therefore, the determination that all *Sargassum* is essential fish habitat, as well as an essential fish habitat area of particular concern, is further supported by this interrelationship between the inhabitants and the growth of *Sargassum*.

The Council concluded the removal of pelagic *Sargassum* habitat constitutes a net loss of essential fish habitat in the South Atlantic region. Also, the Council concluded that the harvest of pelagic *Sargassum* is a violation of Council, NMFS, and NOAA habitat policies. The harvest of *Sargassum* is contradictory to the goals and objectives of the Habitat Plan (SAFMC, 1998a), the Habitat Comprehensive Amendment (SAFMC, 1998b), and the Pelagic *Sargassum* Habitat Plan (SAFMC, 1998d). An experimental fishing provision was considered but dropped because the Council determined this activity constituted a violation of Council habitat policy and goes against the intent of the Magnuson-Stevens Act mandate to address essential fish habitat. This action would meet the directive to identify, describe, and protect essential fish habitat. An acceleration and/or continuation of harvest could degrade the quality of habitat.

Apart from increases in the non-consumptive values discussed below, the Council concluded prohibition of harvest is likely to increase productivity of marine life in the ecosystem. In particular, dolphin-fish and turtles would be protected from any potential negative impacts and could result in increased abundance depending on additional measures implemented.

The Council concluded maintaining the integrity of the non-consumptive values and the value to other species as habitat greatly outweigh the costs resulting from prohibiting harvest. Like any natural resource, *Sargassum* commands what has been termed non-use values; specifically existence value, bequest value, and option value. Existence value refers to the satisfaction individuals derive from the knowledge that a natural resource exists and will continue to exist in the future even though they may never use or see the resource. Bequest value is the benefit associated with endowing a natural resource to future generations. Option value refers to the benefit individuals obtain from retaining the option to use the resource in the future by conserving it now. These values are undoubtedly difficult to measure, but measurement has been done in a few instances (e.g., Amazonian rainforest and Australian Great Barrier Reef).

In terms of non-consumptive uses, the Council concluded prohibiting harvest will reduce further loss of essential fish habitat; increase the possibility of enhancing ecosystem function and marine productivity; and increase existence, bequest, and option values. After implementation, all the direct benefits will go to the non-consumptive users. The other values, existence, bequest, and option are likely to increase at a faster rate. There is no direct method to estimate these benefits. Indirect benefits will accrue to consumptive users to the extent productivity of harvested species (e.g., dolphin-fish) are increased.

The following points noted in Manooch et al. (1984) and the table developed from information presented in Manooch et al. (1984), further emphasizes the complexity of the *Sargassum* community and the importance of pelagic *Sargassum* habitat to pelagic fishes especially dolphin *(Coryphaena hippurus)*. This material further supports the Councils conclusions.

"One major contribution of this paper is that we have documented the importance of the Sargassum community to dolphin, and therefore to anglers that fish for the species. Traditionally, fishermen seek weed-lines to land dolphin and other pelagic fishes. Seasonal angling success has been associated with the distribution of Sargassum along the southeastern United States. For instance, Rose and Hassler (1974) suggested that diminished landings of dolphin off North Carolina were probably caused by lack of tide-lines (usually caused by floating rows of Sargassum) rather than overfishing in previous years as some believed."

"Much of the material indicated that dolphin frequently feed at the surface and ingest fishes, crustaceans, insects, plants, and inorganic items that are associated with floating Sargassum."

"Sargassum which occurred in 48.6% of the stomachs, was considered to be consumed incidental to normal foods."

Table 8. Percentages occurrence of *Sargassum* in the stomachs of dolphin *Coryphaena hippurus* and yellowfin tuna (Data Source: Manooch et al., 1984; Rose and Hassler, 1974; and Manooch and Mason, 1983).

	Species	Number	Season or Size (FL)	% Occurrence of *Sargassum* in stomach
Rose and Hassler, 1974	Dolphin	396	All	28%
Manooch et al., 1984	Dolphin	2,219	All	48.6%
Manooch et al., 1984	Dolphin	158	Spring	55.1%
Manooch et al., 1984	Dolphin	845	Summer	50.9%
Manooch et al., 1984	Dolphin	61	Fall	29.5%
Manooch et al., 1984	Dolphin	14	Winter	41.2%
Manooch et al., 1984	Dolphin	13	≥300 mm	23%
Manooch et al., 1984	Dolphin	987	≥300-500 mm	49%
Manooch et al., 1984	Dolphin	686	≥500-700 mm	55%
Manooch et al., 1984	Dolphin	192	≥700-900 mm	43.8%
Manooch et al., 1984	Dolphin	189	≥900-1,100 mm	43%
Manooch et al., 1984	Dolphin	71	≥1,100 mm	38%
Manooch and Mason (1983)	Yellowfin tuna			26.5%
Manooch and Mason (1983)	Blackfin tuna			12.4%

"The relative contribution of the Sargassum community to the diet may be indicative of physiological constraints on the foraging behavior of these pelagic predators. The pursuit and capture of free-swimming prey in the open ocean is energetically expensive, while grazing on relatively sessile animals associated with Sargassum can be accomplished without great energy expenditure. The tunas consume a greater proportion of pelagic, adult fishes and take less prey from the Sargassum community than do dolphin. Although both tunas and dolphin are capable of high speed pursuit, tunas have highly vascularized locomotion muscles enabling sustained aerobic metabolism. Dolphin, with a much smaller portion of red muscle, must rely primarily on anaerobic metabolic pathways (mainly glycolosis), and therefore are limited to short bursts of acceleration. Thus, the energetic strategy for dolphin seems to be forage primarily on smaller prey from the Sargassum community, but also to capture larger prey with short bursts of high speed pursuit if the opportunity arises."

4.5 Endangered Species and Marine Mammal Acts

The Sustainable Fisheries Act of 1996 established certain requirements and standards the Councils and the Secretary must meet in managing fisheries under the Magnuson-Stevens Act. Implementing the provisions in the SFA will not have any negative impacts on the listed and protected species under the Endangered Species Act (ESA) and Marine Mammals Protection Act (MMPA) including:

	Whales:	Date Listed
(1)	Northern right whale- *Eubalaena glacialis* (ENDANGERED)	12/2/70
(2)	Humpback whale- *Magaptera novaeangliae* (ENDANGERED)	12/2/70
(3)	Fin whale- *Balaenoptera physalus* (ENDANGERED)	12/2/70
(4)	Sei whale- *Balaenoptera borealis* (ENDANGERED)	12/2/70
(5)	Sperm whale- *Physeter macrocephalus* (ENDANGERED)	12/2/70
(6)	Blue whale- *Balaenoptera musculus* (ENDANGERED)	

	Sea Turtles:	Date Listed
(1)	Kemp's ridley turtle- *Lepidochelys kempii* (ENDANGERED)	12/2/70
(2)	Leatherback turtle- *Dermochelys coriacea* (ENDANGERED)	6/2/70
(3)	Hawksbill turtle- *Eretmochelys imbricata* (ENDANGERED)	6/2/70
(4)	Green turtle- *Chelonia mydas* (THREATENED/ENDANGERED)	7/28/78
(5)	Loggerhead turtle- *Caretta caretta* (THREATENED)	7/28/78

	Other Species Under U.S. Fish and Wildlife Service Jurisdiction:	Date Listed
(1)	West Indian manatee- *Trichechus manatus* (ENDANGERED)	3/67
	(Critical Habitat Designated)	1976
(2)	American crocodile - *Crocodulus acutus* (ENDANGERED)	9/75
	(Critical Habitat Designated)	12/79

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6.0 REFERENCES

Adams, J. A. 1960. A contribution to the biology and post-larval development of the *Sargassum* fish, *Histrio histrio* (Linnaeus), with a discussion of the *Sargassum* complex. Bull. Mar. Sci. 10:55-82.

7.0 APPENDICES

Appendix A. Results of Literature Search

Wahoo (*Acanthocybium solandri*)

TI: Title
Fisheries enhancement using artificial habitats in the U.S. Virgin Islands.
AU: Author
Friedlander, A; Beets, J
AF: Author Affiliation
Dep. Plann. and Nat. Resour., Div. Fish and Wildl., 101 Estate Nazareth, St. Thomas, USVI 00802
CA: Corporate Author
Gulf and Caribbean Fisheries Inst., Charleston, SC (USA)
CF: Conference
41. Annu. Gulf and Caribbean Fisheries Inst., St. Thomas (USVI), Nov 1988
ED: Editor
Goodwin, MH; Kau, SM; Waugh, GT (eds)
SO: Source
PROCEEDINGS OF THE FORTY-FIRST ANNUAL GULF AND CARIBBEAN FISHERIES
INSTITUTE, ST. THOMAS, U.S.V.I., NOVEMBER 1988., 1992, pp. 226-242, Proceedings of the Gulf and Caribbean Fisheries Institute [PROC. GULF CARIBB. FISH. INST.], vol. 41
IS: ISSN
0072-9019
AB: Abstract
Artificial habitats ranging from sunken vessels to designed artificial reefs have been utilized by fishermen for many years in the U.S. Virgin Islands. Continuing experiments have documented appropriate materials and design to enhance fisheries habitat using artificial structures. Extreme habitat degradation and overfishing have necessitated the development of these enhancement measures. Experimental artificial reefs and fish aggregating devices (FADs) have been used as models to determine optimal design and location. Inexpensive, easily deployed FADs have been developed to improve recreational commercial catches of migratory pelagics such as wahoo, kingfish, dolphin, tuna and billfish. Experimental inshore artificial reefs have been used to document the importance of structure, material effectiveness, optimal location and design of artificial reefs used to enhance abundances of important target species.

TI: Title

A preliminary investigation of the migration of oceanic pelagic
fish in the Western Central Atlantic.

AU: Author
Hunte, W; Mahon, R

AF: Author Affiliation
Biol. Dep., Univ. West Indies, Cave Hill, Barbados

CA: Corporate Author
FAO Western Cent. Atlantic Fishery Comm., Rome (Italy)

CF: Conference
4. Sess. of the WECAFC Working Party on Assessment of Marine
Fishery Resources, Paipa (Colombia), 29 Oct 1984

SO: Source
WESTERN CENTRAL ATLANTIC FISHERY COMMISSION. NATIONAL REPORTS
AND
SELECTED PAPERS PRESENTED AT THE FOURTH SESSION OF THE WORKING
PARTY ON ASSESSMENT OF MARINE FISHERY RESOURCES, PAIPA
DEPARTMENT
OF BOYACA, COLOMBIA, 29 OCTOBER-2 NOVEMBER 1984., 1985, pp.
154-164, FAO FISH. REP./FAO, INF. PESCA/FAO, RAPP. PECHES., no.
327suppl

IB: ISBN
92-5-002270-0

NT: Notes
FAO FIP/R327-suppl-(Tri).

AB: Abstract
An attempt was made to investigate migration patterns of oceanic
pelagic fish in the western Central Atlantic through comparisons
of the seasonality of catch in the different territories. The data
suggest that there may be separate northwest and southeast stocks
of the dolphin-fish (Coryphaena hippurus) in the Western Central
Atlantic. This hypothesis is supported by comparative life history
and electrophoretic studies of dolphin-fish from Barbados and
Miami. Preliminary data on seasonality of catch are also supplied
by blue marlin, yellowfin tuna, wahoo, king mackerel and Spanish
mackerel, but few conclusions on migration can be drawn. For king
mackerel and Spanish mackerel stocks may be moving northerly along
the southeastern coast of the United States.

TI: Title
Survey of the charter boat troll fishery in North Carolina, 1977

AU: Author
Manooch,C.S.; Laws,S.T.

AF: Author Affiliation
US Natl. Mar. Fish. Serv., Southeast Fish. Cent., Beaufort, NC, USA

SO: Source
Mar. Fish. Rev., 41(4), 15-27, (1979)

ER: Environmental Regime

Marine

AB: Abstract

North Carolina's 127 charter boats made 7,935 trips trolling for pelagic fishes in 1977. The number of boats fishing for pelagic species varied from 65 to 107 depending on the month. Excluding billfishes, 238,413 fish weighing 1.6 million pounds (726 metric tons) were caught, an average of 30 fish and 198 pounds per trip. Major species landed by weight were: king mackeral, Scomberomorus cavalla , 737,680 pounds (344.7t); bluefish, Pomatomus saltatrix , 244,618 pounds (110.0t); dolphin, Coryphaena hippurus , 174,435 pounds (79.3t); amberjack, Seriola spp., 108,998 pounds (49.9t); and wahoo, Acanthocybium solanderi , 76,324 pounds (34.6t). Catch per unit effort varied with season and geographic area and reflected fish migrations. The highest catch rate occurred in October, 4.9 fish per trip, and the lowest in July, 16.3 fish per trip. Boats fishing out of Oregon Inlet and Hatteras Village usually caught a higher percentage of oceanic pelagic species (dolphin, tunas, etc.) and, as a result, had higher mean weights per fish landed.

TI: Title

Survey of the charter boat troll fishery in North Carolina, 1977

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TI: Title
Stomach contents and giant trematodes from wahoo, Acanthocybium solanderi , collected along the South Atlantic and Gulf coasts of the United States.
AU: Author
Manooch, CS III; Hogarth, WT
AF: Author Affiliation
Natl. Mar. Fish. Serv., Southeast Fish. Cent., Beaufort, NC 28516-9722, USA
SO: Source
Bulletin of Marine Science [BULL. MAR. SCI.], vol. 33, no. 2, pp. 227-238, 1983
IS: ISSN
0007-4977
AB: Abstract
Stomachs of 885 wahoo, A. solanderi , collected along the southeastern Atlantic and Gulf of Mexico coasts of the United States from 1965-1981 were examined for food contents and parasites. Approximately 53% of the stomachs contained food consisting primarily of pelagic fishes and squids. Frigate mackerel, Auxis thazard , procupinefish, Diodon hystrix and flyingfish, Cypselurus sp., occurred mopst frequently. There were only slight differences between the diets of wahoo collected from the Gulf of Mexico and from the southeastern United States. Unlike several sympatric species, wahoo did not eat small items, nor did they feed as readily at the surface. No relationship was found between the size of wahoo and the size of prey. Giant digenetic trematodes, tentatively identified as Hirudinella ventricosa , were found in 80.5% of the stomachs (x@u- = 2 parasites/fish). Size and sex of the host had no significant effect on parasitic infestation; geographical area of collection did.

Dolphin (***Coryphaena hippurus***)

TI: Title
Feasibility of a commercial growout of juvenile mahimahi Coryphaena hippurus
AU: Author
Ako, H; Kraul, S; Fujikawa, L; Britten, K; Holland, MC
AF: Author Affiliation
Dep. Environ. Biochem., Univ. Hawaii, Honolulu, HI 96822, USA
CF: Conference
World Aquaculture '93 Int. Conf., Torremolinos (Spain), 26-28 May 1993
ED: Editor
Carrillo, M; Dahle, L; Morales, J; Sorgeloos, P; Svennevig, N; Wyban, J (eds)

SO: Source
FROM DISCOVERY TO COMMERCIALIZATION., EUROPEAN AQUACULTURE SOC.,
OOSTENDE (BELGIUM), 1993, p. 306, Special Publication, European Aquaculture Society [SPEC. PUBL. EUR. AQUACULT. SOC.], no. 19
IS: ISSN
0774-0689
NT: Notes
Summary only.
PB: Publisher
EUROPEAN AQUACULTURE SOC., OOSTENDE (BELGIUM)
AB: Abstract
Mahimahi (Coryphaena hippurus) is an attractive candidate for aquaculture in Hawaii. In 1986, about 400,000 pounds of fresh mahimahi were landed and 4,000,000 pounds of frozen mahimahi filets were imported at an estimated total value of $6,000,000. Husbandry concerns were getting fish to consume optimal amounts of lysine, DHA, and energy and limiting mortality due to aggression and bloating. 11.5 g fingerlings grew to 2 kg in 4 months at a water temperature was 23-25 degree C. Survival was 81%. We used a 20 foot tank in which 4 airstones and 4 spraybars were able to sustain a dissolved oxygen level of 6.5 ppm at a fish density of 10 kg/m super(3). The feed conversion ratio was 1.04. Growth followed an equation that assumed a 7.63% daily growth rate on day 57 post-hatch (stocking day). Daily decreases in growth rate were 1% of the previous day's growth rate except after day 128, when decreases were 2%/day. The fish started eating at approximately 7% of their bodyweight/day but slowed down to 1.5-2% near the end of the trial. After harvest, filets contained about 3-4 times the DHA level of either wild caught Hawaiian mahimahi or frozen mahimahi. The filets contained 5.8 plus or minus 1.2% fat, suggesting an alternate method of cooking (barbeque) and a "jucier" taste. Experiences with pilot scale on-farm production are related.

TI: Title
First record of larval stages of Coryphaena hippurus (Pisces: Coryphaenidae) in the Mediterranean Sea
OT: Original Title
Primera cita de estadios larvarios de Coryphaena hippurus (Pisces: Coryphaenidae) en el Mar Mediterraneo
AU: Author
Alemany, F; Massuti, E
AF: Author Affiliation
I.E.O. Centre Oceanografic de les Balears, Moll de Ponent s/n, Apdo. 291, 07080 Palma de Mallorca, Spain
SO: Source

Scientia Marina (Barcelona) [Sci. Mar. (Barc.)], vol. 62, no. 1-2, pp. 181-184, Jun 1998
IS: ISSN
0214-8358

AB: Abstract
The occurrence of early larval stages of Coryphaena hippurus is reported for the first time in Mediterranean waters. Four larvae between 3.25 and 4.80 mm standard length were found in ichthyoplanktonic collections taken off the Balearic Islands between 1985 and 1995. Their capture is discussed in relation to the life cycle proposed for this species in the area.

TI: Title
[Rearing of Coryphaena hippurus]
OT: Original Title
Elevage de la dorade coryphene (Coryphaena hippurus)
AU: Author
Ayari, A; Ben Ouada, H; Peyrou, B
AF: Author Affiliation
Centre National d'Aquaculture, B.P. 59, Route de Khniss, 5000 Monastir, Tunisia
CA: Corporate Author
International Cent. for Advanced Mediterranean Agronomic Studies, Paris (France)
CF: Conference
Seminar of the CIHEAM Network on Technology of Aquaculture in the Mediterranean (TECAM), Nicosia (Cyprus), 14-17 Jun 1995
SO: Source
[MARINE AQUACULTURE FINFISH SPECIES DIVERSIFICATION. PROCEEDINGS OF THE SEMINAR OF THE CIHEAM NETWORK ON TECHNOLOGY OF AQUACULTURE
IN THE MEDITERRANEAN (TECAM), NICOSIA (CYPRUS), 14-17 JUNE 1995.] DIVERSIFICATION DES ESPECES DE POISSONS EN AQUACULTURE MARINE. ACTES DU SEMINAIRE DU RESEAU CIHEAM SUR LES ASPECTS TECHNOLOGIQUES
DE L'AQUACULTURE EN MEDITERRANEE (TECAM), NICOSIE (CHYPRE), 14-17 JUIN 1995., CIHEAM, ZARAGOZA (SPAIN), 1995, pp. 125-130, CAH. OPTIONS MEDITERR., vol. 16
IS: ISSN
1022-1379
PB: Publisher
CIHEAM, ZARAGOZA (SPAIN)

AB: Abstract
Spawning, larvae rearing, weaning and first ongrowing of Coryphaena hippurus were experimented at the AST hatchery in Tunisia. A total of 67 juveniles were collected from the sea and acclimatised to be used as a brood stock. Sexual maturity begins

at 1.5 kg body mean weight. Spawns were obtained daily when temperature is maintained at 23 degree C. The pelagic eggs size varies between 1600 and 1800 microns. Fecundity and hatch rates are respectively 90% and 85%. Incubation lasts 40 hours at 22 degree C which is the optimal temperature. Larval rearing was conducted for a period of 20 days at a temperature of 22 degree C, with a density of 50 larvae/l and a diet based on artemia nauplii. The survival rate was only 1%, the highest mortality occurs between 11th and 12th day age old. Weaning and first ongrowing shows high growth performance, nevertheless the survival rate is still very low caused principally by cannibalism which begins and continues throughout this rearing period.

TI: Title
A contribution to the natural history of the white-tip shark, Pterolamiops longimanus (Poey)
AU: Author
Backus, RH; Springer, S; Arnold, EL Jr
AF: Author Affiliation
Woods Hole Oceanographic Institution, Woods Hole, MA, USA
SO: Source
Deep-Sea Research [Deep-Sea Res.], vol. 3, no. 3, pp. 178-188, 1956
IS: ISSN
0146-6313
AB: Abstract
Until recently little has been known about the common, pelagic shark, Pterolamiops longimanus. Data gathered during recent offshore cruises show it to be abundant and widely distributed in the warm waters of the western North Atlantic. It occurs at a wide range of salinities but withdraws from some waters when the temperature gets as low as about 21 degree C. It is rarely present in water shallower than about 100 fathoms. In a sample of 110 sharks few were over 250 cm in total length, although the maximum size reported in the literature is much longer. Fish and cephalopods are the most frequent food items in white-tip stomachs. White-tips are cautious, persistent, and sluggish in their behaviour. They are responsible for considerable damage to long line caught tuna in the Gulf of Mexico. Geographical sexual segregation is a feature of white-tip life history. Fragmentary data indicate that the mating and pupping season is in the late spring or early summer and that the gestation period is about one year. Females probably first mate at a length of about 200 cm, and probably bear young in alternate years thereafter. The number of pups per litter varies from 2 to 9 with a mean of about 6. Shark suckers (Remora remora), pilotfish (Naucrates ductor), dolphin (Coryphaena hippurus) and a copepod parasite or parasites are

common associates of the white-tip.

TI: Title
Nutritional value of protein from fresh and spoiled mahimahi (Coryphaena hippurus).
AU: Author
Baranowski, JD; Brust, PA
AF: Author Affiliation
Dep. Food Sci. and Human Nutr., Univ. Hawaii at Manoa, Honolulu, HI 96816, USA
SO: Source
Nutrition Reports International [NUTR. REP. INT.], vol. 30, no. 6, pp. 1337-1342, 1984
AB: Abstract
The net protein utilization (NPU) values of (1) fresh, (2) slightly spoiled (20 mg histamine/100 g) and (3) moderately spoiled (40 mg histamine/100 g) mahimahi (dolphin fish, Coryphaena hippurus) protein were determined at the 10% dietary level in male Wistar rats. It was found that these proteins had higher NPU's than casein and that the 20 mg/100 g diet had a significantly higher NPU than the fresh (0 mg/100 g). Results may indicate that very slight microbial decomposition of the tissue may have made the protein more available for utilization, but that these effects can be offset by elevated histamine levels.

TI: Title
Respiratory distress in dolphin, Coryphaena hippurus, larvae
AU: Author
Benetti, DD; Martinez, L
AF: Author Affiliation
Univ. Miami, Rosenstiel Sch. Mar. and Atmosph. Sci., Div. Mar. Biol. Fish., 4600 Rickenbacker Cswy., Miami FL 33149, USA
CF: Conference
World Aquaculture '93 Int. Conf., Torremolinos (Spain), 26-28 May 1993
ED: Editor
Carrillo, M; Dahle, L; Morales, J; Sorgeloos, P; Svennevig, N; Wyban, J (eds)
SO: Source
FROM DISCOVERY TO COMMERCIALIZATION., EUROPEAN AQUACULTURE SOC.,
OOSTENDE (BELGIUM), 1993, p. 312, Special Publication, European Aquaculture Society [SPEC. PUBL. EUR. AQUACULT. SOC.], no. 19
IS: ISSN
0774-0689
NT: Notes

Summary only.
PB: Publisher
EUROPEAN AQUACULTURE SOC., OOSTENDE (BELGIUM)
AB: Abstract
Microscopic and histological studies of the gills of dolphin (Coryphaena hippurus) larvae during metamorphosis (2-3 weeks after hatching) were conducted to find out whether the mortalities often observed during their larval rearing could be related to respiratory distress. It has been previously reported that the larvae resistance to hypoxia decreases and their oxygen tolerance increases markedly during that stage. Growth rates of dolphin larvae during the 2nd-3rd week after hatching are very high, and the diffusion of gases across the skin is reduced because of the thicker blood/water barrier caused by tissue growth. The rapid decline in the surface/volume ratio decreases the role of cutaneous respiration as the larvae grow. At 27 degree C, the formation of the primary lammellae began at 11 days after hatching, and was not completed until day 13, when the rudimentary secondary lammellae (where the gases exchange takes place) were first observed. Their gills were not completely formed and were unlikely to be fully functional until 16 days after hatching, following the presence of red cells in the larvae blood. The findings support the hypothesis that the respiratory distress exhibited by dolphin larvae is caused by a switch from cutaneous to branchial respiration during metamorphosis. Since this physiological constraint can lead to stress and cause direct or indirect mortality, better survival of dolphin larvae should be achieved by providing vigorous aeration or moderate levels of hyperoxia in the larval rearing tanks.

TI: Title
Growth rates of captive dolphin, Coryphaena hippurus, in Hawaii
AU: Author
Benetti, DD; Iversen, ES; Ostrowski, AC
AF: Author Affiliation
Rosenstiel Sch. Mar. and Atmos. Sci., Div. Mar. Biol. and Fish., Univ. Miami, 4600 Rickenbacker Causeway, Miami, FL 33149, USA
SO: Source
Fishery Bulletin [FISH. BULL.], vol. 93, no. 1, pp. 152-157, 1995
IS: ISSN
0090-0656
AB: Abstract
Dolphin, Coryphaena hippurus, also known as mahimahi or dolphin fish, are pelagic, predatory fish distributed in tropical and subtropical regions throughout the world. In this paper, growth rates of dolphin reared in Hawaii are presented and compared with

those of captive and wild dolphin from different populations, as well as other teleost species. The data presented suggest that there are differences in growth rates and morphology between captive and wild dolphin.

TI: Title
The standard metabolic rate of dolphin fish
AU: Author
Benetti, DD; Brill, RW*; Kraul, SA Jr
AF: Author Affiliation
Southwest Fish. Sci. Cent. Honolulu Lab., NMFS/NOAA, 2570 Dole St., Honolulu, HI 96822-2396, USA
SO: Source
Journal of Fish Biology [J. FISH BIOL.], vol. 46, no. 6, pp. 987-996, 1995
IS: ISSN
0022-1112
AB: Abstract
The standard metabolic rates (SMRs) of 11 (1.395-4.125 kg) dolphin fish (mahimahi or dorado, Coryphaena hippurus) were measured at 25 degree plus or minus 0.5 degree C. Fish were prevented from swimming with neuromuscular blocking agents and force ventilated. Heart rates were determined simultaneously, SMRs (358-726 mg O/H) super(-1) were several times those of other similarly sized active teleosts such as salmonids, but close to those of tunas. Heart rates (84-161 beats min super(-1)) were also high, but alike those of tunas under similar circumstances. As in tunas, the high SMR of dolphin fish may result from high osmoregulatory costs engendered by their large gill surface areas and/or other adaptations necessary for achieving exceptionally high maximum metabolic rates.

TI: Title
[Basic ecology of Coriphaena hippurus (Pisces: Coriphaenidae) and abundance of other large pelagic in the Costa Rica Pacific]
OT: Original Title
Ecologia basica de Coriphaena hippurus (Pisces: Coriphaenidae) y abundancia de otos grandes pelagicos en el Pacifico de Costa Rica
AU: Author
Campos, JA; Segura, A; Lizano, O; Madrigal, E
AF: Author Affiliation
Centro de Investigacion en Ciencias del Mar y Limnologia, Universidad de Costa Rica, San Jose, Costa Rica
SO: Source
Revista de biologia tropical. San Jose [Rev. Biol. Trop.], vol. 41, no. 3B, 1993

IS: ISSN
0034-7744
AB: Abstract
Catch records, reproductive biology, length population structure, and feeding were studied for Coryphaena hippurus and other large pelagics for six months. C. hippurus represented more than 75% of capture in surface long lines. Landing statistics analysis, CPUE curves vs. effort and net monthly changes in catch, indicate that C. hippurus presents a strong "pulse" that responds positively to fishing pressure. The monthly length structure and the gonadal analysis reflect a bimodal reproductive pattern, with recruitment peak between September and October.

TI: Title
Basic ecology of Coryphaena hippurus (Pisces: Coryphaenidae) and abundance of other large pelagic organisms in the Pacific of Costa Rica.
OT: Original Title
Ecologia basica de Coryphaena hippurus (Pisces: Coryphaenidae) y abundancia de otros grandes pelagicos en el Pacifico de Costa Rica
AU: Author
Campos, JA; Segura, A; Lizano, O; Madrigal, E
AF: Author Affiliation
Cent. Invest. Cienc. Mar Limnol. (CIMAR), Univ. Costa Rica, San Jose, Costa Rica
SO: Source
Revista de biologia tropical. San Jose [REV. BIOL. TROP.], vol. 41, no. 3-B, pp. 783-790, 1993
IS: ISSN
0034-7744
AB: Abstract
Catch records, reproductive biology, length population structure, and feeding were studied for Coryphaena hippurus (dorado) and other large pelagics. Historical data, sampling on landing sites and experimental fishing for six months were employed. Dorado represented more than 75% of capture in surface long lines. Other species of importance were Istiophorus platypterus (sail fish) and Carcharhinus falciformis (shark). Analysis of landing statistics, curves of CPUE vrs. effort and net monthly changes in catch, indicate that C. hippurus presents a strong "pulse" and is a resource that responds positively to fishing pressure. No significant statistical relations were found between CPUE and surface temperature or the initial, mid and final depth of the termocline. Experimental fishing yielded an adult and sexually mature stock. The monthly length structure and the gonadal analysis reflect a bimodal reproductive pattern, with a

recruitment peak between September and October, resulting from spawning in January and February. Exocoetidae was the best represented family in numbers and weight of prey found.

TI: Title
Note on the length-weight relationship in dolphin fish, Coryphaena hippurus L.
AU: Author
Chatterji, A; Ansari, ZA
AF: Author Affiliation
Natl. Inst. Oceanogr., Dona Paula, Goa-403 004, India
SO: Source
Mahasagar. Dona Paula [MAHASAGAR.], vol. 18, no. 3, pp. 425-427, 1985
IS: ISSN
0542-0938
AB: Abstract
Length-weight relationship in Coryphaena hippurus almost follows the cube law and the weight of the fish increases more than the square of the length. The value of "b" was higher in males as compared to females. The equations for length-weight relationship were: Log W = -4.987 + 2.114 Log L for females, Log W = -4.177 + 2.510 Log L for males and Log W = -4.926 + 2.894 Log L for combined sexes.

TI: Title
Fecundity of dolphin fish, Coryphaena hippurus L.
AU: Author
Chatterji, A; Ansari, ZA
AF: Author Affiliation
Natl. Inst. Oceanogr., Dona Paula-403004, Goa, India
SO: Source
Mahasagar. Dona Paula [MAHASAGAR.], vol. 15, no. 2, pp. 129-133, 1982
IS: ISSN
0542-0938
AB: Abstract
Fecundity of Coryphaena hippuras from the central west coast of India, ranged from 139636 to 549540 with an average of 300878. The number of ova per mm total length, per g body weight and per g ovary weight were 407, 175 and 5851 respectively. A linear relationship was noticed between fecundity, body weight and ovary weight of the fish while fecundity and total length showed a parabolic relationship.

TI: Title

Larval development, distribution, and abundance of common dolphin, Coryphaena hippurus, and pompano dolphin, C. equiselis (family: Coryphaenidae), in the northern Gulf of Mexico

AU: Author

Ditty, JG; Shaw, RF; Grimes, CB; Cope, JS

AF: Author Affiliation

Cent. Coast., Energy, and Environ. Resour., Louisiana State Univ., Baton Rouge, LA 70803, USA

SO: Source

Fishery Bulletin [FISH. BULL.], vol. 92, no. 2, pp. 275-291, 1994

IS: ISSN

0090-0656

AB: Abstract

Dolphinfishes (Coryphaena) are highly prized commercial and recreational species of worldwide distribution in tropical and subtropical seas, but the development and distribution of their larvae are poorly understood. Common dolphin eggs hatch in about 38 hours at 25 degree C based on a predictive relationship among egg diameter, water temperature, and development time. Morphometrics are generally greater in pompano dolphin than in common dolphin. Pompano dolphin are deeper-bodied and have a larger eye by 9 mm, and a larger mouth and longer pre-anal length by about 13 mm. Differences in pigment along the caudal peduncle and its finfold separate common dolphin from pompano dolphin <4.0-4.5 mm SL; common dolphin lack pigment in these areas. Number of spines along the outer shelf of the preopercle also separate species although preopercle spines are often difficult to count on larvae not cleared and stained; common dolphin have four spines along the outer preopercular shelf and pompano dolphin have five. Pigmented pelvic fins and bands of pigment laterally on both the body and median fins of common dolphin are diagnostic for separating species >8 mm SL; pompano dolphin lack these characters. Both common dolphin and pompano dolphin larvae usually are found at greater than or equal to 24 degree C, greater than or equal to 33 ppt, and beyond the 50 m isobath. Preflexion larvae (<7.0-7.5 mm SL) were primarily collected in oceanic waters. Both species may spawn year-round, at least in the southern part of the survey area. Larval common dolphin are significantly more abundant than pompano dolphin.

TI: Title

Enzymes present in pancreatic extracts of the dolphin (fish) Coryphaena hippurus .

AU: Author

Divakaran, S; Ostrowski, AC

AF: Author Affiliation

Oceanic Inst., Makapuu Point, P.O. Box 25280, Honolulu, HI 96825,

USA
SO: Source
Journal of the World Aquaculture Society [J. WORLD AQUACULT. SOC.], vol. 21, no. 1, pp. 35-40, 1990
IS: ISSN
0893-8849
AB: Abstract
Pancreatic extract of adult dolphin Coryphaena hippurus was found to have a broad range of proteolytic activity with two peaks, one at pH 5-6 and another at pH 10, when casein was used as a substrate. Enzymes similar in activity to those of pepsin, trypsin, amylase, lipase and collagenase were detected in the extracts by the use of specific chromogenic substrates for each enzyme. The relationship between these enzyme activities, and the formation of diets for culture of this species, is discussed.

TI: Title
Gastrointestinal helminth-mix in thirteen dolphinfish (Coryphaena hippurus) from southern Puerto Rico
AU: Author
Dyer, WG; Williams, EH Jr; Bunkley-Williams, L
AF: Author Affiliation
Department of Zoology, Southern Illinois University, Carbondale, IL 62901-6501, USA
SO: Source
Caribbean Journal of Science [CARIBB. J. SCI.], vol. 33, no. 1-2, pp. 120-121, Jan 1997
IS: ISSN
0008-6452
AB: Abstract
Dolfinfish are swift predators that feed on a variety of fish, squids, and other invertebrates. Fifty-five species of fish, belonging to 34 families have been recorded from the stomachs of Coryphaena hippurus Linnaeus, 1758, from the southeastern and Gulf of Mexico coasts of the United States (Manooch et al., 1984). Few surveys on the parasites, and in particular the helminths, of C. hippurus have been reported. Most reports are restricted either to descriptions of new species or to the listing of parasites as a minor study objective in conjunction with a food content survey. The present study constitutes the first report of the parasite-mix of helminths in dolphinfish from southern Puerto Rico.

TI: Title
Effects of fish aggregating device design and location on fishing success in the U.S. Virgin Islands
AU: Author

Friedlander, A; Beets, J; Tobias, W

AF: Author Affiliation

Dep. Zool., Univ. Hawaii, 2538 The Mall, Honolulu, HI 96822, USA

CF: Conference

5. Int. Conf. on Aquatic Habitat Enhancement, Long Beach, CA (USA), 3-7 Nov 1991

SO: Source

FIFTH INTERNATIONAL CONFERENCE ON AQUATIC HABITAT ENHANCEMENT., 1994, pp. 592-601, Bulletin of Marine Science [BULL. MAR. SCI.], vol. 55, no. 2-3

IS: ISSN

0007-4977

AB: Abstract

Fish aggregating devices (FADs) of various designs were deployed around the U.S. Virgin Islands to test their relative effectiveness in concentrating pelagic fishes and improving recreational and commercial fishing. Subsurface FADs were deployed along the shelf edge and inshore off St. Thomas. Off St. Croix, surface and subsurface FADs were placed along the shelf edge. Fishing success was evaluated by experimental trolling around FAD and control locations. Over 170 trolling trips comprising 447 fishing h were conducted between 1986 and 1990. Catch per boat hour ranged from 0.04 to 1.054 on the FADs and 0.07 to 0.305 on the controls. Trolling around FADs yielded a significantly greater number of fish and strikes than control areas except for the St. Croix subsurface FADs. Species diversity of catch also was significantly greater on the FADs compared to controls except for the St. Croix subsurface units. No significant differences in fishing success were found between the St. Thomas subsurface FADs and the St. Croix surface FADs. The St. Thomas subsurface FADs attracted more coastal pelagic species such as barracuda (Sphyraena barracuda), jacks (Carangidae) and king mackerel (Scomberomorous cavalla), while the St. Croix surface FADs attracted more oceanic pelagics such as tunas (Scombridae) and dolphin (Coryphaena hippurus). The evaluation of various FAD designs and locations can help in the decision of future FAD deployment to meet specific management needs.

TI: Title

[Oceanological prerequisites for formation of concentrations of large pelagic predators in the Indian Ocean]

OT: Original Title

Okeanologicheskie predposylki formirovaniya skoplenij krupnykh pelagicheskikh khishchnikov v Indijskom okeane

AU: Author

Gubanov, EP; Paramonov, VV

AF: Author Affiliation
Southern Scientific Research Institute of Marine Fisheries & Oceanography (YugNIRO), 2, Sverdlov St., 334500, Kerch, Crimea, Ukraine
CF: Conference
1. Interstate Conf. 'Resources of Tunas and Related Species in the World Ocean and Problems of their Rational Utilization', Kerch (Ukraine), 1-5 Jun 1992
ED: Editor
Yakovlev, VN; Romanov, EV; Lebedeva, NA; Trushyn, YuK; Timokhin, IG; Trotsenko, BG; Korkosh, VV; (eds.)
SO: Source
[RESOURCES OF TUNAS AND RELATED SPECIES IN THE WORLD OCEAN AND PROBLEMS OF THEIR RATIONAL UTILIZATION.] SYR'EVYE RESURSY TUNTSOV I SOPUTSTVUYUSHCHIKH OB"EKTOV PROMYSLA MIROVOGO OKEANA I PROBLEMY
IKH RATSYONAL'NOGO ISPOL'ZOVANIYA., YUGNIRO, KERCH (UKRAINE), 1993, pp. 69-71
PB: Publisher
YUGNIRO, KERCH (UKRAINE)
AB: Abstract
The specific feature of the North-Western Indian Ocean, where main tuna long-line and purse seine fisheries take place, is seasonal variability of water circulation connected with periods of north-eastern and south-western monsoons. Somali and Monsoon currents have significant impact on formation of tuna concentrations. Significant difference in biological state and species composition of objects of long-line and purse fishing defines difference in conditions of formation of their concentrations. Concentrations, fished by purse seines, are the mixture of small tunas (Katsuwonus, Auxis, Euthynnus) and juveniles of large tunas (Thunnus albacares, Thunnus obesus) and with a small share of billfishes (Istiophoridae, Xiphiidae) and other associated fishes (triggerfish Canthidermis maculatus, rainbow runner Elagatis bipinnulatus, dolphin fish Coryphaena hippurus). Using satellite images of ocean surface temperature made possible to determine that concentrations have bent for local warm 'spots' standing out against a background of colder waters. Long-line is a passive fishing gear, even rather scarce tuna concentrations inhabiting in the depth range of 80-380 m as well as large sharks and billfishes are fished with it. The border dividing ecological niches of inhabiting of these two species is a layer of surface minimum of oxygen (Ivshin et al., 1971). Tunas migrating in the vicinity of gradient zones or in the parallel direction are the most available for fishing off, therefore search of gradient zones is the main task during tuna fisheries.
Long-line sets between nearly located temperature maximum and

minimum are the most promising. (DBO).

TI: Title
The growth and culture of dolphin Coryphaena hippurus, in North Carolina
AU: Author
Hassler, W.W.; Hogarth, W.T.
AF: Author Affiliation
Dep. Zool., NC State Univ., Raleigh, NC 27607, USA).
SO: Source
Aquaculture, 12(2), 115-122, (1977)
IS: ISSN
ISSN 0044-8486
ER: Environmental Regime
Marine
AB: Abstract
Juvenile dolphin were captured in the vicinity of the Gulf Stream off Hatteras, N.C., and held in pens in estuarine waters. A tank was designed specifically for fish transportation. Captive fish tolerated salinities ranging from 16 to 16 parts per thousand and temperatures ranging from 15 to 29.4 degree C. Separate feeding trials resulted in food conversion ratios of 3.54 and 3.44 (wet weights). Another trial involving 21 dolphin resulted in an average gain of 0.39 kg per week. Dolphin fed readily on a variety of cut fresh fish but rejected dolphin flesh. They were also trained to accept pelletized food. Dolphin have great potential for use in mariculture because of their rapid growth, palatability, good market price, and tolerance to estuarine conditions. As the growing season for dolphin does not extend for more than 6 months at Hatteras, N.C., warmer climates with year-round growing seasons are recommended for dolphin culture.

TI: Title
Use of beef liver in the diet of juvenile mahimahi, Coryphaena hippurus L
AU: Author
Iwai, T Jr; Ako, H; Yasukochi, LE
SO: Source
World Aquaculture [WORLD AQUACULT.], vol. 23, no. 3, pp. 49-50, 1992
IS: ISSN
1041-5602
AB: Abstract
Incorporating beef liver into the basal diet of the mahimahi, Coryphaena hippurus resulted in a significant improvement in both growth and survival of juvenile mahimahi (42d posthatching) over a 26 experimental period. A basal diet consisting of a 1:1 mixture

(by weight) of frozen squid (no entrails) and skinned mahimahi fillets was compared against a diet that incorporated frozen beef liver in a 1:1:1 ratio. Significantly higher survival (100% versus 50%), average fork length (19.9 plus or minus 1.7 cm versus 12.2 plus or minus 1.8 cm), and average body weights (88.2 plus or minus 17.6 g versus 34.1 plus or minus 13.4 g) were obtained from mahimahi fed the diet in which beef liver was added. Mahimahi fed the basal diet had numerous physical deformities typical of past results in the culture of this species. Some of these abnormalities were reversed when beef liver was incorporated into the diet of afflicted individuals.

TI: Title
Trials with fish aggregation devices (FADs) off west and south-west coasts of Sri Lanka
AU: Author
Jayakody, DS; Pieris, SSC
CA: Corporate Author
National Aquatic Resources Agency, Colombo (Sri Lanka)
SO: Source
ANNUAL SCIENTIFIC SESSIONS OF THE NATIONAL AQUATIC RESOURCES AGENCY 1994. ABSTRACTS OF PAPERS, NARA, COLOMBO (SRI LANKA), 1994, pp. 2-3
NT: Notes
Summary only.
PB: Publisher
NARA, COLOMBO (SRI LANKA)
AB: Abstract
Three fish aggregation devices (FADs), made from bamboo and other locally available materials, were deployed on the continental slope off Lunawa, Panadura (West coast of Sri Lanka) and Ambalangoda (Southwest coast of Sri Lanka). Information on fishing effort associated with the FADs, catch and species composition were collected during weekly vists. When compared to other non-FAD associated fisheries conducted by the same gear, handline fishing with live bait using non-mechanized traditional canoes was shown as the ideal fishing craft/gear combination to fish around FADs. Coryphaena hippurus and Elagatus bipinnatus contributed 42.4% and 21.7% respectively to the total catch. As these 2 species are not caught in large quantities in other fisheries, FADs proved to be useful in exploiting this underutilized resource.

TI: Title
Thermal dependence of contractile properties of single skinned muscle fibres from Antarctic and various warm water marine fishes including skipjack tuna (Katsuwonus pelamis) and Kawakawa (Euthynnus affinis)

AU: Author
Johnston, IA; Brill, R
AF: Author Affiliation
Dep. Physiol., Univ. St Andrews, St Andrews, Fife KY16 9TS, UK
SO: Source
Journal of Comparative Physiology, B [J. COMP. PHYSIOL., B], vol. 155, no. 1, pp. 63-70, 1984
IS: ISSN
0174-1578
AB: Abstract
Single fast fibres and small bundles of slow fibres were isolated from the trunk muscles of an Antarctic (Notothenia neglecta) and various warm water marine fishes (Carangus melampygus; Mugil cephalus; Coryphaena hippurus; Katsuwonus pelamis and Euthynuus affinis). Fibres were chemically skinned with the non-ionic detergent Brij 58. For warm water species, maximum Ca super(2+)-activated tension (P sub(0)) almost doubled between 5-20 degree C with little further increase up to 30 degree C. In general, Q sub(10(15-30 degree C)) values for V sub(max) were in the range 1.8-2.0 for all warm water species studied except Skipjack tuna. V sub(max) for the internal red muscle fibres of Skipjack tuna were much more temperature dependent. (Q sub(10(15-30 degree C))=3.1) than for superficial red or white muscle fibres. In tuna, both red and white muscle may contribute to power generation during high speed swimming. (DBO)

TI: Title
Review of hatchery design and techniques used at the Oceanic Institute for intensive culture of the mahimahi (Coryphaena hippurus) on a commercial scale

AU: Author
Kim, BG; Ostrowski, AC; Brownell, C
AF: Author Affiliation
Ocean. Inst., Makapu'u Point, Waimanalo, HI 96795, USA
CF: Conference
Finfish Hatchery in Asia '91, Tungkang (Taiwan), 17-19 Dec 1991
ED: Editor
Lee, Cheng-Sheng; Su, Mao Sen; Liao, I Chiu (eds)
SO: Source
FINFISH HATCHERY IN ASIA. PROCEEDINGS OF FINFISH HATCHERY IN ASIA '91., TUNGKANG MARINE LABORATORY, TFRI, KEELUNG (TAIWAN), 1993, pp. 179-190, TML conference proceedings. Tungkang [TML CONF. PROC.], no. 3
IS: ISSN
0256-2227
IB: ISBN
957-00-3086-0

PB: Publisher
TUNGKANG MARINE LABORATORY, TFRI, KEELUNG (TAIWAN)
AB: Abstract
Much interest has been generated during the last decade in promoting the culture of the mahimahi, Coryphaena hippurus, due to its rapid growth rate and high marketability. The purpose of the mahimahi program at the Oceanic Institute in Hawaii is to advance culture technology to the point of commercial feasibility. Hatchery research and design has focused on the creation of a cost-effective, commercially applicable operation. Larvae are cultured using Artemia as the sole food source, high water inflow rates, and no algal inputs. Carefully regulated rearing temperatures, feeding, nutritional enrichment of Artemia and tank hygiene are critical components. Survival of larvae from eggs to metamorphosis (Day 20) is currently 5%. Juveniles are weaned onto dry pellets between 25-30 days of age. To promote rapid growth and limit aggressive behavior, special attention is given to assure that feeding rates are adequate during the nursery period (Day 20-Day 45). Shallow raceways are used to provide a continuous water current to also control aggressive behavior. Survival rates of 50% during the nursery stage are consistently achieved.

TI: Title
Intensive hatchery culture of mahimahi (Coryphaena hippurus) at the Oceanic Institute [Hawaii]
AU: Author
Kim, BG; Monahan, S; Schaleger, E; Ostrowski, AC
AF: Author Affiliation
Oceanic Inst., Makapuu Point, Waimanalo, HI 96795, USA
CF: Conference
World Aquaculture '93 Int. Conf., Torremolinos (Spain), 26-28 May 1993
ED: Editor
Carrillo, M; Dahle, L; Morales, J; Sorgeloos, P; Svennevig, N; Wyban, J (eds)
SO: Source
FROM DISCOVERY TO COMMERCIALIZATION., EUROPEAN AQUACULTURE SOC.,
OOSTENDE (BELGIUM), 1993, p. 401, Special Publication, European Aquaculture Society [SPEC. PUBL. EUR. AQUACULT. SOC.], no. 19
IS: ISSN
0774-0689
NT: Notes
Summary only.
PB: Publisher
EUROPEAN AQUACULTURE SOC., OOSTENDE (BELGIUM)

AB: Abstract

The purpose of the Mahimahi Program at The Oceanic Institute is to advance the culture technology of mahimahi (Coryphaena hippurus) to the point of commercial feasibility. Hatchery research and design have focused on the creation of a cost-effective, commercially applicable operation. Larvae cultured from eggs obtained from captive broodstock are raised using Artemia as the sole food source, high water inflow rates, and no algal inputs. Carefully regulated rearing temperatures, feeding, nutritional enrichment of Artemia and tank hygiene are critical components. Survival of larvae from eggs to metamorphosis (Day 17) has achieved 10%. Juveniles are weaned onto pelleted, practical diets between 20-25 days of age. To promote rapid growth and limit aggressive behavior, special attention is given to assure that feeding rates are adequate during the nursery period (Day 20 - Day 45). Shallow raceways are used to provide a continuous water current as another means of controlling aggressive behavior. Survival rates of 50%, and growth rates of up to 15 g by Day 45, are achieved during the nursery phase. Growout on practical diets to densities between 10 - 15 kg/m super(3) in circular tanks has been achieved. Six harvests have been conducted; the most recent yielded over 300 kg. Individual fish weights average 1 kg at five months of age and 2 kg at 6 months of age.

TI: Title

Comparison of copepods and enriched Artemia as feeds for larval mahimahi, Coryphaena hippurus

AU: Author

Kraul, S; Ako, H; Brittain, K; Ogasawara, A; Cantrell, R; Nagao, T; Lavens, P; Sorgeloos, P; Jaspers, E; Ollevier, F

AF: Author Affiliation

Larval Res. Dep., Waikiki Aquarium, 2777 Kalakaua Ave., Honolulu, HI 96815, USA

CF: Conference

Fish and Crustacean Larviculture Symp., Gent (Belgium), 27-30 Aug 1991

SO: Source

LARVI '91., 1991, pp. 45-47, Special Publication, European Aquaculture Society [SPEC. PUBL. EUR. AQUACULT. SOC.], no. 15

IS: ISSN

0774-0689

IB: ISBN

90-71625-09-5

AB: Abstract

The first dependable methods to raise mahimahi (Coryphaena hippurus) from eggs required using copepods. Watanabe suggested long ago that copepods' high HUFA levels are responsible for better larval survival of marine fishes. Recent improvements in enriching Artemia with HUFAs make mahi culture more practical without using copepods. We still find that mahimahi survive better when cultured copepods (Euterpina acutifrons) are used, especially when the larvae are under stresses such as high stocking density, disease outbreak, cold weather, or the rigors of metamorphosis. Using copepods increases their degree of stress resistance. In this study, we find that stress resistance is a matter of degree, and is increased by increasing the concentration of docosahexaenoic acid (DHA), while eicosapentaenoic acid (EPA) does not appear limiting in the foods tested.

TI: Title
Nutritional factors affecting stress resistance in the larval mahimahi Coryphaena hippurus
AU: Author
Kraul, S; Brittain, K; Cantrell, R; Nagao, T; Ako, H*; Ogasawara, A; Kitagawa, H
AF: Author Affiliation
Dep. Environ. Biochem., Univ. Hawaii, Honolulu, HI 96822, USA
SO: Source
Journal of the World Aquaculture Society [J. WORLD AQUACULT. SOC.], vol. 24, no. 2, pp. 186-193, 1993
IS: ISSN
0893-8849
AB: Abstract
Recent improvements in enriching Artemia make mahimahi culture possible without using copepods. Mahimahi survive better when cultured copepods Euterpina acutifrons are used, especially when the larvae are under stresses such as high stocking density, cold weather, or the rigors of metamorphosis. This study looked at some differences between copepods and enriched Artemia. This study tested stress resistance by holding postlarval (PL) mahimahi out of water in a hand net for varying periods of time. Recovery from this stress shock was higher in PLs whose diet was higher in docosahexaenoic acid (DHA). DHA appeared to play an important role in stress resistance. High eicosapentaenoate (EPA) or high HUFA did not confer stress resistance when DHA levels were low. Copepods contained higher levels of many essential amino acids in addition to higher levels of DHA compared with enriched brine shrimp. Larvae sickened by disease appeared to lose fat, including DHA, but they conserved DHA relative to other fatty acids. Even when sick, mahimahi larvae fed a copepod diet resisted stress better than larvae fed an enriched brine shrimp diet. Optimal Artemia enrichment levels of DHA for mahimahi have not been reached and this may explain why it has been difficult for others to raise this fish consistently. E. acutifrons is relatively easy

to culture, but may not be practical for commercial hatcheries, due to low yield (less than 10 g per 100 L per week).

TI: Title
Special session marine fish: Mahimahi panel session
AU: Author
Kraul, S
AF: Author Affiliation
Univ. Hawaii, Waikiki Aquar., 2777 Kalakaua Ave, Honolulu, HI 96815, USA
CF: Conference
World Aquaculture '93 Int. Conf., Torremolinos (Spain), 26-28 May 1993
ED: Editor
Carrillo, M; Dahle, L; Morales, J; Sorgeloos, P; Svennevig, N; Wyban, J (eds)
SO: Source
FROM DISCOVERY TO COMMERCIALIZATION., EUROPEAN AQUACULTURE SOC.,
OOSTENDE (BELGIUM), 1993, p. 291, Special Publication, European Aquaculture Society [SPEC. PUBL. EUR. AQUACULT. SOC.], no. 19
IS: ISSN
0774-0689
NT: Notes
Summary only.
PB: Publisher
EUROPEAN AQUACULTURE SOC., OOSTENDE (BELGIUM)
AB: Abstract
Mahimahi, Coryphaena hippurus, is the fastest growing cultured fish known, has a 1:1 feed conversion to market size on a commercially available pellet, a high market price, highly fecund natural spawns, and relatively large marine larvae that can eat Artemia nauplii at first feeding. Although mahimahi are adaptable to several hatchery and growout systems, most facilities find it difficult to adapt to the challenges of this exciting fish. Broodstock capture and husbandry, egg quality, larval nutrition and hygiene, juvenile cannibalism and growout feed quality demand special attention. The chairperson presented a short slide show on mahimahi biology and the state of the art. Six scientists presented nine posters. The panel discussed their farm or "farm-like" experiences with mahimahi, with a focus on innovation and diversification. The panel and the audience discussed mahi as a sole versus a diversified crop, special requirements, adapting to new sites and how to solve certain problems.

TI: Title

Larviculture of the mahimahi Coryphaena hippurus in Hawaii, USA
AU: Author
Kraul, S
AF: Author Affiliation
Waikiki Aquarium, 2777 Kalakaua Ave., Honolulu, HI 96815, USA
SO: Source
Journal of the World Aquaculture Society [J. WORLD AQUACULT. SOC.], vol. 24, no. 3, pp. 410-421, 1993
IS: ISSN
0893-8849
AB: Abstract
The Mahimahi Coryphaena hippurus has excellent potential for aquaculture due to its fast growth, good food conversion ratio, high fecundity with natural captive spawns, and high price. Using current technology, three crops a year could yield 288,000 kg/ha of water/yr with a potential profit of US $1,280,000/ha water/yr. Hatchery methods are now adequate for pilot-scale production, and two venture capital companies are pursuing this course. Significant improvement could be made in egg quality, plankton nutrition, plankton substitutes, disease control, reduced aggression, and weaning feeds. More research is needed to learn about digestive physiology, weaning behavior, and the effects of crowding on mahimahi health. Hatchery production is limited most often by the amount of grown out Artemia or yolk-sac mahi larvae provided for postlarval feeding. Problems that occur at the broodstock, hatching, first feeding, second feeding, third feeding, weaning, and early juvenile stages are discussed. Using the current technology, the cost of post-hatchery mahimahi is 33 cents per fry. This cost could be reduced to 6 cents per fry by successfully (consistently) weaning postlarvae from live feeds by 25 days.

TI: Title
Diseases of mahi mahi or common dolphin fish, Coryphaena hippurus, in Australia
AU: Author
Langdon, JS
AF: Author Affiliation
Western Australian Fish. Dep. Fish Health Sect., South Perth WA 6151, Australia
SO: Source
Fisheries research bulletin. Fisheries Department (Western Australia). Perth [FISH. RES. BULL. FISH. DEP. (WEST. AUST.)], FISHERIES DEPARTMENT OF WESTERN AUSTRALIA, PERTH, W.A. (AUSTRALIA), 1991, no. 29, 17 pp
IS: ISSN
0155-9435

IB: ISBN
0-7309-1736-3
NT: Notes
illus., 3 ref.
PB: Publisher
FISHERIES DEPARTMENT OF WESTERN AUSTRALIA, PERTH, W.A. (AUSTRALIA)
AB: Abstract
The diseases encountered in mahi mahi (Coryphaena hippurus) in a land-based hatchery, grow-out sea cages, and from wild populations between 1987 and 1990 were predominantly due to protozoan and metazoan parasites. Milky flesh, or flesh liquefaction post-mortem, due to Kudoa thyrsites, Trichodina gill infections, and eye lesions induced by Benedenia were the most serious infectious diseases of cultured fish. Bacterial diseases were limited to secondary opportunist infections and fin "rot", and no fungal or viral conditions were detected. Non-infectious diseases included Vitamin E deficiency in fry, lateral canal erosions, and miscellaneous dietary and therapeutic toxicities. Several of these agents could restrict the success of mahi mahi farming if not controlled. The principles of a preventative health management plan include use of disease-free stock, quarantine of new stock, use of filtered seawater for on-shore facilities or biological controls such as cleaner wrasses in sea cages, and farm site assessment for pathogens by deployment of sentinel fish. Such measures will assist the successful culture of this promising species.

TI: Title
Marine finfish hatchery technology in the USA - status and future
AU: Author
Lee, Cheng-Sheng
AF: Author Affiliation
Oceanic Institute, Makapuu Point, Waimanalo, HI 96795, USA
CF: Conference
Live Food and Marine Larviculture Symp., Nagasaki (Japan), 1-4 Sep 1996
SO: Source
Hydrobiologia, vol. 358, no. 1-3, pp. 45-54, 22 Dec 1997
IS: ISSN
0018-8158
PB: Publisher
Kluwer Academic Publishers
AB: Abstract
In 1993, about 52% of the 433 698 tons of the total US aquaculture production came from the production of freshwater catfish. Excluding salmonid culture, the percentage of marine finfish culture in total aquaculture production in the US has been

negligible, Commercial scale production of marine finfish in hatcheries is very limited in the US. Studies on eggs and larvae of marine finfish species in the US have stemmed from the consideration of fisheries management rather than aquaculture. Most of the marine finfish larvae produced in the laboratory has been for the purpose of providing materials for other academic related studies. Results of these studies can be applied in the development of marine finfish hatchery technology. Hatchery technology for several marine finfish species has been developed for stock enhancement, technology transfer and aquaculture. This paper reviews the current hatchery technology of striped mullet (Mugil cephalus), dolphin fish (Coryphaena hippurus), red drum (Sciaenops ocellatus), and other potential aquaculture species.

TI: Title
The influence of spatial food distribution on agonistic behavior in juvenile mahimahi, Coryphaena hippurus .
AU: Author
Lutnesky, MMF; Szyyper, JP
AF: Author Affiliation
Hawaii Inst. Mar. Biol., P.O. Box 1346, Kaneohe, HI 96744, USA
SO: Source
Journal of applied ichthyology/Zeitschrift fur angewandte Ichthyologie. Hamburg, Berlin [J. APPL. ICHTHYOL./Z. ANGEW. ICHTHYOL.], vol. 7, no. 4, pp. 253-256, 1991
IS: ISSN
0175-8659
AB: Abstract
Agonistic behavior in juvenile mahimahi Coryphaena hippurus , has been shown to decrease in the presence of food. In this study, we show that agonistic behavior increases in the presence of food when the distribution of food is spatially clumped. Because agonistic behavior potentially leads to disproportional food acquisition, and differential growth rates, the influence of food distribution on agonistic behavior may be important for efficient aquaculture of this species.

TI: Title
Food and gastrointestinal parasites of dolphin Coryphaena hippurus collected along the southeastern and Gulf coasts of the United States.
OT: Original Title
Beikoku tonanbu engan kaiiki no shiira no i naiyobutsu to shokakan kiseichu
AU: Author
Manooch, CS III; Mason, DL; Nelson, RS

AF: Author Affiliation

Southeast Fish. Cent., Beaufort Lab., NMFS, Beaufort, NC, USA

SO: Source

BULL. JAP. SOC. SCI. FISH./NISSUISHI., vol. 50, no. 9, pp. 1511-1525, 1984

IS: ISSN

0021-5392

AB: Abstract

A total of 2,632 dolphin C. hippurus , 250 to 1,530 millimeters for length (FL), were captured by hook and line off the southeastern United States and in the Gulf of Mexico in 1980 and 1981. Eighty-four percent (2,219) of the stomachs contained ingested material consisting of 13,383 individual items. Fishes occured in 77.6% of the stomachs, invertebrates in 27.5%, and miscellaneous items (Sargassum , tar balls, plastics, etc.) in 50.6%. Much of the material indicated that dolphin frequently feed at the surface and ingest fishes, crustaceans, insects, plants, and inorganic items that are associated with floating Sargassum . The ascaridoid nematode Hysterothylacium pelagicum sp.n. and an unidentified digenetic trematode were found in the digestive tracts.

TI: Title

Observations on the pelagic fish community around floating objects in the open sea off Mallorca.

OT: Original Title

Observaciones sobre la comunidad de peces pelagicos asociados a objetos flotantes en aguas oceanicas de Mallorca

AU: Author

Massuti, E; Renones, O

AF: Author Affiliation

Cent. Ocean. Baleares, Inst. Esp. Oceanogr., Muelle de Poniente, Apdo. 291, 07080 Palma de Mallorca, Spain

SO: Source

Boletin del Instituto Espanol de Oceanografia. Madrid [BOL. INST. ESP. OCEANOGR.], vol. 10, no. 1, pp. 81-93, 1994

IS: ISSN

0074-0195

NT: Notes

36 refs.

AB: Abstract

The pelagic fish community associated with floating objects in the open sea off Mallorca was studied, by means of a continuous assessment of a traditional fishery developed on the island. A total of 9 species were found, associated to a greater or lesser extent with this community, within which three groups are distinguishable: (i) Trachurus spp., Balistes carolinensis and small specimens of Naucrates ductor are found very near the floating objects and used as a shelter from predators; (ii) in the case of N. ductor, Seriola dumerili, Polyprion americanus, Schedophilus ovalis and Lobotes surinamensis, the floating objects act as a point of reference in the uniformity of the offshore environment, favoring the formation of schools of fish and their recruitment; whereas (iii) for the large predators such as Coryphaena hippurus and Thunnus thynnus they are indicators of high productivity areas, where they subsist during their migrations.

TI: Title
Observations on the pelagic fish community around floating objects in the open sea off Mallorca.
OT: Original Title
Observaciones sobre la comunidad de peces pelagicos asociados a objetos flotantes en aguas oceanicas de Mallorca
AU: Author
Massuti, E; Renones, O
AF: Author Affiliation
Cent. Oceanogr. Baleares, Inst. Espanol Oceanogr., Mulle de Poniente, s/n. Apdo. 291, 07080 Palma de Mallorca, Spain
SO: Source
Boletin del Instituto Espanol de Oceanografia. Madrid [BOL. INST. ESP. OCEANOGR.], vol. 10, no. 1, pp. 81-93, 1994
IS: ISSN
0074-0195
AB: Abstract
The pelagic fish community associated with floating object in the open sea off Mallorca was studied, by means of a continuous assessment of a traditional fishery developed on the island. A total of 9 species were found, associated to a greater or lesser extent with this community, within which three groups are distinguishable: (i) Trachurus spp., Balistes carolinensis and small specimens of Naucrates ductor are found very near the floating objects and used as a shelter from predators; (ii) in the case of N. ductor, Seriola dumerili, Polyprion americanus, Schedophilus ovalis and Lobotes surinamensis, the floating objects act as a point of reference in the uniformity of the offshore environment, favoring the formation of schools of fish and their recruitment; whereas (iii) for the large predators such a Coryphaena hippurus and Thunnus thynnus they are indicators of high productivity areas where they subsist during their migrations.

TI: Title
Seasonality and reproduction of dolphin-fish (Coryphaena hippurus) in the western Mediterranean
AU: Author
Massuti, E; Morales-Nin, B
AF: Author Affiliation
I.E.O, Cent. Oceanogr. Balears, Moll de Ponent s/n, Apdo. 291, 07080 Palma de Mallorca, Spain
CF: Conference
Int. Symp. on Middle-Sized Pelagic Fish, Las Palmas de Gran Canaria, Gran Canaria, Canary Islands (Spain), 24-28 Jan 1994
ED: Editor
Bas, C; Castro, JJ; Lorenzo, JM (eds)
SO: Source
INTERNATIONAL SYMPOSIUM ON MIDDLE-SIZED PELAGIC FISH HELD IN LAS PALMAS DE GRAN CANARIA 24-28 JANUARY 1994., 1995, pp. 357-364, Scientia Marina (Barcelona) [SCI. MAR. (BARC.)], vol. 59, no. 3-4
IS: ISSN
0214-8358
AB: Abstract
Dolphin-fish (Coryphaena hippurus) appear seasonally in Mallorcan waters from May-June to December, when the surface water temperature is higher than 16-18 degree C. Adult fish (63-117 cm fork length) are caught as a by-catch of the swordfish (Xiphias gladius) fishery from spring to summer. Juvenile fish (14-70 cm fork length) are occasionally captured by purse-seiners, and are exploited by a traditional fishery, developed in the Island from late August to early December. Monthly progression of maturity stage and gonadosomatic index in adult fish showed a reproduction period from June to September, in agreement with back-calculated birthdates determined from daily growth rings in the otoliths of juvenile fish. The back-calculated birthdates for adult fish showed a more protracted spawning period. Our results suggest a pre-spawning migration of C. hippurus into the Mediterranean, following migratory patterns similar to bluefin tuna (Thunnus thynnus). The adult fish are probably originated from different spawnings, at least one occurring during the previous summer in Western Mediterranean waters, with a peak in June and July. This is the origin of the juvenile fish caught by the traditional fisheries of the area between August and December (Malta, Tunisia, Sicily and Mallorca).

TI: Title
Pelagic fish predation on cerataspis, a rare larval genus of oceanic Penaeoids
AU: Author
Morgan, SG; Manooch, CS III; Mason, DL; Goy, JW

AF: Author Affiliation
Dep. Zool., Univ. Maryland, Coll. Park, MD 20742, USA
SO: Source
Bulletin of Marine Science [BULL. MAR. SCI.], vol. 36, no. 2, pp. 249-259, 1985
IS: ISSN
0007-4977
AB: Abstract
Two hundred and thirty-nine specimens of the larval crustacean genus Cerataspis were found during analysis of the stomach contents of over 10,500 pelagic fishes from the North Atlantic Ocean. Eighty-seven percent of the specimens collected were C. monstrosa and 13% were C. petiti. Surface-feeding skipjack tuna (Katsuwonus pelamis), yellowfin tuna (Thunnus albacares), blackfin tuna (T. atlanticus) and dolphin (Coryphaena hippurus) preyed upon the last three mysis stages of Cerataspis. Yellowfin and skipjack tunas accounted for 95% of the Cerataspis collected. Other pelagic fishes feeding in deeper waters did not consume a single specimen, although mysis stages I and II have only been collected from deep water plankton tows. Fishes feeding around Sargassum are more likely to feed on Cerataspis as evidenced by the co-occurrence of the crustaceans and algae in the stomachs. Predation by yellowfin tuna on Cerataspis does not decrease with increasing fish length. This pattern differs from that for other crustaceans and indicates that Cerataspis are opportunistically preyed upon when encountered. Most records of Cerataspis, either from stomach contents or plankton tows, consist of one or two specimens. However, 46 Cerataspis were collected from one yellowfin stomach, indicating that swarms may be encountered. Ninety-three percent of Cerataspis were collected from coastal waters off North Carolina, suggesting that a population of as yet undescribed adults may reside there, or that the larvae are concentrated there by upwelling currents. A review of food surveys of pelagic fishes conducted worldwide together with other published accounts indicates that C. monstrosa and C. petiti have a nearly circumglobal distribution between 40 degree N and 40 degree S. (DBO)

TI: Title
Physiological responses to hyposaline exposure and handling and confinement stress in juvenile dolphin (mahimahi: Coryphaena hippurus)
AU: Author
Morgan, JD; Balfry, SK; Vijayan, MM; Iwama, GK
AF: Author Affiliation
Department Animal Science, University British Columbia, Vancouver, BC V6T 1Z4, Canada

SO: Source

Canadian Journal of Fisheries and Aquatic Sciences/Journal Canadien des Sciences Halieutiques et Aquatiques. Ottawa [CAN. J. FISH. AQUAT. SCI./J. CAN. SCI. HALIEUT. AQUAT.], vol. 53, no. 08, pp. 1736-1740, 1996

IS: ISSN

0706-652X

AB: Abstract

Juvenile dolphin fish (mahimahi: Coryphaena hippurus) were exposed for 24 h to a reduced water salinity (20 ppt) to examine effects on selected aspects of metabolism, ionic regulation, hematology, and immune function. The oxygen consumption rate and gill Na+,K+-ATPase activity were significantly lower in water with 20-ppt salinity compared with full-strength seawater (34 ppt). These results may have reflected a decrease in osmoregulatory costs. There were no differences in any of the variables associated with the salinity transfer. Plasma cortisol concentrations were significantly higher in the experimental tanks (200 L) than in the stock tank(2500 L), indicating a stress response elicited by handling and confinement in the smaller tank. Handling and confinement significantly decreased plasma lysozyme activity and increased hematocrit levels, hemoglobin concentration, and erythrocyte and leucocyte numbers. There were no changes in liver glycogen content or plasma glucose, protein, or ion concentrations in response to salinity or handling or confinement during the experiment. This study is the first to provide information on selected physiological variables of juvenile dolphin and changes associated with an acute hyposaline exposure and handling or confinement stress.

TI: Title

Growth and mortality in the dolphin-fish Coryphaena hippurus caught off Saint Lucia, W.I.

AU: Author

Murray, PA

AF: Author Affiliation

Fish. Manage. Unit, Minist. Agric., Castries, Saint Lucia

CA: Corporate Author

FAO Western Cent. Atlantic Fishery Comm., Rome (Italy)

CF: Conference

4. Sess. of the WECAFC Working Party on Assessment of Marine Fishery Resources, Paipa (Colombia), 29 Oct 1984

SO: Source

WESTERN CENTRAL ATLANTIC FISHERY COMMISSION. NATIONAL REPORTS AND

SELECTED PAPERS PRESENTED AT THE FOURTH SESSION OF THE WORKING

PARTY ON ASSESSMENT OF MARINE FISHERY RESOURCES, PAIPA DEPARTMENT
OF BOYACA, COLOMBIA, 29 OCTOBER-2 NOVEMBER 1984., 1985, pp. 147-153, FAO FISH. REP./FAO, INF. PESCA/FAO, RAPP. PECHES., no. 327suppl
IB: ISBN
92-5-002270-0
NT: Notes
FAO FIP/R327-suppl-(Tri).
AB: Abstract
Data from samples of landings of Coryphaena hippurus caught off Saint Lucia, W.I., during 1982 are subjected to a variety of analytical methods. Cassie's method of obtaining the component groups from polymodal size frequency data was used to determine mean length at age on a monthly basis, and five pairs of these data were chosen to provide values of mean increment per month and mean length for each of five growth segments, which were then used in a Gull and Holt plot to obtain values of growth constant, k and asymptotic length, L sub(infinity). These values were subsequently used to obtain relative age and a catch curve drawn to determine total mortality, z.

TI: Title
Biological and rearing datas on dolphinfish (Coryphaena hippurus, L. 1758): a literature review
OT: Original Title
Elements de biologie et donnees d'elevage de la dorade coryphene (Coryphaena hippurus, L. 1758): synthese bibliographique
AU: Author
Noguerra, B
CA: Corporate Author
IFREMER, Le Robert (Martinique), DRV/RA
SO: Source
IFREMER, Le Robert (Martinique), 1997, 30 pp
PB: Publisher
IFREMER, Le Robert (Martinique)
NU: Other Numbers
IFREMER Rapp. Interne DRV/RA/ 97-03 /Le Robert
AB: Abstract
Caribbean islands, especially French West Indies, have a notable potential in cage culture of marine fish due to availability of suitable sites, large local demand, possibility of export to Europe and North America and good zootechnical performances of tropical species. Among tropical marine fishes, dolphinfish is attractive because of its world wide distribution, a large and well known market due to fisheries, and exceptional high

zootechnical performances. Nevertheless, despite American work indicating control of biological cycle, and serious investment projects, this culture has not been yet developed. This report makes a review of biological and culture data on dolphinfish in order to point out the potential problems and guide research program accordingly. Growth performance is high (weight of 2 kg obtained 6 months after hatch), reproduction occurs all the year long in our area, larval rearing technique seems to be efficient despite survival which can be improved, and nutritional problem seems to be resolved. On the other hand, aggressive behaviour is poorly studied and this problem has to be resolved especially for males heavier than 2 kg with a perspective of research on sex and/or maturation control.

TI: Title
Occasional availability of dolphin, Coryphaena hippurus, to southern California commercial passenger fishing vessel anglers: Observations and hypotheses
AU: Author
Norton, JG; Crooke, SJ
AF: Author Affiliation
Pac. Fish. Environ. Group, Southwest Fish. Sci. Cent., P.O. Box 831, Monterey, CA 93942, USA
SO: Source
REP. CCOFI, vol. 35, pp. 230-239, 1994
IS: ISSN
0575-3317
AB: Abstract
Records from California-based commercial passenger fishing vessels (CPFV) show that dolphin, Coryphaena hippurus, catch off southern California was more than 8% of the total southern and Baja California CPFV catch in 1983, 1984, 1990, 1992, and 1993. The major portion of the catch is made off northern Baja California. Record catches for southern and Baja California were recorded in 1990 and 1992. Dolphin enter California waters under conditions that include elevated ocean temperatures and increased onshore and poleward coastal ocean transport. Large-scale environmental events, which apparently increase dolphin abundance off southern California, appear related to regional decrease in eastern Pacific high-pressure systems. When the high-pressure system is less intense, there is less southward wind along the coast. Consequently, California Current southward transport and coastal upwelling decrease, and the inshore countercurrent brings anomalously warm water into the Southern California Bight. Local kelp mat cover and local ocean processes are also likely to be important in aggregating dolphin and making them available to CPFV anglers.

TI: Title
Growth and feeding rates of juvenile dolphins (Coryphaena hippurus) fed a practical diet through growout.
AU: Author
Ostrowski, AC; Brownell, C; Duerr, EO
AF: Author Affiliation
Oceanic Inst., Makapuu Point, Waimanalo, HI 96795, USA
SO: Source
World Aquaculture [WORLD AQUACULT.], vol. 20, no. 4, pp. 104-105, 1989
IS: ISSN
1041-5602
AB: Abstract
The findings are presented of a trial conducted to determine the growth rate of juvenile dolphin fish (Coryphaena hippurus), describing also the problems encountered during the long-term feeding of the juveniles on a formulated, practical diet. Although a good feed conversion rate was obtained with the diet OI-F982, the growth rate was found to be well below that obtained with fresh squid or fish (diets too costly to be used in a commercial venture). It is concluded that more work is required to improve feeding aggressiveness and growth rate by improving feed formulations, optimizing pellet size and feeding rates, testing feeding attractants and developing remedies for observed bloating phenomena.

TI: Title
Practical diets for growout of mahimahi (Coryphaena hippurus)
AU: Author
Ostrowski, AC; Schaleger, E; Duerr, EO
AF: Author Affiliation
Oceanic Inst., Makapuu Point, Waimanalo, HI 96795, USA
CF: Conference
World Aquaculture '93 Int. Conf., Torremolinos (Spain), 26-28 May 1993
ED: Editor
Carrillo, M; Dahle, L; Morales, J; Sorgeloos, P; Svennevig, N; Wyban, J (eds)
SO: Source
FROM DISCOVERY TO COMMERCIALIZATION., EUROPEAN AQUACULTURE SOC.,
OOSTENDE (BELGIUM), 1993, p. 426, Special Publication, European Aquaculture Society [SPEC. PUBL. EUR. AQUACULT. SOC.], no. 19
IS: ISSN
0774-0689

NT: Notes
Summary only.
PB: Publisher
EUROPEAN AQUACULTURE SOC., OOSTENDE (BELGIUM)
AB: Abstract
Growout trials were conducted using various practical diet formulations to determine optimum diet conditions for growout of mahimahi (Coryphaena hippurus). Fish were raised in both large (7 m super(3)) and small (3.5 m super(3)) circular tanks from 2 to 6 months of age. Rapid growth and low feed conversion ratios were achieved using both low (12%) and high (22%) lipid diets. However, high lipid diets resulted in excessive liver lipid deposition, poor water quality, and slightly lower growth. Soybean meal up to 20% of the dry diet was an effective replacement for fishmeal during growout. Average growth of fish was from 30 g (at stocking) to 1.8 kg (at harvest). The results of these trials confirmed those conducted on younger juveniles indicating that high protein (55-60%) and low lipid (10-15%) diets are appropriate for growout of this species. Practical diet formulation for mahimahi appears feasible.

TI: Title
The importance of fishmeal source and quality in the formulation of practical diets for mahimahi (Coryphaena hippurus)
AU: Author
Ostrowski, AC; Kim, BG; Divakaran, S
AF: Author Affiliation
Oceanic Inst., Makapuu Point, Waimanalo, HI 96795, USA
CF: Conference
World Aquaculture '93 Int. Conf., Torremolinos (Spain), 26-28 May 1993
ED: Editor
Carrillo, M; Dahle, L; Morales, J; Sorgeloos, P; Svennevig, N; Wyban, J (eds)
SO: Source
FROM DISCOVERY TO COMMERCIALIZATION., EUROPEAN AQUACULTURE SOC.,
OOSTENDE (BELGIUM), 1993, p. 425, Special Publication, European Aquaculture Society [SPEC. PUBL. EUR. AQUACULT. SOC.], no. 19
IS: ISSN
0774-0689
NT: Notes
Summary only.
PB: Publisher
EUROPEAN AQUACULTURE SOC., OOSTENDE (BELGIUM)
AB: Abstract
A series of feeding trials was conducted to determine the effects

of various fishmeal sources and quality on feeding rate, growth, and feed conversion of juvenile mahimahi (Coryphaena hippurus). In trial 1, triplicate groups of 15 juvenile mahimahi were fed isocaloric, isonitrogenous diets made with various types and qualities of commercial fishmeal sources for a period of two weeks. Weight gain and FCR were significantly affected by the type of meal used. Fish fed diets containing LT white fishmeal ("Golden Alaska", IPC Fresno, CA) and LT-94 from Norway grew best and had the lowest FCR. Performance of fish was correlated with the level of free fatty acids and Torry Pepsin Digestibility. In trial 2, triplicate groups of 20 juvenile mahimahi were fed isocaloric, isonitrogenous diets containing combinations of high and low performance fishmeal for two weeks. Weight gain and FCR were correlated with addition levels. The results of these trials indicate the importance of fishmeal quality in the acceptability and performance of practical diets fed to mahimahi. These results will prove important to the formulation of diets for this species in the future.

TI: Title
Responses of larval and juvenile mahimahi (Coryphaena hippurus) to various dietary lipid sources and N-3 HUFA contents
AU: Author
Ostrowski, AC; Kim, BG
AF: Author Affiliation
Oceanic Inst., Makapuu Point, Waimanalo, HI 96795, USA
CF: Conference
World Aquaculture '93 Int. Conf., Torremolinos (Spain), 26-28 May 1993
ED: Editor
Carrillo, M; Dahle, L; Morales, J; Sorgeloos, P; Svennevig, N; Wyban, J (eds)
SO: Source
FROM DISCOVERY TO COMMERCIALIZATION., EUROPEAN AQUACULTURE SOC.,
OOSTENDE (BELGIUM), 1993, p. 424, Special Publication, European Aquaculture Society [SPEC. PUBL. EUR. AQUACULT. SOC.], no. 19
IS: ISSN
0774-0689
NT: Notes
Summary only.
PB: Publisher
EUROPEAN AQUACULTURE SOC., OOSTENDE (BELGIUM)
AB: Abstract
A series of trials was conducted with larval (D8-D17) and juvenile (D40-D54) mahimahi (Coryphaena hippurus) to determine the effects

of diets containing various lipid sources on survival, growth, feed utilization, and fatty acid requirements. Four replicate groups of 300 larvae were fed live Artemia enriched with commercial enrichment preparations (SELCO, SUPER SELCO, and NEW SUPER SELCO) varying in n-3 HUFA content, and with emulsified preparations of olive and squid oils. Three replicate groups of 20 juveniles were fed isocaloric, isonitrogenous diets containing coconut, corn, linseed, olive, and menhaden oils for three weeks. Fatty acid profiles of whole body larval and juvenile liver phospholipid (PL) fractions resembled the particular lipid source fed. Survival and growth of larvae were related to the level of n-3 HUFA content. Growth, but not survival of juveniles was affected by the dietary level of n-3 HUFA. Preliminary results indicate a n-3 HUFA requirement between 0.6 and 1% of total dietary lipids for juveniles. The results of both trials indicate the importance of dietary n-3 HUFAs, particularly C22:6n-3, to promote optimum growth and survival of this species.

TI: Title
Migration of the dolphin (Coryphaena hippurus) and its implications for fisheries management in the Western Central Atlantic.
AU: Author
Oxenford, HA; Hunte, W
AF: Author Affiliation
Biol. Dep., Univ. West Indies, Cave Hill Campus, Barbados
CF: Conference
37. Annual Gulf and Caribbean Fisheries Institute, Cancun (Mexico), Nov 1984
ED: Editor
Williams, F (ed)
SO: Source
PROCEEDINGS OF THE THIRTY-SEVENTH ANNUAL GULF AND CARIBBEAN FISHERIES INSTITUTE, CANCUN, MEXICO, NOVEMBER, 1984., 1986, pp. 95-111, Proceedings of the Gulf and Caribbean Fisheries Institute [PROC. GULF CARIBB. FISH. INST.], vol. 37
IS: ISSN
0072-9019
NU: Other Numbers
GCFI-37
AB: Abstract
Regional differences in the seasonality of catch data were used to investigate migration and stock structure of the dolphin Coryphaena hippurus in the Western Central Atlantic. The data suggest at least two dolphin stocks in the region, one southeast and the other northwest of the Virgin Islands.

TI: Title
Synopsis of the biological data on dolphin-fishes, Coryphaena hippurus Linnaeus and Coryphaena equiselis Linnaeus.
AU: Author
Palko, BJ; Beardsley, GL; Richards, WJ
AF: Author Affiliation
Natl. Mar. Fish. Serv., Southeast Fish. Cent., Panama City, FL 32407, USA
CA: Corporate Author
National Marine Fisheries Serv., Seattle, WA (USA). Scientific Publ. Off
SO: Source
NOAA TECH. REP., NOAA/NMFS, SEATTLE, WA (USA) , 1982, 32 pp
NT: Notes
Incl. bibliogr.: 205 ref. Also as: FAO Fish. Synop. No. 130.
PB: Publisher
NOAA/NMFS, SEATTLE, WA (USA)
NU: Other Numbers
NOAA-TR-NMFS-CIRC443
AB: Abstract
The biological data presented on dolphin-fishes, Coryphaena hippurus and C. equiselis , encompasses the following: nomenclature, taxonomy, morphology, distribution, bionomics and life history, population, exploitation, protection and management, and culture. An extensive bibliography is included.

TI: Title
Exploitation of the dolphin-fish Coryphaena hippurus L. off Ecuador: analysis by length-based virtual population analysis
AU: Author
Patterson, KR; Martinez, J
AF: Author Affiliation
Overseas Development Administration, 94 Victoria Street, SW1E 5JL, UK
SO: Source
Fishbyte, vol. 9, no. 2, pp. 21-23, 1991
IS: ISSN
0116-0079
AB: Abstract
Dolphin-fish Coryphaena hippurus in the east Central Pacific are principally exploited by Ecuador. A length-based virtual population analysis of this fishery was sensitive to assumed values of growth parameters in respect of calculated fishing mortalities, but relatively robust in the estimation of exploitation rates. Comparison of estimated actual exploitation rates with estimated rates for F sub(0.1) obtained from

length-based stock projections indicates the fishery to be somewhat overexploited. (DBO).

TI: Title
Anchored fish aggregating devices in Azorean waters (SCRS/95/121)
AU: Author
Pinho, MR; Pereira, J
AF: Author Affiliation
Universidade dos Acores, Departamento de Oceanografia e Pescas, 9900 Horta, Acores, Portugal
CF: Conference
Meet. of the ICCAT Standing Committee on Research and Statistics (SCRS), [Madrid (Spain)], 1995
SO: Source
Collective volume of scientific papers. International Commission for the Conservation of Atlantic Tunas/Recueil de documents scientifiques. Commissio internationale pour la Conservation des Thonides de l'Atlantique/Coleccion d documentos cientificos [COLLECT. VOL. SCI. PAP. ICCAT/RECL. DOC. SCI. CICTA/COLECC. DOC. CIENT. CICAA.], vol. 45, no. 3, pp. 229-235, 1996
IS: ISSN
1021-5212
AB: Abstract
Anchored fish aggregation devices were evaluated as fish attractants in the Azores waters to determine if such objects could attract and hold tuna schools and other pelagic fish long enough to be fished profitably. Floating devices were constructed and anchored in 9 selected locations around the islands, banks and sea mounts during 1993 and 1994. The results of the commercial activities around the buoys by the local tuna fleets were not encouraging. A small number of species aggregated to the buoys, mainly Polyprion americanus, Coryphaena hippurus, Schedophilus ovalis and Balistes carolinensis. Technical aspects of the artificial buoys, their behavior, and aggregating effects are described and discussed.

TI: Title
[Distribution of 'cannizzi' in the southern Tyrrhenian Sea and in the Ionian Sea for the capture of Coryphaena hippurus]
OT: Original Title
Distribuzione dei 'cannizzi' nel Tirreno meridionale e nello Ionio per la cattura della lampuga Coryphaena hippurus L. 1758
AU: Author
Potoschi, A; Sturiale, P
AF: Author Affiliation
Dipartimento di Biologia Animale ed Ecologia Marina, Universita di

Messina, Salita Sperone, 31, 98166 S. Agata, Messina, Italy
CF: Conference
26. Congresso della Societa Italiana di Biologia Marina, Sciacca (Italy), 22-27 May 1995
SO: Source
Biol. Mar. Mediterr., vol. 3, no. 1, pp. 384-386, 1996
IS: ISSN
1123-4245
AB: Abstract
The positions of the special floating structures called 'cannizzi', used by some fisheries on the Ionian and Tyrrhenian coasts of Sicily as artificial shadow-casting bodies to attract dolphin fish (Coryphaena hippurus), are shown geographically. Concentrations of the species and fishing in the above-mentioned seas run from September until almost the end of December.

TI: Title
Stomach contents of dolphinfish Coryphaena hippurus caught around bamboo rafts in Tosa Bay, the waters southwestern Japan.
OT: Original Title
Tosawan no tsukegi tsuki shiira no i-naiyobutsu
AU: Author
Sakamoto, R; Taniguchi, N
AF: Author Affiliation
Miyazaki Prefect. Fish. Exp. Stn., Aoshima, Miyazaki 889-22, Japan
SO: Source
BULL. JAP. SOC. FISH. OCEANOGR./SUISAN KAIYO KENKYU, vol. 57, no. 2, pp. 17-29, 1993
IS: ISSN
0916-1562
AB: Abstract
In "shiira-zuke" fishery, fishermen catch dolphinfish. Coryphaena hippurus, and other fishes gathering around the bamboo rafts called "Tsukegi" with a purse seinenet. Frum Jun to Nov in 1985, a total of 575 dolphinfish and 126 other fishes were captured by "shiira-zuke" fishery in Tosa Bay, the Water of Southwestern Japan, for analysis of their stomach contents. Of the total dolphinfish, 53% (306) of the stomachs contained ingested materials consisting of 772 individual items, and representing 57 different categories. When expressed in the percentage frequency of occurrence, Sardinoes melanostictis was the most represented species with 51%. Pelagic fishes and juvenile fishes that float on or near the sea surface were the most important food in the diet of the dolphinfish. So far as feeding habits concerned, dolphinfish seems to have no direct connection with "Tsukegi".

TI: Title

Ichthyological observations made in the open sea during a transatlantic swimming

AU: Author

Seret, B; Delage, G

AF: Author Affiliation

Antenne ORSTOM, Lab. Ichtyol., Museum National d'Histoire Naturelle, 43 rue Cuvier, 75231 Paris Cedex 05, France

SO: Source

Cybium. Paris [CYBIUM], vol. 19, no. 4, pp. 413-417, 1995

IS: ISSN

0399-0974

AB: Abstract

From 16 December 1994 to 9 February 1995, one of the authors (GD) swam across the Atlantic Ocean, from Mindelo Island (Cape Verde) to Barbados (Caribbean). During this crossing,a number of ichthyological observations were made, some related to the feeding behavior of the dolphin fish (Coryphaena hippurus) and to fish congregating around his raft. Sharks and pelagic fishes (flying fish, trigger fish, jacks, barracudas) have also been observed.

TI: Title

[Fish concentrations near floating objects, their species composition and some features of their biology]

OT: Original Title

Skopleniya ryb u 'plava', ikh vidovoj sostav i nekotorye cherty biologii

AU: Author

Timokhin, IG; Korkosh, VV

AF: Author Affiliation

Southern Scientific Research Institute of Marine Fisheries & Oceanography (YugNIRO), 2, Sverdlov St., 334500, Kerch, Crimea, Ukraine

CF: Conference

1. Interstate Conf. 'Resources of Tunas and Related Species in the World Ocean and Problems of their Rational Utilization', Kerch (Ukraine), 1-5 Jun 1992

ED: Editor

Yakovlev, VN; Romanov, EV; Lebedeva, NA; Trushyn, YuK; Timokhin, IG; Trotsenko, BG; Korkosh, VV; (eds.)

SO: Source

[RESOURCES OF TUNAS AND RELATED SPECIES IN THE WORLD OCEAN AND PROBLEMS OF THEIR RATIONAL UTILIZATION.] SYR'EVYE RESURSY TUNTSOV I SOPUTSTVUYUSHCHIKH OB"EKTOV PROMYSLA MIROVOGO OKEANA I PROBLEMY

IKH RATSYONAL'NOGO ISPOL'ZOVANIYA., YUGNIRO, KERCH (UKRAINE), 1993, pp. 82-86

PB: Publisher

YUGNIRO, KERCH (UKRAINE)

AB: Abstract

The development of purse seine fishery in the Indian Ocean is closely connected with use of drifting objects in the vicinity of which fish schools are concentrated. Along with tunas which are the base of catches accompanying fish species are caught as well. Fish of 25 species from 17 families (Lamnidae, Carcharhinidae, Sphyrnidae, Mobulidae, Sphyraenidae, Carangidae, Coryphaenidae, Kyphosidae, Platacidae, Gempylidae, Scombridae, Istiophoridae, Xiphiidae, Nomeidae, Balistidae, Monacanthidae, Diodontidae) were found in purse seine catches in addition to 5 species of tunas (Thunnus albacares, Katsuwonus pelamis, T. obesus, T. alalunga, Auxis thazard). Jacks (4 species) are predominant by the number of species in by-catches, yellowtail (Seriola dumereli) and rainbow runner (Elagatis bipinnulatus) being the most abundant. Dolphin (Coryphaena hippurus) stands out by the greatest frequency of occurrence; the number of individuals of this species in the vicinity of floating objects may exceed 100. Sharks (Carcharhinus falciformis, C. longimanus) made a considerable amount of catch (by weight) -- from 0.1 to 35% of the total catch. The concentration of accompanying fish in accumulations near floating objects which often make a considerable part of the catch may be used as the additional reserve for food products. (DBO).

TI: Title

A study of population dynamics of dolphin fish (Coryphaena hippurus) in waters adjacent to eastern Taiwan

AU: Author

Wang,C.-H.

AF: Author Affiliation

Address not stated

SO: Source

Acta Oceanogr. Taiwan, (no. 10), 233-251, (1979)

ER: Environmental Regime

Marine

AB: Abstract

The survey was carried out from Jan 1978 to July 1979. The main group was present in the waters of the northeastern part of Batan Islands in early spring, and migrated to the coast of Hsing-kang gradually, arriving as a spawning group from April to May. From early June, this group divided into 2 branches, one migrating to the northeast of Taiwan with the Kuroshio Current and the other returning to Batan Islands. Larvae of dolphin fish in waters adjacent to Hsing-kang are present annually. The spawning activity has 2 modes per year, one in April and the other in Sept. The dolphin grows rapidly throughout its life. The increment of average growth of the 1-yr group was 10 cm /month in fork length (about 1.5 kg); 26-27 C average surface water

temperature gives over 70% of total catch of dolphin fish in longline fishery.

TI: Title
Occurrence of fishes, caphalopods and crustaceans in stomachs of tunas and related species caught by longline in Brazil (23 degree S-34 degree S) 1972-1985.
OT: Original Title
Ocorrencia de peixes, cefalopodos e crustaceos em estomagos de atuns e especies afins, capturadas com espinhel no Brasil (23 degree S-34 degree S) 1972-1985
AU: Author
Zavala-Camin, LA
AF: Author Affiliation
Sec. Biol. Pesq., Div. Pesca Mar., Inst. Pesca, Sao Paulo, Brazil
SO: Source
Boletim do Instituto de Pesca Sao Paulo [BOL. INST. PESCA SAO PAULO], vol. 14, pp. 93-102, 1987
IS: ISSN
0046-9939
AB: Abstract
In 3799 stomachs of Thunnus alalunga, Thunnus albacares, Xiphias gladius, Coryphaena hippurus, Tetrapturus albidus, Istiophorus albicans and Thunnus obesus, fish was the most important food item occurrence in the southern area and in the fourth and first quarter of the year (summer) and also was the first in the total sample (69,3%). Cephalopod was the most important food item occurrence in the southern area and in the second and third quarter (winter) but was the second in the total (53,8%). Item crustacea occurred in small quantity (17,6%). Differences in the food items occurrences in the predators caught in the southeast or southern areas no matter what season was, indicate a zoogeographic dissimilarity in the pelagic zone near the continental slope about the 27 degree.S parallel. (DBO)

Appendix B. Characterization of the Dolphin Fish (Coryphaenidae, Pices) Fishery of the United States Western North Atlantic Ocean (MSAP/98/03)

MSAP/98/03
MSAP/98/03

Title: Characterization of the Dolphin Fish (Coryphaenidae. Pices) Fishery of the United States Western North Atlantic Ocean

Running title: Dolphin Fishery. Western North Atlantic of the U.S.

Keywords: Southeast U.S., dolphin fishery, recreational, commercial, annual landings, annual average weights, length-weight relationship, gear, CPUE

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Feb. 1998

Summary: Fishery dependent data from various commercial and recreational sampling programs U.S form the basis for characterizing the fishery for dolphin fishes (Coryphaenus hippurus) in the waters of the Gulf of Mexico and off the southeastern U.S coast. Many states in the region have implemented size and bag limits for dolphin fishes. however. there are no federal regulations in place at this time. Commercial landings in metric tons have been relatively small in comparison to recreational landings for the time series of data available from 1984 through 1996. In 1995 however. commercial landings in the Atlantic Ocean of the southeastern U.S., were almost twice in weight of the previous years. The average weight per fish was calculated for each water body and fishing sector and there appear to have been large increases in the average weight of fish landed both in the commercial and recreational sectors in the Atlantic and the Gulf of Mexico. Catch per unit of effort. measured as numbers of fish caught per angler per hour in the recreational fishery. In the Gulf of Mexico, recreational CPUE appears to fluctuate and appears to be decreasing since 1985. CPUE appears to have been increasing in the Atlantic particularly from 1984 to 1991 and appears to have been decreasing since 1991.

Introduction

Dolphin fishes (*Coryphaena hippurus)* in the Western North Atlantic waters of the United States support both commercial and recreational fishing. The biology of this species including discussions on their distributions. stock structure and migratory movements in the Western North Atlantic have been reviewed periodically (Oxenford 1986: Palko et al. Unpublished manuscript 1990; Bentivoglio. 1989: Ditty et al 1994; Palko. 1982). Their tendency to form large schools associated with floating objects makes them easy targets for fishing and there is a significant recreational fishery in the U.S Atlantic which exploits their seasonal presence particularly in the summer months in both the Atlantic and Gulf of Mexico.

Fishery management for this species in federal waters is completed under the joint responsibility of the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council. Recently, concerns have been expressed to the Councils regarding the perceived increase in commercial landings from long lining particularly off the southeast U.S. coast. Currently within this region there is no management for this species in federal waters and only Florida, North Carolina, and Georgia have regulations for their state waters. Florida currently has a 10 fish per person per day limit with a 20 inch (50.8 cm) size limit for the sale of dolphin. North Carolina also has a limit of 10 fish per person per day for the recreational fishery. Georgia has a 15 fish per angler per day limit with a minimum size limit of 18" (45.7 cm) fork length for the recreational fishery. At this time, management alternatives are being considered to insure that catches are sustainable and potential options include trip limits, bag limits, minimum size limits, and gear restrictions.

The purpose of this paper is to describe both the commercial and recreational fishery for dolphin fishes in waters of the southeast United States which is the focus of the fishery in the U.S. Atlantic Ocean. Catch information is provided for both fishing sectors, commercial and recreational, in the Gulf of Mexico and from southeastern U.S. Atlantic Ocean waters from North Carolina to the Florida east coast. Data are either provided by whole weight of fish or numbers of fish or both with samples taken to evaluate weight- length relationships. Additional information includes gear used by the commercial sector and catch per unit of effort for the recreational sector. Catches are presented by area as the Gulf of Mexico and Atlantic Ocean to better track these landings within these areas. While it has been suggested that the Western North Atlantic may include multiple stocks (Oxenford 1986), the separation of catches by area for this exercise does not imply stock separation and is simply done as a convenient method to track landings for each of the Councils.

Materials and Methods

Data

Fisheries dependent data are available from both the commercial and recreational sectors. Commercial data are reported annually in whole pounds weight which was converted to kilograms landed. Individual fish are sampled on a trip basis for length and weight and average weight per fish sampled is recorded in whole pounds and was converted to kilograms. A trip is defined as time from leaving the dock to returning to the dock and can be one or several days in length. For the most part commercial catches are primarily reported as bycatch from fishing that is directed at pelagic species including tunas, swordfish, and sharks.

Fisheries dependent recreational data are from three separate sources which are additive to sum to total landings. These data are from the National Marine Fisheries Service's (NMFS) Marine

Recreational Fisheries Statistical Survey (MRFSS), the state of Texas recreational creel survey, and the NMFS/Southeast Fisheries Science Center (SEFSC) head boat survey. The MRFSS data are collected for the charter, private, and shore fishing modes for all states in the southeast U.S. except Texas. Texas data are for all modes and include catches from head boats for the state of Texas only. The head boat survey includes all the states except Texas.

Data from the head boat survey are reported by total weight of fish in whole pounds landed per trip. Weights were converted to kilograms and a trip is defined as before as leaving and returning to the dock. These trips are generally no more than a single day in length and multiple trips can be completed in one day. The total number of anglers fishing per trip and the length of the trip in total hours are reported. These trip data were used to estimate CPUE as total numbers of fish caught per angler per hour.

The Texas creel survey data are reported numbers of fish landed, total length of each fish landed and weight of each fish in whole pounds. Average weight per fish is multiplied by the total numbers of fish reported to estimate total pounds in whole weight and was converted to kilogram weight. The total number of anglers and the total hours fished are reported and used to estimate CPUE as numbers of fish caught per angler per hour.

The MRFSS data are reported as total numbers of fish caught with samples provided on length and weight of fish to allow for the estimation of total whole pounds landed which was converted to total kilograms of fish landed. These data were added to the results from the Texas creel survey and head boat survey to determine total annual landings by weight in kilograms. The numbers of anglers and trip length are also reported and used to estimate CPUE as for the other data sets. as numbers of fish caught per angler per hour. These data which represent the majority of data for this species were also sorted and apportioned by mode. as charter. private. and shore.

All of the recreational data were pooled to develop a length-weight relationship using the natural log for weight and length and completing a linear regression. This relationship was evaluated for the Atlantic and Gulf of Mexico separately and with the areas combined. This relationship is compared with those available in the literature.

Results

Total landings in metric tons for the Gulf and Mexico and Atlantic for the commercial and recreational fishing sectors are presented in Table 1 and Figure 1. The time series for landings begins in 1984 and are considered preliminary for 1996. Commercial landings have been low relative to the recreational sector over the thirteen year time series. While commercial landings in the Gulf of Mexico have fluctuated. landings in the Atlantic appear to have been increasing since 1992 with a peak in 1995 when total landings appear to have nearly doubled as compared to previous years.

Recreational landings have fluctuated considerably over this same time period with a peak in the Atlantic and the Gulf of Mexico in 1995. While the landings from both the Gulf of Mexico and

Atlantic have fluctuated over the time series there appears to be an increasing trend in total landings since 1988.

The average weight per fish was evaluated annually for each body of water and fishing sector (Figures 2 and 3). The average weight per fish has been increasing in the commercial landings in both the Atlantic and Gulf of Mexico. In the Atlantic average weight has increased from about 1.5 kg in 1988 to 5.6 kg in 1996. In the Gulf of Mexico, the increase from 1988 to 1995 has been from 1.7 kg to about 5.6 kg in 1995.

The average weight per fish from the recreational sector has fluctuated more over the time series since 1981 however, there appears to have been an increasing trend in the average weight landed by recreational anglers both in the Atlantic and Gulf of Mexico. Average weight over the time series appears to have almost tripled in the Gulf of Mexico in the recreational sector from about 1.4 kg per fish to 3.8 kgs from 1987 to 1996 with significant fluctuations between this time period. In the Atlantic, the magnitude of increase appears to have been about from about 2.3 kg to about 3.0 kg from 1987 to 1996, about a 25% increase over this time series.

The relationship between weight and length was examined using the recreational data because the sample size for both weight and length is large from this sector. Data from each source, MRFSS, Texas creel survey, and headboat survey were combined to maximize the sample size available. The length weight relationship for the Gulf of Mexico and Atlantic were similar and data were pooled over areas with the resulting relationship described as a log linear equation with sample size (n) and r^2 from the linear regression:

ln weight= 2.71 ln fl- 10.42

ln weight= natural log whole weight in kg.

Ln fl= natural log of fork length in cm

$r^2 = .97$

n = 32,215 individual fish sampled

In the non-linear form of the equation, this relationship translates to: $A=2.98 \times 10^{-4}$ mm and b=2.71 with y=weight in kilograms and x=fork length in mm where $y=ax^b$. In comparing this result with previously published results, it compares well with the relationship provided by Beardsley (1967) where $A=2.35 \times 10^{-4}$ and b=2.63 for 40 females sampled from the southeast U.S. Atlantic Ocean. From other published studies it appears that b ranges from about 2.5 to 3.7 depending on where samples are taken. The value of b calculated for the 32,000 plus fish sampled throughout the Gulf of Mexico and the Atlantic is within the published range for this parameter.

The gear types reported for the commercial landings included troll lines, rod and reel which includes both manual and electric, and long lines which includes surface lines and traditional swordfish type long lines. The distribution of records for the commercial sector was: 6977 or 54.3% from trolling lines; 4845 or 37.7% from rod and reel; 1003 or 7.9% from long lines; and 16 or .1% from unknown gear (Figure 4). Of a total of 32906 records from the MRFSS, 32898 or virtually all records reported landing dolphin fish by hook and line.

While the gear from the recreational sector was almost always noted as hook and line. However. for the MRFSS landings are reported as from shore, charter boat and private or rental boat. A charter boat is a vessel for hire that usually includes a captain. one crew member and usually no more than 6 anglers per trip. For the Gulf of Mexico. 65.3% (2250) of the total reports (n=3513) were from the charter boat mode. A total of 1218 or 34.7% of the reports were from the private/rental mode. Less than 1% were reported as landed while fishing from the shore.

Catch per unit of effort was estimated from the three recreational data bases as the total number of fish caught per angler per hour (Figures 5 and 6). In this way. these CPUE indices can be compared between sampling programs. water bodies. and years. CPUE for the Gulf of Mexico was estimated from the Texas creel survey, the head boat survey. and the MRFSS. Notably. the total catches from the head boat survey are small as would be expected given that these trips are generally prosecuted nearshore and not in deeper shelf waters where dolphin fish are found. The Texas creel survey data are also consistently low except in from 1993 to 1995 when a significant peak in CPUE occurred. Note that the 1996 data are preliminary only and incomplete. CPUE from the MRFSS is higher as expected since the charter boat fishery is a large component of the catch where there are generally more than a single angler on board and they most likely are targeting pelagic species including dolphin. Since dolphin tend to aggregate at certain size classes they are easily caught in large numbers by several anglers. In addition. in federal waters there is no limit to the numbers which can be landed and even in Florida state waters. the bag limit is currently 10. CPUE from the MRFSS fluctuates almost annually suggesting that this species may in fact be an annual crop.

Estimated CPUE for the S. Atlantic included the MRFSS and head boat survey only since Texas is limited to the Gulf of Mexico (Figure 3). CPUE for the head boat fishery fluctuates without trend over the past 16 years. CPUE for the MRFSS appears to have increased from 1986 to 1990 and been somewhat stable and comparatively high since 1991. The CPUE estimate for 1996 is preliminary as the data are incomplete for this year.

Discussion

The fishery for dolphin fishes remains dominated by the recreational sector with the highest amount of landings by weight and number in the south Atlantic. However, except with the Gulf of Mexico commercial landings which appear stable over the time series, there appears to be an increasing trend in landings by weight in the recreational fishery in both areas and in the commercial landings in the southeast while the numbers of fish landed appears somewhat stable although also fluctuating annually. The average weight of fish landed has been increasing since the mid 1980's and this certainly must account for some of the increase seen in overall landings by weight.

Sample sizes to describe shifts in gear in the commercial sector are small when stratified annually, however, in sum the dominant gear types have been trolling gear and rod and reels.

including both manual and electric. For the recreational sector, the overwhelming majority of fish are reported as caught by hook and line with the charter boat and private/rental boat modes dominating the catches. It is difficult to evaluate the sustainability of the fishery based on these trends and in the context of such large annual variability in the catches. Since 1996 data are preliminary, these data must be evaluated when available to determine if a significant shift or change in the prosecution of this fishery has occurred.

Acknowledgments

The data used in this manuscript were obtained through the efforts of various programs and people including the field samplers for the Southeast Fisheries Science Center (SEFSC) and the individual states. The actual data sets I used in manipulating these data were assembled by Ms. Patty Phares. Division of Sustainable Fisheries (DSF). SEFSC. Miami. Florida. Similar compilations of landings were completed by Mr. Josh Bennett. DSF. SEFSC. Miami. Florida and used to verify the data included in this paper. I gratefully acknowledge these people and their efforts in forming the basis for this manuscript.

Table 1. Annual dolphin landings in metric tons. Landings were estimated for the commercial and recreational sectors for Gulf of Mexico and southeastern Atlantic waters.

Atlantic X 1000 kgs.

Year	Commercial	Recreational	Total
84	72.3	1556.0	1628.3
85	64.9	2516.5	2581.4
86	86.2	3106.8	3193.0
87	96.7	1999.1	2095.8
88	96.5	2879.1	2975.6
89	193.4	4468.3	4661.7
90	230.8	3377.5	3608.3
91	295.6	5123.6	5419.2
92	148.5	2360.4	2508.9
93	236.6	2461.5	2698.1
94	281.2	4383.6	4664.8
95	529.1	5543.1	6072.3
96	248.4	3379.1	3627.5

Gulf X 1000 kgs.

Year	Commercial	Recreational	Total
84	128.6	480.2	608.8
85	122.6	630.3	752.9
86	223.8	1394.3	1618.1
87	183.6	1194.9	1378.5
88	226.9	534.2	761.1
89	502.8	1368.3	1836.8
90	761.6	2341.5	2896.8
91	324.9	2560.7	3322.3
92	271.4	1877.2	2202.1
93	271.4	2369.8	2641.2
94	309.1	1250.6	1559.7
95	535.1	3432.3	3967.4
96	474.5	2148.3	2622.7

Figure 1. Total annual landings by weight from the commercial and recreational data for the Gulf of Mexico (GOM) and the southeasern U.S. Atlantic Ocean (Atlantic).

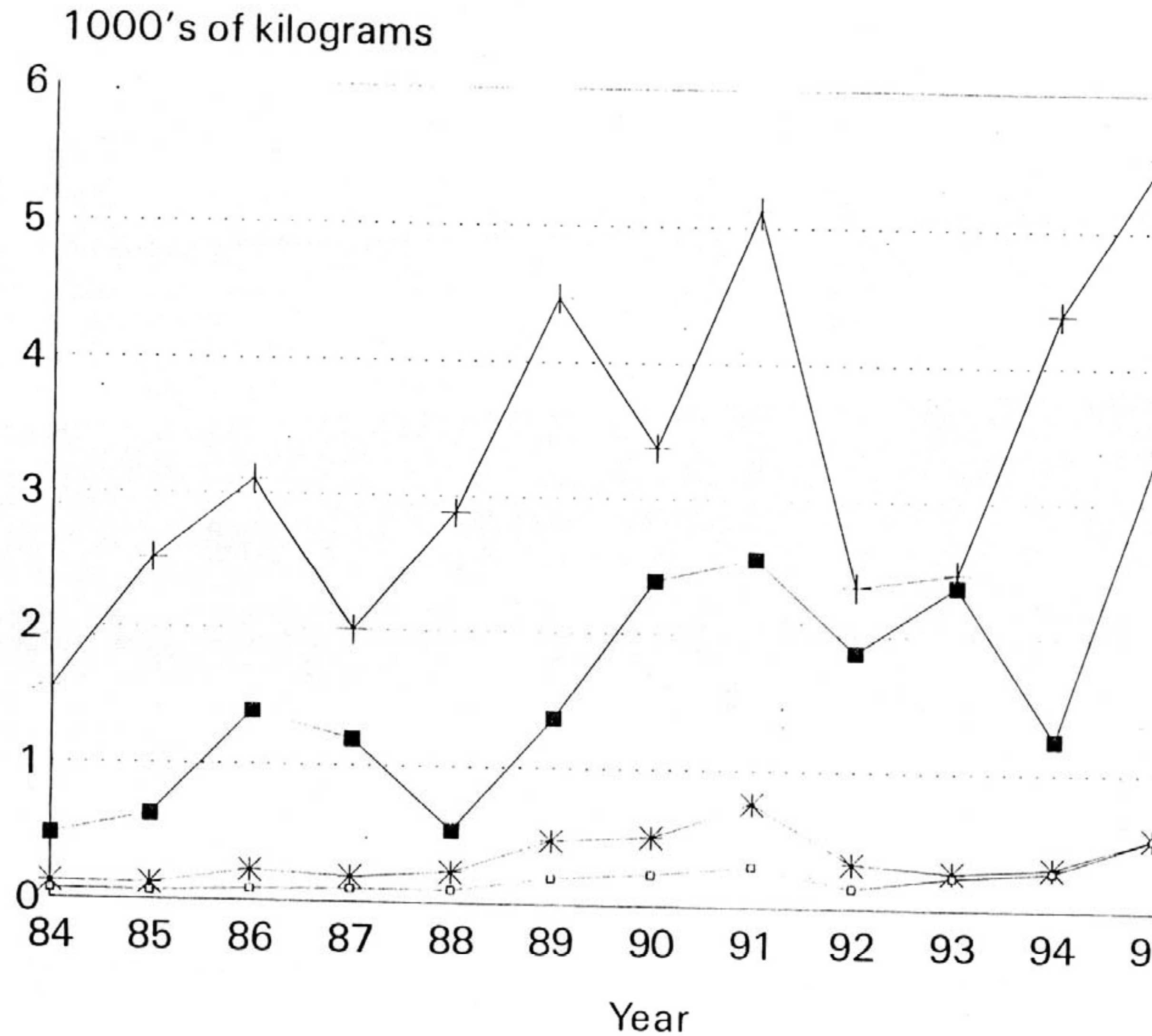

1000's of kilograms
6
5
4
3
2
1
0
84
85
86
87
88
89
90
91
92
93
94
Year

Figure 2. Average weight of individual fish by year for the commercial fishery in the Gulf of Mexico (GOM) and southeastern U.S. Atlantic Ocean (Atlantic).

Appendix B. Characterization of the Dolphin Fish (Coryphaenidae, Pices) Fishery of the United States Western North Atlantic Ocean

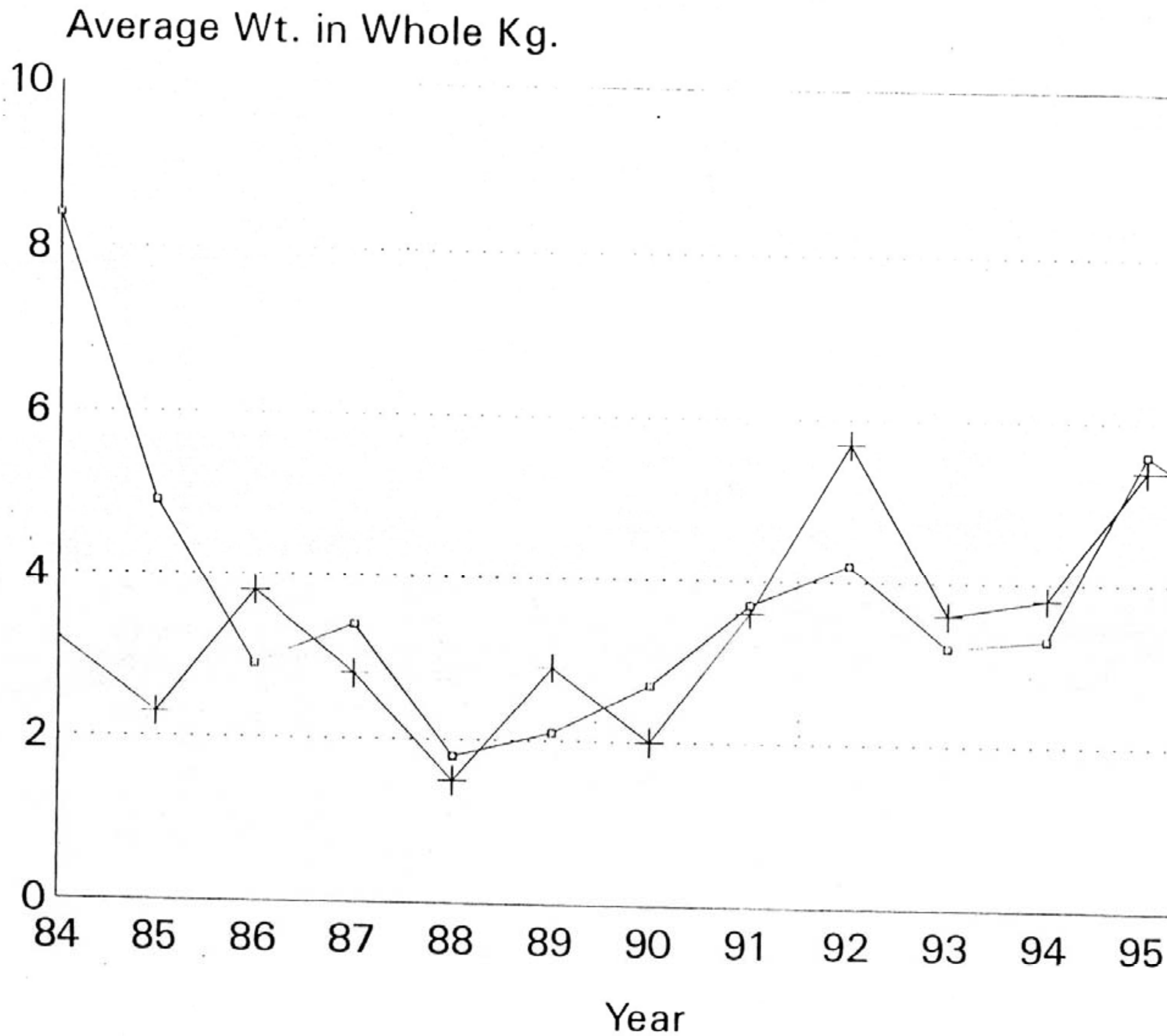


Figure 3. Average weight of individual fish sampled from the recreational sector in the Gulf of Mexico (GOM) and southeastern U.S. Atlantic Ocean (Atlantic).

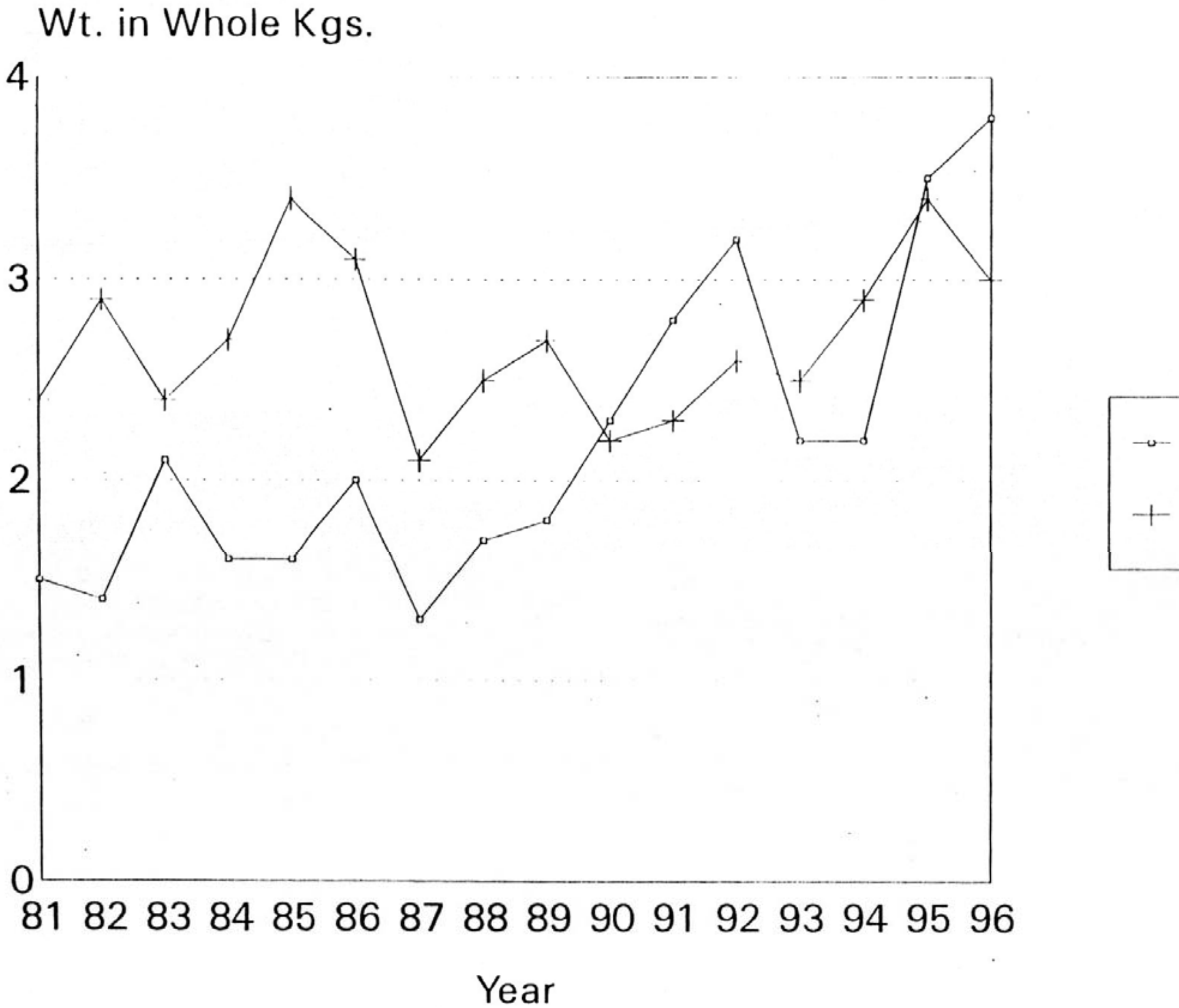

Wt. in Whole Kgs.
4
3
2
1
0
81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
Year

Figure. 4. Numbers of fish landed and recorded with gear identified for samples from the commercial fishery, all years, 1981-1996 combined. The total sample size is 12,841 individual fish.

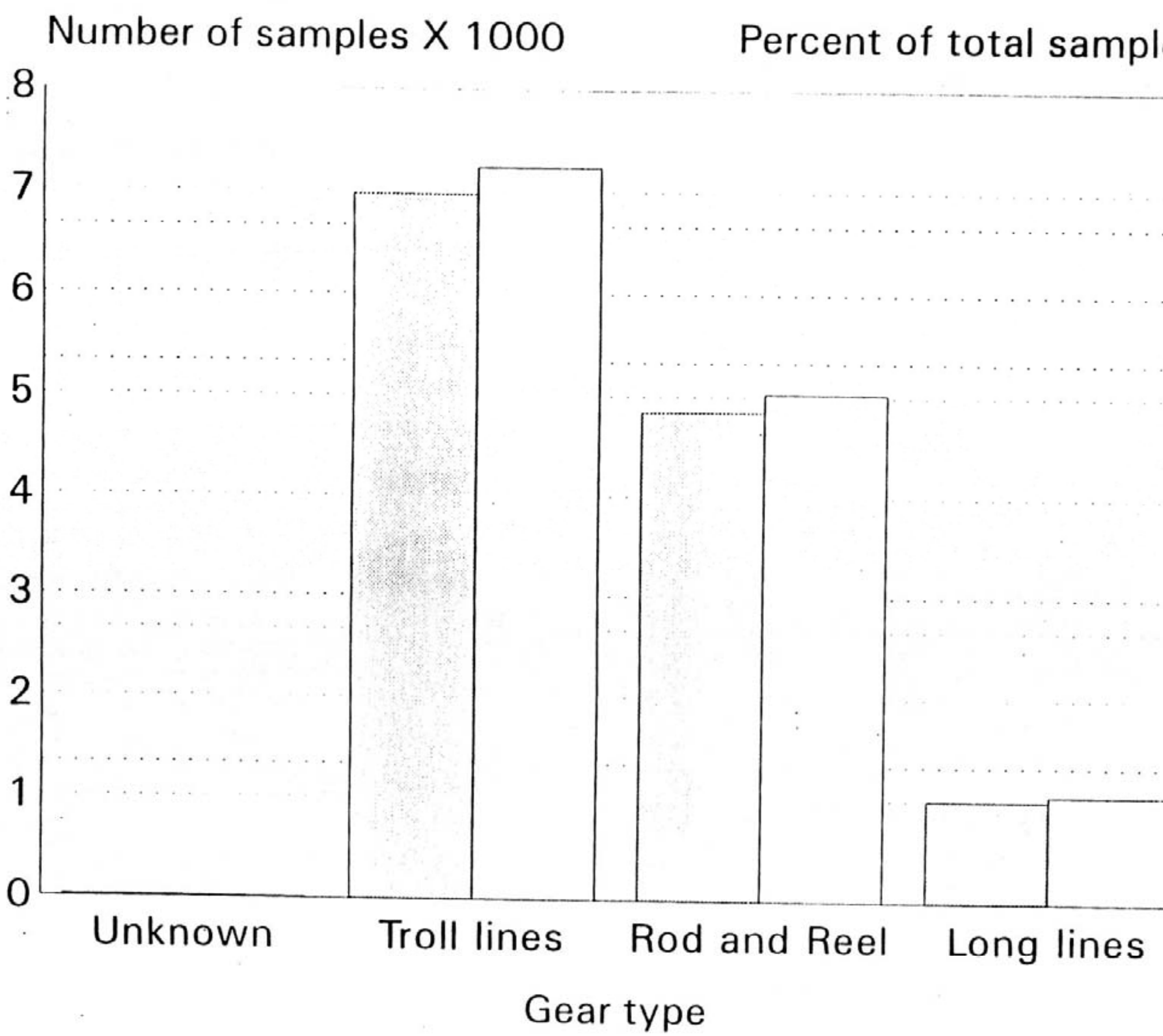

Number of samples X 1000
Percent of total sampl
8
7
6
5
4
3
2
1
0
Unknown
Troll lines
Rod and Reel
Long lines
Gear type

Figure 5. Annual number of fish reported by each angler per hour of fishing for the Gulf of Mexico recreational fishery. The three data sources for recreational samples are the Texas creel survey (-o-): the headboat survey (+); and the Marine Recreational Fishery Statistical Survey (MRFSS. •).

Appendix B. Characterization of the Dolphin Fish (Coryphaenidae, Pices) Fishery of the United States Western North Atlantic Ocean

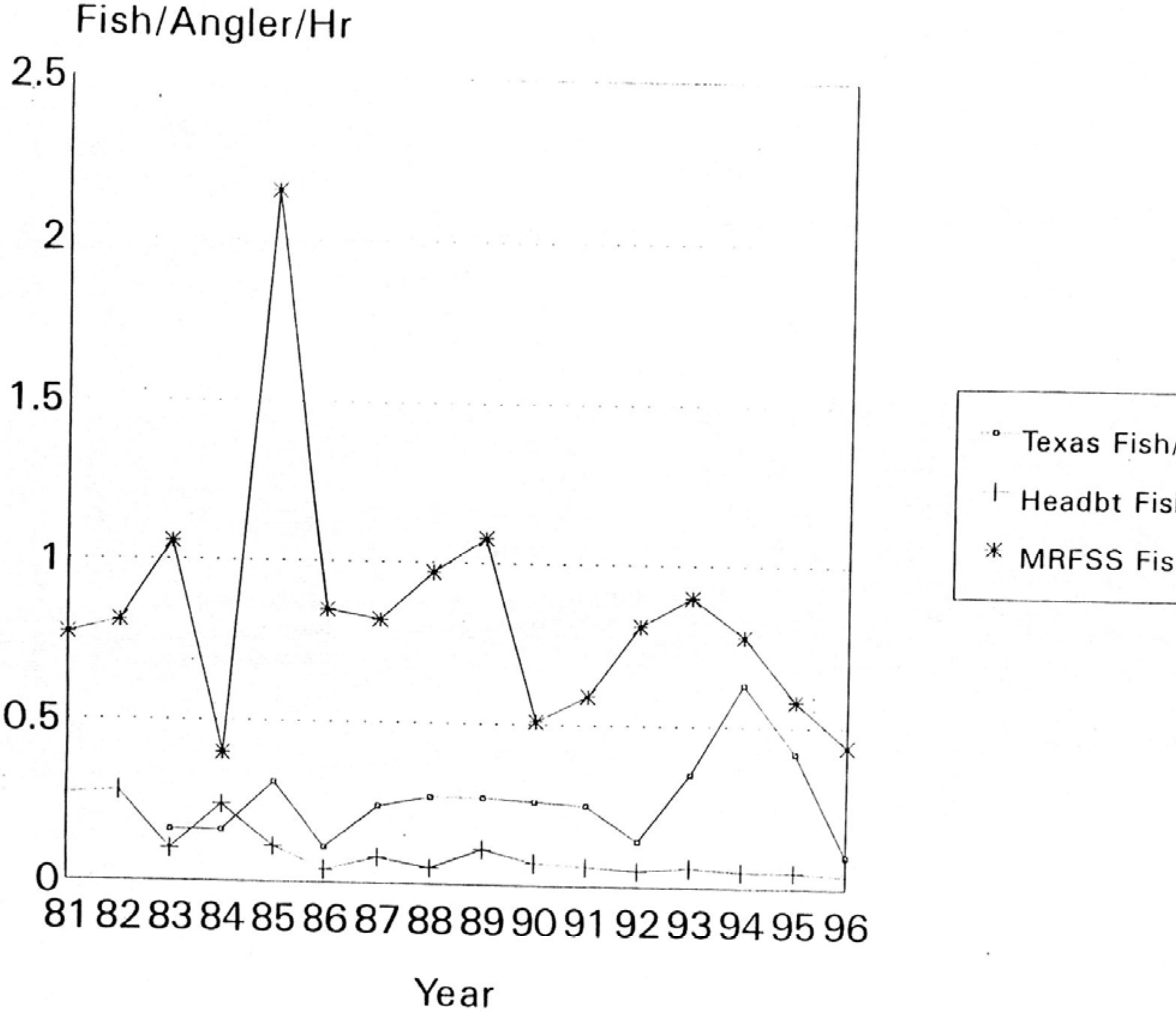
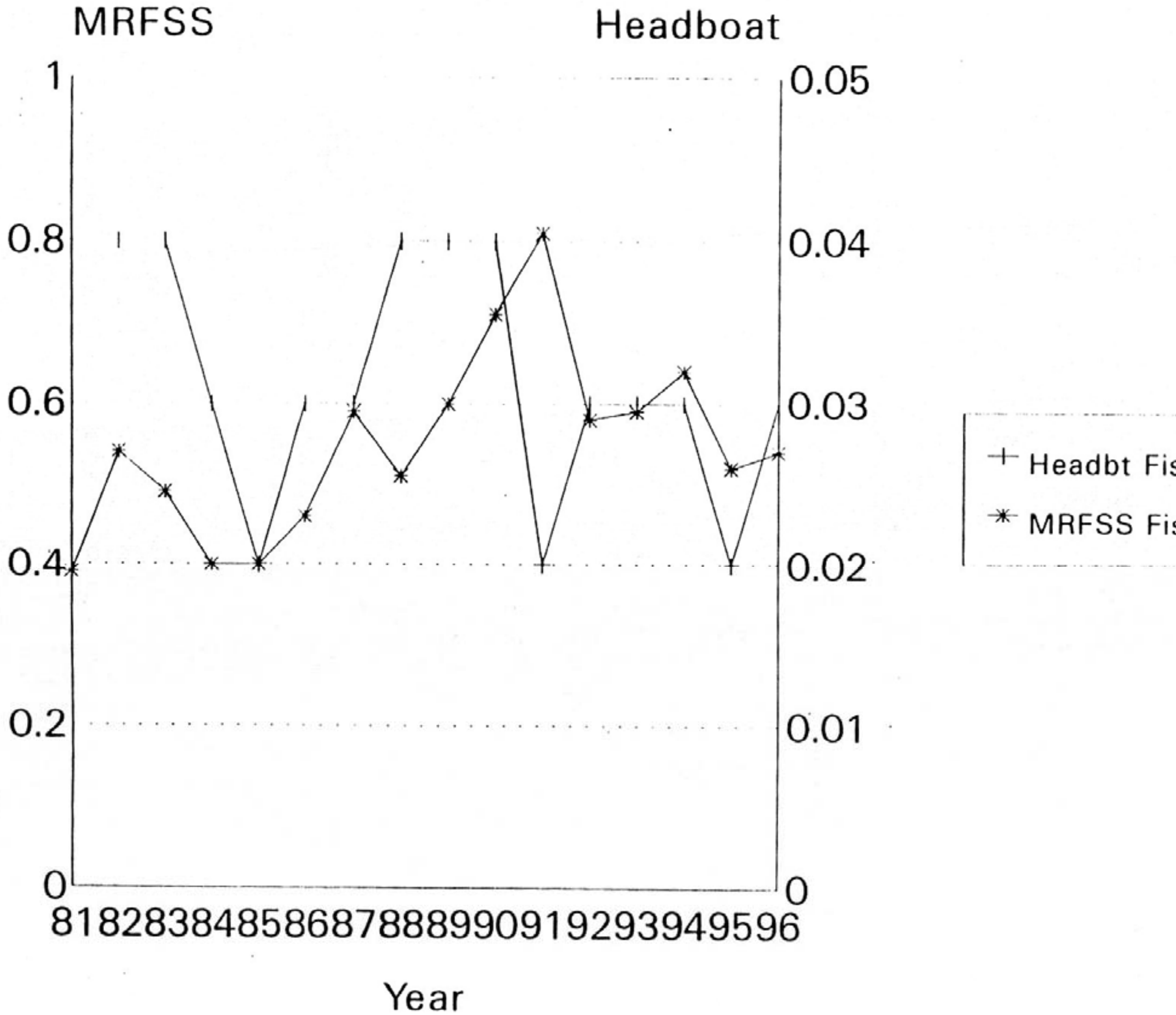


Figure 6. Annual number of fish reported per angler per hour of fishing for the southeastern U.S. Atlantic Ocean. The sources of samples were from the headboast survey (+), and the MRFSS (•).

Appendix B. Characterization of the Dolphin Fish (Coryphaenidae, Pices) Fishery of the United States Western North Atlantic Ocean



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Oxenford, H. A.- 1986. A preliminary investigation of the stock of the dolphin, Coryphaena hippurus, in the western central Atlantic. Fish. Bull. U.S. 84:451- 459.

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NOAA Tech. Rpt. NMFS Circular 443. 28 pages.

Appendix C. 1998 Report of the Mackerel Stock Assessment Panel (March 23-26, 1998)

4/27/98

1998 REPORT
OF THE MACKEREL STOCK ASSESSMENT PANEL

Prepared by the Mackerel Stock Assessment Panel
at the Panel Meeting Held March 23 - 26, 1998

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SUMMARY OF RECOMMENDATIONS

GROUP	ABC (RANGE) of OY= yield	Transitional SPR %	Static SPR %	OVERFISHED/ OVERFISHING
King mackerel: Atlantic migratory group	9.3 (8.4 - 11.9) million lbs @$F_{40\%}$ static SPR	39 (36-42)	36	Not overfished* Not overfishing
King mackerel: Gulf migratory group	8.7 (7.1 - 10.8) million lbs. @$F_{30\%}$ static SPR	23 (20 -27)	21	Overfished Overfishing
Spanish mackerel: Atlantic migratory group	6.6 (5.4 - 8.2) million lbs. @$F_{40\%}$ static SPR	40 (36-44)	42	Not overfished* Not overfishing
Spanish mackerel: Gulf migratory group	10.3 (7.3 - 14.1) million lbs. @$F_{30\%}$ static SPR	35 (30-39)	47	Not overfished* Not overfishing

* The "not overfished" recommendations are based on the Council's overfished criterion of 30% SPR for mackerel.

Notes: Transitional spawning potential ratio (SPR) (calculated from fishing mortality rates by age and year) is used to determine whether a stock is currently in an overfished status.

Static SPR (projected from most recent years fishing mortality rates) is used to determine whether a stock is being fished at a rate that will eventually lead to an overfished status, i.e. overfishing.

Acceptable biological catch (ABC) and Transitional SPR are presented at the 50th percentile mark of probability. The range (in parentheses) is presented for ABC between the 16th percentile and the 84th percentile and for transitional SPR from the 10th percentile to the 90th percentile.

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1998 REPORT OF THE MACKEREL STOCK ASSESSMENT PANEL (MSAP)
March 23 - 26, 1998
MIAMI, FLORIDA

I. INTRODUCTION

At the direction of the Gulf of Mexico and South Atlantic Fishery Management Councils (Councils), the Mackerel Stock Assessment Panel (Panel) met in Miami from March 23 - 26, 1998. The tasks for this Panel are specified by the Councils in Amendment 1 to the Fishery Management Plan (FMP) for the Coastal Migratory Pelagic Resources (Mackerels) dated April, 1985 (and subsequent amendments). Most recently, Amendment 8 includes a modified framework that respecifies the Panel's charge (See Appendix A). Previous Panel reports reflect the actions required by subsequent amendments.

Amendment 6 required full stock assessments every other year, and Amendment 8 requires full stock assessments in even numbered years. Accordingly, this year's assessments for Atlantic and Gulf migratory groups of king and Spanish mackerel are full assessments.

The list of documents that were reviewed by the Panel is included in the Literature Cited section. Copies of documents are available from the Councils or the Southeast Fisheries Science Center (SEFSC).

II. OVERFISHED, OVERFISHING, AND TARGET (OPTIMUM YIELD) CRITERIA

The current definitions of overfished, overfishing, target Optimum Yield (OY), and a rebuilding program, as approved under the Coastal Migratory Pelagics Fishery Management Plan (FMP), as amended, are as follows:

Overfished: A mackerel stock or migratory group is considered to be overfished when the transitional SPR falls below 30%.

Overfishing: When a stock or migratory group is not overfished (transitional SPR equal to or greater than 30%), the act of overfishing is defined as harvesting at a rate that exceeds the fishing mortality rate associated with a threshold static SPR of 30% (i.e., $F_{30\%}$). If fishing mortality rates that exceed the level associated with the static SPR threshold rate are maintained, the stock may become overfished. Therefore, if overfishing is occurring, a program to reduce fishing mortality rates toward management target levels (OY) will be implemented, even if the stock or migratory group is not in an overfished condition (Amendment 8).

For species like cobia, when there is insufficient information to determine whether the stock or migratory group is overfished (transitional SPR), overfishing is defined as a fishing mortality rate in excess of the fishing mortality rate corresponding to a default threshold static SPR of 30%. If overfishing is occurring, a program to reduce fishing mortality rates to at least the level corresponding to management target levels will be implemented (Amendment 8).

Target Optimum Yield (OY): The South Atlantic Council's target level or OY is 40% static SPR. The Gulf Council's target level or OY is 30% static SPR. ABC is calculated relative to the probability of achieving the target level or OY fishing mortality rate in the following fishing year (SAFMC = 40% static SPR and GMFMC = 30% static SPR).

Rebuilding Program: When a stock or migratory group is overfished (transitional SPR less than 30%), a rebuilding program that makes consistent progress towards restoring stock condition must be implemented and continued until the stock is restored beyond the overfished condition. The rebuilding program must be designed to achieve recovery within an acceptable time frame as specified by the Councils. The Councils will continue to rebuild the stock until the stock is restored to the management target (OY) within a unspecified time frame.

III. DATA SOURCES AND ANALYTICAL METHODOLOGY

A. AVAILABLE DATA TO ASSESS MACKEREL STOCKS

Data from a variety of sources were included in these assessments. Revised recreational landings and intercept data for 1995 and 1996, as well as preliminary estimates for 1997 came from the Marine Recreational Fisheries Statistical Survey (MRFSS). Additional recreational landings and catch rate information came from NMFS's Headboat Survey and Texas Parks and Wildlife Department Creel Survey. Commercial landings for 1996 were revised and preliminary estimates for 1997 used in these assessments came from NMFS's General Canvass. Commercial catch rates came from the Trip Interview Program (TIP) and Florida's Marine Fisheries Information System (Trip Ticket Program).

Auxiliary information included size and sex of fish from the commercial fishery, aging from collections of otoliths, numbers of juveniles from Atlantic SEAMAP, and catch rates from numerous directed fisheries. Due to time constraints, updated larval information from Gulf SEAMAP sampling was not available for this year's assessments. Last year, the Panel requested that analyses be performed to quantify the effects that various sampling designs and sample sizes have on assessment results. Although this research activity was considered during operations planning, the Gulf Council placed highest priority on completing full assessments of all mackerel stocks; and under the accelerated delivery schedule for this assessment, evaluations of this nature could not take place. The Panel again requests that these analyses be performed because the results of the analyses and the Panel's subsequent recommendations are highly dependent on these statistics.

Table 1 shows biological sampling and sampling fractions used in various analyses for Atlantic and Gulf migratory groups of king and Spanish mackerel.

e 1. Spanish mackerel biological samples and sampling fractions

Migratory Group	1987	1988	1989	1990	1991	1992	1993	1994	1995*	1996 *
Age Samples (number of specimens aged for age-length keys):										
ATL	246	174	212	507	625	681	451	200	295	564
GLF	378	276	479	1019	871	987	358	612	422	266
Age Sample Fractions (expressed as % of directed fisheries catch in numbers):										
ATL	0.007	0.004	0.006	0.015	0.014	0.020	0.013	0.005	0.013	0.020
GLF	0.011	0.007	0.020	0.037	0.021	0.026	0.011	0.020	0.023	0.017
Length Samples (number of specimens measured):										
ATL	6724	4165	6159	11194	15619	17609	13295	12927	4684	6997
GLF	12625	18016	9637	5686	10687	8541	7923	4655	4075	2346
Length Sample Fractions (expressed as % of directed fisheries catch in numbers):										
ATL	0.192	0.095	0.185	0.330	0.357	0.505	0.386	0.304	0.207	0.247
GLF	0.375	0.473	0.410	0.209	0.261	0.224	0.246	0.175	0.224	0.149

*Re: 1995-1996 length samples - Spanish mackerel commercial net samples from North Carolina were not available in 1995-1997.

Table 1.(cont.) King mackerel biological samples and sampling fractions

Migratory Group	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Age Samples (number of specimens aged for age-length keys):											
ATL	375	498	440	836	907	746	1246	780	805	410	831
GLF	302	846	660	812	572	1339	1271	1213	972	877	1607
Age Sample Fractions (expressed as % of directed fisheries catch in numbers):											
ATL	0.038	0.056	0.049	0.130	0.121	0.080	0.132	0.130	0.133	0.139	0.119
GLF	0.049	0.201	0.102	0.116	0.080	0.139	0.122	0.127	0.086	0.118	0.154
Length Samples (number of specimens measured):											
ATL	8232	12736	8909	8233	8599	10203	9356	5692	7961	4181	6265
GLF	7807	6287	5570	6215	4164	12726	13055	7581	7614	9267	7013
Length Sample Fractions (expressed as % of directed fisheries catch in numbers):											
ATL	0.842	1.428	0.994	1.241	1.147	1.092	0.993	0.948	1.310	0.650	0.896
GLF	1.270	1.491	0.860	0.891	0.579	1.324	1.253	0.796	0.678	1.000	0.673

B. ANALYTICAL METHODOLOGY

As in previous assessments, the status of exploitation of Atlantic and Gulf group king and Spanish mackerels is currently evaluated using age-based sequential virtual population analysis (VPA) models. Age-structured models require that the catches by species and migratory group be assigned ages. Catch-at-age data by group through fishing year 1996/97 developed for the 1998 mackerel assessments were used in the population assessments. The VPA models were calibrated with abundance indices from fisheries dependent CPUE data and from fisheries independent resource surveys. In the past, the age-specific selectivities in the most recent year were estimated from a separable VPA; however, this year's analyses used an iterative procedure to estimate those selectivities. Population sizes and fishing mortality rates were estimated using the ADAPT method (Restrepo 1996).

The results of the stock assessment analyses were used to evaluate the status of the stocks relative to specific biological reference points, and project forward in time to determine the ABC ranges for fishing year 1998/99. As in previous assessments, the fishing mortality rates (F's) were estimated in the VPA based on observed catches in 1996/97 and preliminary catch estimates for 1997/98. Catches for the remainder of 1997/98 were based on projected harvest rates. The estimated F's in 1996/97, 1997/98, and the target F's in 1998/99 were used to project stock sizes and catches through 1998/99 and to determine ABC ranges for that year. The projection model estimates future yields from the recreational sector in numbers and from the commercial sector in pounds using $F_{40\%}$ for Atlantic coast species and $F_{30\%}$ for Gulf coast species. Details of these estimates and projections are presented in Legault et al. (1998).

The effects of uncertainty in key parameter estimates and data sources on the ABC ranges for each of the mackerel species and migratory groups were evaluated by using a mixed Monte Carlo/bootstrap method to generate ABC probability distributions. The key parameters of catch at age, natural mortality rate at age, and abundance indices were assumed to be random variables exhibiting either known probability distributions or a distribution of the observed residuals from the original fit. Bootstrap analyses were repeated 400 times, and projections were made using fishing mortality rates corresponding to static spawning potential ratios of 5% to 50%. The probability distributions from the 400 results per each fishing mortality rate were used to construct confidence intervals surrounding the ABC estimates.

Because the distributions are skewed, the upper portion of the ABC ranges are much more difficult to determine and less certain than the central portion (median or 50^{th} percentile mark) of the ABC ranges. Consequently, the Panel strongly recommends that the Councils adopt a more risk adverse approach by choosing the median (50%) of the ABC range, as the upper bound instead of the 84th percentile. At the median, there are about even odds of achieving the Councils' goals ($F_{30\%}$ SPR - Gulf Council and $F_{40\%}$ SPR - South Atlantic Council).

The method of calculating current SPR, called transitional SPR, continues to follow the recent recommendations of Mace et al. (1996). Transitional SPR uses estimated year and age-specific fishing and natural mortality rates as well as average fecundity to calculate SPR on a per recruit basis. Mace et al. (1996) also recommended using static SPR for projections or the evaluation of alternative management options. Static SPRs are calculated by estimating the equilibrium age-structure associated with the most recent fishing mortality rates.

C. REVIEW AND EVALUATION OF SHRIMP TRAWL BYCATCH DATA

1. DELTA METHOD VERSUS GLM

In previous Gulf king and Spanish mackerel stock assessments, a generalized linear model (GLM) approach was used to estimate annual bycatch of mackerels in shrimp trawls (Nichols et al. 1987). In the GLM approach, the raw data are first transformed by adding a constant (1.0) to each CPUE value, and then the log of (CPUE + 1) is used as input data for the analysis. The addition of a constant is necessary because the raw values are mostly of zeros. They must be transformed because the log of zero is undefined. Two problems with using this approach are: 1) transformed data may not meet the GLM assumption of normality, and 2) the constant added to the CPUE values is not an arbitrary scalar because different values of the transformed constant yield different results in the bycatch estimates. To address these problems and consider possible alternative methods to estimate bycatch, the Panel reviewed the delta lognormal method, as presented by Legault and Ortiz (1998).

The delta lognormal method is a two-part process that first estimates the probability of encountering a fish (i.e. a tow with a king or a Spanish mackerel), and then estimates the expected value if a positive value is encountered. The estimated portion of positive tows is multiplied by the estimated CPUE, given that a positive tow has occurred. A stratum is the combinations of data set, year, season, area, and depth zone factors used in the model fitting. Bycatch CPUE is estimated by multiplying the results within each stratum. The approach may prove to be more robust statistically; however, there is a high probability that the delta-method bycatch estimates are biased due to the overwhelming dominance of zero values in the mackerel bycatch data sets (Legault and Ortiz 1998). Because the direction and magnitude of potential biases are unknown, the Panel opted to retain the GLM estimation procedure in the 1998 Gulf king and Spanish mackerel stock assessments. The Panel will review the appropriateness of using the delta method as more data become available.

2. ATLANTIC GROUP KING & SPANISH MACKEREL BYCATCH DATA

The Panel reviewed several estimates of mackerel bycatch in the southeast Atlantic shrimp trawl fisheries. One approach used SEAMAP data and two methods of estimation for the years 1992-1997. The two estimation methods are essentially based upon stratum-by-stratum expansions of bycatch by either shrimp effort expressed as numbers of tows or by the ratio of finfish to shrimp. For the 1996 assessment, the Panel elected to include estimated bycatch for 1992-1994, based on the effort expansion method, with the caveat that the available estimates were both very imprecise and highly variable from year to year. Upon further review of estimates for 1992-1997 using the same methodology, the Panel no longer supports inclusion of these estimates of annual bycatch in the VPA analyses because of the very high variability of the estimates. Furthermore, the number of sampled shrimp trips is very low and has decreased since 1994-1995. For example, in 1996/1997, there were no samples available to characterize nearly 60% of the trips by strata.

For this year's assessment, the Panel reviewed another proposed method of bycatch estimation based on sampling conducted in South Carolina during 1991 and 1992. This approach estimated the total regional bycatch for 1981-1995 by expanding mackerel catch per tow by an estimate of the total number of tows. The Panel does not feel that the limited sampling of this study (137 trips sampled from 3 ports over 2 years) is adequate for use as a regional bycatch estimate in the stock assessment.

Although bycatch of both Spanish and king mackerel is known to occur in southeast Atlantic shrimp trawl fisheries, to-date no acceptable method of estimating the magnitude of that bycatch has been derived. Further, the large variability of the available estimates both between and within years hampers attempts to provide meaningful average estimates. The Panel concluded that the best approach was to estimate ABC ranges without including any bycatch estimates. The Panel noted, however, that this approach could cause overestimation of SPR values if bycatch is occurring.

D. STOCK IDENTIFICATION OF KING MACKEREL

The present management regime specifies two migratory groups for management purposes based on tagging data, growth rate differences, and temporal differences in the fisheries: the Gulf migratory group and the Atlantic migratory group (although fish captured in the eastern Gulf of Mexico off west Florida are genetically indistinguishable from the Atlantic). The Atlantic migratory group that occurs along the U.S. east coast to New York mixes with the Gulf migratory group along southeast Florida in winter. For management and stock assessment purposes, the boundary between migratory groups currently is specified as the Volusia/Flagler county border along the Florida east coast in winter (November 1 - March 31) and the Monroe/Collier county border on the southwest Florida coast in summer (April 1 - October 31). Those boundaries were established based upon the results of mark-recapture studies conducted from 1975-1979.

The 1996 Panel report includes a review of the Working Group's report on stock identity and mixing. After a review of those findings, the Panel concluded that "the biological information supports a zone of mixing on the Florida east coast. The current boundary was specified by the Councils at the Flagler/Volusia county boundary. The Councils should be reminded that the east coast of Florida in the winter is a zone of mixing and that both Gulf and Atlantic migratory group fish occur there at that time. It is our understanding that some of the reasons that the original boundary was chosen was to provide greater biological protection to the overfished Gulf migratory group."

Tagging data from the 1970s indicated that during winter the Atlantic and Gulf migratory groups of king mackerel mix off the southeastern coast of Florida. The extent of mixing is not well-known, but it has been estimated at over 50 %. Both Councils continue to question the extent of mixing between the Gulf and Atlantic migratory groups, particularly in south Florida.. Consequently, investigations to identify fish belonging to each of the migratory groups continues. This year, the Panel reviewed a draft paper by DeVries and Grimes (in prep.) that examined the potential of using otolith shape analysis to distinguish between the Gulf and Atlantic migratory groups in the mixing zone. An image analysis system was developed and used to evaluate otolith shape using otoliths collected from female king mackerel that were caught during summer in the Atlantic (SC, GA, and NE FL) and the Gulf (NW FL). Using otolith shape characteristics as classification variables, a multivariate, discriminate functions analysis was used to classify fish caught in the mixing zone during November-March as belonging to either the Gulf or Atlantic migratory groups. In a preliminary study using females collected from 1986-1993 (n = 355), Atlantic and Gulf fish were correctly classified with a high degree of accuracy (> 80 %), both by resampling the fish used to estimate the discriminate function and by using an independent data set of fish from both areas (n = 105). Next, females were collected (n = 363; FL = 80 - 96 cm) on the spawning grounds of the Atlantic and Gulf during the summer of 1996. Otolith shape data from these fish were used to estimate a discriminate function that correctly classified 77.1 % of Gulf fish and 85 % of Atlantic fish from an independent data set (n = 240). They applied this discriminate function to otolith shape data from fish collected in the mixing zone (Cape Canaveral to West Palm Beach, FL) during December and January 1996-97, and the discriminate function estimated that 88 % of the mixing zone fish belonged to the Atlantic migratory group and 12 % belonged to the Gulf migratory group. The Panel re-estimated the mixing to correct for the proportion not identified correctly. The corrected, preliminary proportions were 70% Atlantic migratory group and 30% Gulf migratory group.

The Panel thinks this work is a unique and useful approach to estimating the dynamics of mixing in the winter fishery of southeast Florida, and it may prove to be a useful management tool in allocating mixing zone fish to either group. Before this technique is routinely utilized in king mackerel stock assessment or management, however, the Panel recommends four issues for further study or clarification: 1) variance estimates of the percent fish classified as belonging to each group are needed; 2) the analysis needs to be adjusted for misclassification errors estimated in the rule discriminate function when estimating percent mixing zone fish belonging to each group; 3) the assumption that differences in growth rates between Atlantic and Gulf migratory group females are driving the signals seen in otolith shapes needs to be tested; and 4) the temporal stability of the signal between years and/or across age classes needs to be tested.

After discussing the mixing issue, the Panel decided not to change their 1996 conclusions. Otolith shape analyses hold promise as a method to estimate rates of mixing; however, more research is needed (See Future Research and Assessment Considerations section). Additionally, this and other methods (e.g., otolith chemical analysis) should continue to be evaluated.

IV. STATUS OF THE STOCKS

1. Atlantic Migratory Group King Mackerel

Landings and History of Management

Catches since 1981/82 have ranged from a low of 5.93 million pounds in 1994/95 to a high of 9.62 million pounds in 1985/86 (Table 2) (Figure ATK -1). Projected fishing year 1997/98 landings were estimated using the recreational estimates from the most recent 12-month period available, current commercial quota monitoring reports or dealer surveys, and personal communications with fisheries statistics personnel. For Atlantic group king mackerel, the 1997/98 projected landings are:

Commercial	=	2.52 million pounds*
Recreational	=	6.00 million pounds (574,000 fish)
Total	=	8.52 million pounds

- the commercial fishery closed on March 27, 1998 following the filling of the commercial allocation of TAC.

Estimates of Fishing Mortality Rates

The pooled fishing mortality rates (F's) on age 3+ adults increased from just below 0.2 in 1982/83 to a high of about 0.3 in 1985/86 and then varied without trend around 0.2 between 1987/88 through 1992/93 (Figure **ATK-2**). From 1992/93 through 1994/95, fishing mortality declined to a low of below 0.1, but it has increased each year since 1994/95. The median pooled F on ages 3+for 1997/98 was 0.11 per year within the 10^{th} percentile to 90^{th} percentile range of 0.08 to 0.13.

Trends in Recruitment

Recruitment for ages 1-2 was low in the 1980s, increased through the early 1990s, and then declined to a low in 1994/95. It subsequently rebounded to its highest level in 1997/98 (Figure **ATK-3**).

Trends in Biomass

Biomass estimates of ages 3+ showed a slight decline during the 1980s and subsequently increased through 1997/98 (Figure **ATK-4**). Total biomass estimates have remained relatively stable (Figure ATK-5).

Acceptable Biological Catch (ABC)

For the 1998/99 fishing year, given the South Atlantic Council's objective not to exceed F_{40}% SPR, the Panel recommends the best estimate of yield to be 9.3 million pounds. There is a 50 percent chance that a TAC of 9.3 million pounds will achieve a $F_{40\%}$SPR level, a 16 percent chance that a 11.9 million pound TAC would achieve a $F_{40\%}$SPR level, and an 84 percent chance that a TAC of 8.4 million pounds would achieve a $F_{40\%}$SPR level. Estimated landings for the last five years have averaged 6.7 million pounds.

Discussion of Stock Status

Landings of Atlantic group king mackerel in the last five years have averaged 6.7 million pounds; and total landings have been below TAC in every year except 1997/98 (Table 2). The transitional SPR has also steadily increased since about 1994, and the current estimate for 1998/99 is 39 percent. As previously noted, SPR estimates are presented as "conditional on no bycatch."

Overfishing

Static SPR was estimated at 36 percent based on the F multiplier for 1996-97 of 0.47. Consequently, the Panel concludes that the Atlantic group king mackerel fishery was not overfishing the available stock because the fishing mortality rate was less than F at 30% static SPR in 1996-97.

Overfished Status

The Panel concludes that the Atlantic migratory group of king mackerel is not overfished because the transitional SPR is estimated at 39 percent, which is above 30% (Figure ATK-6).

Table 2. King mackerel Atlantic stock catch summary for numbers in thousands.

Fishing Year	Mid and North (N. of NC) Com	Mid and North (N. of NC) Rec	Mid and North (N. of NC) Total	South (NC - FL) Com	South (NC - FL) Rec	South (NC - FL) Total	Combined Com	Combined Rec	Combined Total
1981/82	<0.5	3	3	275	494	769	276	497	772
1982/83	2	<0.5	2	380	530	910	382	530	911
1983/84	1	<0.5	1	234	671	905	235	671	906
1984/85	<0.5	<0.5	<0.5	181	613	794	182	613	794
1985/86	1	<0.5	1	232	818	1050	233	818	1051
1986/87	<0.5	10	10	277	690	967	277	700	977
1987/88	2	7	9	346	537	883	348	544	892
1988/89	2	13	15	339	543	882	340	556	897
1989/90	1	7	8	282	373	655	283	380	664
1990/91	2	2	5	308	437	745	310	439	750
1991/92	3	10	13	293	628	921	296	639	934
1992/93	4	13	17	265	660	925	270	673	943
1993/94	2	17	20	223	358	581	225	375	600
1994/95	0	2	3	226	379	605	226	382	607
1995/96	1	1	2	179	462	641	180	463	644
1996/97	0	1	2	315	383	698	316	384	700
1997/98									

Table 2 (cont.). King mackerel Atlantic stock catch summary for weight in thousands of pounds.

Fishing Year	Mid and North (N. of NC) Com	Mid and North (N. of NC) Rec	Mid and North (N. of NC) Total	South (NC - FL) Com	South (NC - FL) Rec	South (NC - FL) Total	Combined Com	Combined Rec	Combined Total
1981/82	3	28	31	2387	4394	6781	2390	4422	6812
1982/83	14	<0.5	14	3924	5246	9170	3938	5246	9185
1983/84	7	<0.5	7	2434	6253	8687	2441	6253	8694
1984/85	3	<0.5	3	1944	6131	8075	1947	6131	8078
1985/86	10	2	12	2485	7119	9604	2495	7121	9616
1986/87	4	78	81	2833	5901	8734	2837	5979	8816
1987/88	16	49	65	3436	3856	7293	3453	3905	7357
1988/89	15	122	137	3076	4759	7835	3091	4881	7972
1989/90	10	72	82	2625	3329	5954	2635	3400	6036
1990/91	15	14	28	2662	3704	6366	2676	3718	6394
1991/92	22	93	115	2494	5730	8224	2516	5822	8338
1992/93	31	100	132	2195	6150	8345	2227	6251	8477
1993/94	20	219	240	1997	4219	6216	2018	4438	6456
1994/95	1	24	25	2196	3703	5900	2197	3728	5925
1995/96	10	13	24	1859	4140	5999	1870	4153	6023
1996/97	5	16	21	2697	4000	6697	2702	4016	6718
1997/98							2520*	6000*	8520*

- 1997/98 landings are preliminary

Table 2. (cont.) King mackerel Atlantic stock management regulations. Pounds are in millions.

Fishing Year	ABC (lbs)	TAC (lbs)	Rec. Alloc./Quota[3] (lbs / numbers)	Rec. Bag Limit	Com. Allocation[4] (lbs)
1986/87	6.9 - 15.4	9.68	6.09	3	3.59 (PS=0.40)
1987/88	6.9 - 15.4	9.68	6.09	3	3.59 (PS=0.40)
1988/89	5.5 - 10.7	7.00	4.40	2 in FL, 3 GA-NC	2.60 (PS=0.40)
1989/90	6.9 - 15.4	9.00	5.66 / 666,000	2 in FL, 3 GA-NC	3.34
1990/91	6.5 - 15.7	8.30	5.22 / 601,000	2 in FL, 3 GA-NY	3.08
1991/92	9.6 - 15.5	10.50	6.60 / 735,000	5 in FL-NY	3.90
1992/93	8.6 - 12.0	10.50	6.60 / 834,000[5]	2 in FL, 5 GA-NY	3.90
1993/94	9.9 - 14.6	10.50	6.60 / 854,000	2 in FL, 5 GA-NY	3.90
1994/95	7.6 - 10.3	10.00	6.29 / 709,000	2 in FL, 5 GA-NY	3.71
1995/96	7.3 - 15.5	7.30	4.60 / 454,000	2 in FL, 3[6] GA-NY	2.70
1996/97	4.1 - 6.8	6.80	4.28 / 438,525	2 in FL, 3 GA-NY	2.52
1997/98	4.1 - 6.8	6.80	4.28 / 438,525	2 in FL, 3 GA-NY	2.52

[1]Fishing year 1979/80 begins on 1 April 1979 and ends on 31 March 1980.
[2]Sums within rows may not appear to equal the Total value shown due to rounding of numbers before printing.
[3]Recreational quota in numbers is the allocation divided by an estimate of annual average weight (not used prior to fishing year 1989).
[4]The commercial allocation includes the purse seine allocations listed.
[5]Bag limit will not be reduced to zero when allocation reached, beginning in fishing year 1992.
[6]Bag limit reduced from 5 to 3 effective 1/1/96.

2. Gulf Migratory Group King Mackerel

Landings and History of Management

Catches since 1981/82 have ranged from a to a high of 12.3 million pounds in 1982/83 to a low of 3.0 million pounds in 1987/88 (Table 3 and Figure GK-1). Since 1986/87, landings have generally increased and have exceeded TAC in most years (Table 4). Preliminary estimates of 1997/98 landings are:

1997/98	
Commercial	3,390,000*
Recreational	8,393,226 (779,319 fish)**
Total	11,783,266

* The total commercial landings for the 1997 fishing year are expected to equal the allocated quota.

** This total was computed based upon 1996/97 average weights in the recreational fishery, plus calendar landings based on 1996 headboat and Texas recreational levels and 1997 MRFSS data.

Estimates of Fishing Mortality Rates

Pooled F's on age 4+ adults generally declined from 1981/82 to their lowest point in 1987/88. The last peak in F was during the 1994/95 fishing year with lower, relatively stable levels since 1995 (Figure GK-2). The median pooled F on ages 4+ for 1997/98 was 0.19 per year within the 10th percentile to 90th percentile range of 0.15 to 0.23.

Trends in Recruitment

Estimates of recruitment for ages 1-3 declined from 1981/82 to a low in 1984/85, then steadily increased to a high in 1996/97 (Figure GK-3). The 1997/98 estimate is somewhat lower, as is the 1998 projection; however, recruitment is still higher than levels that existed prior to 1994.

Trends in Biomass

Biomass estimates of ages 4+ showed a steady decline from 1981/82 to 1987/88 but have since increased to the current levels that are the highest in the time series (Figure GK-4). Total biomass increased from 1981/82 to about 1988/89 and remained relatively stable thereafter (Figure GK-5). The expected biomass at the beginning of the 1998-99 season is the highest in the time series. *A note of caution is that biomass has consistently lagged recruitment with an offset of about 3 years. Since recruitment has remained level or may be declining, continued increases in biomass may not occur in the short-term.*

Acceptable Biological Catch (ABC)

For the 1998/99 fishing year, given the Gulf Council's objective not to exceed F 30% SPR, the Panel recommends the best estimate of TAC to be 8.7 million pounds. There is a 50 percent chance that a TAC of 8.7 million pounds will achieve a $F_{30\%}$ SPR level, a 16 percent chance that a 10.8 million pound TAC would reach a $F_{30\%}$ SPR level, and an 84% that a TAC of 7.1 million pounds would provide a $F_{30\%}$ SPR level. Clearly, the lower the TAC is set, the lower the probability of overfishing during the 1998-99 fishing year. The Panel emphasizes that there are greater uncertainties with regard to estimates above the 50th percentile mark.

Discussion of Stock Status

Landings of Gulf group king mackerel in the last five years have been the highest in the series since 1982/'83, and total landings have exceeded TAC in every year since 1986 (Table 4). Since the 1986/87 fishing year, transitional SPR has varied between 20 and 25 percent with a slightly increasing trend since 1995 (Figure GK-6). Transitional SPR for the 1998/99 fishing year is estimated at 23 percent, which is below the Council's objective.

Overfishing

Static SPR was estimated at 21 percent based on the F multiplier for 1996-97 of 1.00. Consequently, the Panel concludes that the Gulf group king mackerel fishery was overfishing the available stock because the fishing mortality rate was greater than F at 30 percent static SPR in 1996/97. If fishing mortality continues at this rate, the fishery will remain overfished and will not be able to recover above the 30 percent transitional SPR level.

Overfished Status

The Panel concludes that the Gulf migratory group of king mackerel is overfished because the transitional SPR is below 30 percent. Although the Panel did not address rebuilding of the stock, NMFS developed various scenarios for the Council's use should it desire to implement a new rebuilding schedule (Appendix B).

Table 3. King Mackerel Gulf Stock catch summary for numbe... thousands[1,2]. The listings for East and West Gulf represent catch estimates derived by assuming a zone of mixing between these two hypothesized stocks. The assumed mixing zone ranges from Alabama through Texas with variable proportions of the catch attributed to each of the hypothesized stocks as a function of distance along the U.S. Gulf of Mexico coast.

	East Gulf			West Gulf			US Gulf		
Fishing Year	Com	Rec	Total	Com	Rec	Total	Com	Rec	Total
1981/82	654	172	827	<0.5	126	126	654	299	953
1982/83	406	435	841	42	388	430	449	823	1271
1983/84	360	270	630	29	72	101	389	342	731
1984/85	282	317	599	44	81	125	326	398	724
1985/86	335	116	451	42	68	110	377	184	561
1986/87	153	384	538	19	58	77	172	442	615
1987/88	107	257	364	12	46	58	119	303	422
1988/89	103	463	566	19	62	81	122	526	647
1989/90	156	469	625	27	45	73	184	514	698
1990/91	180	436	616	37	66	103	217	502	719
1991/92	195	648	843	28	90	118	223	738	961
1992/93	340	540	881	70	92	162	410	632	1042
1993/94	215	560	775	52	125	177	267	685	952
1994/95	281	709	991	55	83	137	336	792	1128
1995/96	241	569	811	49	65	114	290	634	925
1996/97	328	595	923	49	69	118	378	664	1042
1997/98									

Table 3 (cont.). King Mackerel Gulf Stock catch summary for weight in thousands of pounds[1,2].

	East Gulf			West Gulf			US Gulf		
Fishing Year	Com	Rec	Total	Com	Rec	Total	Com	Rec	Total
1981/82	5646	1425	7071	<0.5	1476	1476	5646	2901	8548
1982/83	3802	3735	7538	837	3958	4795	4640	7693	12333
1983/84	2624	1626	4250	348	812	1161	2972	2439	5411
1984/85	2601	2358	4959	603	751	1354	3205	3109	6313
1985/86	2976	979	3956	574	852	1426	3550	1832	5382
1986/87	1165	2618	3784	308	650	958	1473	3269	4742
1987/88	690	1655	2345	178	490	668	868	2145	3013
1988/89	1103	4515	5618	303	761	1063	1405	5276	6681
1989/90	1521	2856	4377	432	504	937	1954	3360	5314
1990/91	1395	3288	4683	421	664	1084	1816	3951	5767
1991/92	1731	3966	5697	386	808	1194	2117	4773	6890
1992/93	2839	5458	8297	760	800	1560	3599	6258	9857
1993/94	1954	4923	6877	618	1224	1841	2572	6146	8718
1994/95	2330	7205	9535	612	659	1271	2942	7863	10806
1995/96	2101	5663	7764	544	602	1146	2645	6265	8910
1996/97	2328	6454	8782	525	700	1225	2853	7154	10007
1997/98							3390*	8393*	11783*

* 1997/98 landings are preliminary.

Table 3. (cont.) King Mackerel US Gulf Stock management regulations. Weights are in millions of pounds.

Fishing Year	ABC (lbs)	TAC (lbs)	Rec. Alloc./Quota[3] (lbs / numbers)	Rec. Bag Limit[4]	Com. Allocation: East/West[5,6]	
1986/87	1.2 - 2.9	2.9	1.97	2/3 FL-TX	0.93 :	0.60/0.27 + PS=0.06
1987/88	0.6 - 2.7	2.2	1.50	2/3 FL-TX	0.70 :	0.48/0.22
1988/89	0.5 - 4.3	3.4	2.31	2/3 FL-TX	1.09 :	0.75/0.34
1989/90	2.7 - 5.8	4.25	2.89 / 298,000	2/3 FL-TX	1.36 :	0.94/0.42
1990/91	3.2 - 5.4	4.25	2.89 / 301,000	2/3 FL-TX	1.36 :	0.94/0.42
1991/92	4.0 - 7.0	5.75	3.91 / 574,000	2 FL; 2/3 AL-TX	1.84 :	1.27/0.57
1992/93	4.0 -10.7[9]	7.80	5.30 / 715,000[8]	2 FL-TX	2.50+0.259:	1.73+0.259/0.77[7]
1993/94	1.9 - 8.1[9]	7.80	5.30 / 759,000	2 FL-TX	2.50 :	1.73/0.77
1994/95	1.9 - 8.1[9]	7.80	5.30 / 768,000	2 FL-TX	2.50+0.300:	1.73+0.300/0.77[10]
1995/96	1.9 - 8.1[9]	7.80	5.30 / 629,000	2 FL-TX	2.50 :	1.73/0.77
1996/97	4.7 - 8.8	7.80	5.30 / 629,000	2 FL-TX	2.50 :	1.73/0.77
1997/98	6.0 - 13.7	10.60	7.21 /	2 FL-TX	3.39 :	2.34/1.05

[1] Fishing year 1979/80 begins on 1 July 1979 and ends on 30 June 1980.
[2] Sums within rows may not appear to equal the total value shown due to rounding of numbers before printing.
[3] Recreational quota in numbers is the allocation divided by an estimate of annual average weight (not used prior to fishing year 1989).
[4] Bag Limit "2/3" means 2 for private boats; for charterboats: 2 with, or 3 without, captain and crew.
[5] E/W com. allocations apply to all legal gears except purse seine in fishing year 1986 (only H&L and runaround gillnet beginning 1990/91).
[6] For quota monitoring, E/W com. allocations apply to East=(Florida) and West=(Alabama-Texas), not accounting for mixing.
[7] 0.259 million pounds added to com. allocation for FL east only, opened 2/18/93 - 3/26/93.
[8] Bag limit will not be reduced to zero when allocation reached, beginning in fishing year 1992/93.
[9] Panel recommended ABC range changed from 16%-84% to 16%-50% and Gulf Council selected TAC accepting greater than 50% risk level.
[10] 0.300 million pounds added to hook-and-line quota for Florida West Coast subzone

TABLE 4. Comparison of Gulf group king mackerel TAC and landings by fishing year(million pounds); percent of total landings over allocation for recreational and commercial sectors.

Fishing Year	TAC	Total Landings	Recreational				Commercial		
			Allocation	Landings	% of Landings	% Over Allocation	Allocation	Landings	% Of Landings
86/87	2.9	4.74	1.97	3.27	69%	66	.93	1.47	31%
87/88	2.2	3.02	1.50	2.15	71%	43	.70	.87	29%
88/89	3.4	6.69	2.31	5.28	79%	128	1.09	1.41	21%
89/90	4.25	5.31	2.89	3.36	63%	16	1.36	1.95	37%
90/91	4.25	5.77	2.89	3.95	68%	37	1.36	1.82	32%
91/92	5.75	6.89	3.91	4.77	69%	22	1.84	2.12	31%
92/93	7.8	9.86	5.30	6.26	63%	18	2.50	3.60	37%
93/94	7.8	8.72	5.30	6.15	71%	16	2.50	2.57	29%
94/95	7.8	10.8	5.30	7.86	73%	48	2.50	2.94	27%
95/96	7.8	8.92	5.30	6.27	70%	18	2.50	2.65	30%
96/97	7.8	10.0	5.30	7.15	72%	35	2.50	2.85	28%
97/98*	10.6	11.78	7.21	8.39	71%	16	3.39	3.39	29%

* 1997/98 landings are preliminary

3. Atlantic Migratory Group Spanish Mackerel

Landings and History of Management

The Atlantic group Spanish mackerel fishery has been fully regulated since 1986/87. While the commercial quota has been met every year up to 1995/96, the total harvest has not exceeded the TAC since the 1991/92 fishing year (Table 5) (Figure ATS-1). Additionally, the recreational sector has not filled their allocation since 1990/1991.

Projected fishing year 1997/98 landings were estimated using the recreational estimates from the most recent 12-month period available, current commercial quota monitoring reports or dealer surveys, and personal communications with fisheries statistics personnel. For Atlantic group Spanish mackerel, the 1997/98 projected landings are:

Commercial	=	4.00 million pounds
Recreational	=	1.35 million pounds (1,047,000 fish)
Total	=	5.35

Estimates of Fishing Mortality

The fishing mortality rate on adults, ages (Age 2+), was slightly above 0.8 for fishing year 1984/85, and declined to about 0.2 in the 1987/88 fishing year. From 1988/89 through 1994/95, F varied around 0.4 and then declined in 1995/96. The trend has been upwards since 1995/96 (Figure ATS-2). The median pooled F on ages 2+ for 1997/98 was 0.21 per year within the 10^{th} percentile to 90^{th} percentile range of 0.16 to 0.27.

Trends in Recruitment

Estimates of age-1 recruits has been variable without trend since 1984/85 (Figure ATS-3).

Trends in Biomass

Estimates of biomass of age 2+ was low in the mid-1980s and increased in the late 1980s. Biomass was stable from 1988/89 through 1995/96, but recent estimates of biomass have been higher (Figure ATS-4). Total biomass has generally increased since about 1989 (Figure ATS-5).

Acceptable Biological Catch (ABC)

For the 1998/99 fishing year, given the Council's objective not to exceed $F_{40\%}$SPR, the Panel recommends the best estimate of yield to be 6.6 million pounds. There is a 50 percent chance that a TAC of 6.6 million pounds will achieve a $F_{40\%}$SPR level, a 16 percent chance that a TAC of 8.2 million pounds would achieve a $F_{40\%}$SPR level, and an 84 percent chance that a TAC of 5.4 million pounds would achieve a $F_{40\%}$SPR level.

Status of the Stock

The Panel believes that the reductions in harvest in recent years reflect the elimination of gill nets from Florida state waters in 1995 and are not due to reduced stock sizes. The current operation of the fishery is expected to harvest less than the estimated median ABC value of 6.6 million pounds.

Overfishing

Static SPR was estimated at 42 percent based on the F multiplier of 0.35 for 1996-97. Consequently, the Panel concluded that the Atlantic migratory group Spanish mackerel fishery was not overfishing the available stock because the fishing mortality rate is above the $F_{30\%\ static}$ rate.

Overfished Status

The Panel concludes that Atlantic migratory group Spanish mackerel are not overfished since the transitional SPR is estimated at 40, which is above the 30 percent level (Figure ATS-6).

Table 5. Spanish mackerel Atlantic stock catch summary for numbers in thousands.

Fishing Year	Mid and North (North of NC) Com	Rec	Total	South (NC - FLA) Com	Rec	Total	Combined Com	Rec	Total
1984/85	10	<0.5	10	2174	942	3116	2184	942	3126
1985/86	38	<0.5	38	2308	496	2804	2346	496	2842
1986/87	246	9	254	1661	789	2450	1907	798	2704
1987/88	578	11	589	1868	1042	2910	2446	1053	3498
1988/89	553	102	655	2094	1624	3718	2647	1726	4373
1989/90	451	97	547	1784	1006	2790	2234	1103	3337
1990/91	540	70	610	1527	1253	2780	2067	1323	3390
1991/92	737	155	893	2176	1308	3484	2913	1464	4377
1992/93	356	88	445	1918	1122	3040	2274	1210	3484
1993/94	63	123	186	2462	797	3258	2525	920	3445
1994/95	476	197	673	2693	887	3580	3169	1085	4254
1995/96	381	113	494	1095	672	1767	1476	785	2260
1996/97	292	71	362	1879	587	2466	2170	658	2829

Table 5 (cont.). Spanish mackerel Atlantic stock catch summary for weight in thousands of pounds.

Fishing Year	Mid and North (North of NC) Com	Rec	Total	South (NC - FLA) Com	Rec	Total	Combined Com	Rec	Total
1984/85	10	<0.5	10	3281	1311	4592	3292	1311	4602
1985/86	15	<0.5	15	4176	747	4923	4192	747	4939
1986/87	176	11	186	2390	1185	3575	2565	1196	3761
1987/88	381	15	396	3179	1458	4637	3559	1474	5033
1988/89	327	153	480	3197	2587	5784	3524	2740	6264
1989/90	423	113	537	3540	1456	4996	3963	1569	5533
1990/91	600	100	699	2960	1975	4935	3560	2075	5635
1991/92	765	217	982	3971	2070	6041	4736	2287	7023
1992/93	396	118	514	3321	1877	5198	3716	1995	5712
1993/94	83	159	242	4731	1333	6064	4813	1493	6306
1994/95	504	231	735	4729	1147	5876	5233	1378	6611
1995/96	392	133	524	1617	957	2574	2009	1089	3098
1996/97	311	86	397	2785	765	3550	3096	851	3946
1997/98							4000*	1350*	5350*

* 1997/98 landings are preliminary

Table 5. (cont). Spanish mackerel Atlantic stock management regulations. Pounds are in millions.

Fishing Year	ABC (lbs)	TAC (lbs)	Rec. Alloc./Quota[3] (lbs / numbers)	Rec. Bag Limit	Com. Alloc. (lbs)
1987/88	1.7 - 3.1	3.1	0.74	4 in FL, 10 GA-NC	2.36
1988/89	1.3 - 5.5	4.0	0.96	4 in FL, 10 GA-NC	3.04
1989/90	4.1 - 7.4	6.0	2.76 / 1,725,000[4]	4 in FL, 10 GA-NC	3.24
1990/91	4.2 - 6.6	5.0	1.86 / 1,216,000	4 in FL, 10 GA-NY	3.14
1991/92	5.5 -13.5	7.0	3.50 / 2,778,000	5 in FL, 10 GA-NY	3.50
1992/93	4.9 - 7.9	7.0	3.50 / 2,536,000[5]	10 FL-NY	3.50
1993/94	7.3 -13.0	9.0	4.50 / 3,214,000	10 FL-NY	4.50
1994/95	4.1 - 9.2	9.2	4.60 / 3,262,000	10 FL-NY	4.60
1995/96	4.9 -14.7	9.4	4.70 / 3,113,000	10 FL-NY	4.70
1996/97	5.0 - 7.0	7.0	3.50 / 2,713,000	10 FL-NY	3.50
1997/98	5.8 - 9.4	8.0	4.00 / 2,564,000	10 FL-NY	4.00

[1]Fishing year 1979 begins on 1 April and ends on 31 March 1980.
[2]Sums within rows may not appear to equal the total value shown due to rounding of numbers before printing.
[3]Recreational quota in numbers is the allocation divided by an estimate of annual average weight (not used prior to fishing year 1989).
[4]Allocations and rec. quota are as revised October 14, 1989.
[5]Bag limit will not be reduced to zero when allocation reached ,beginning fishing year 1992.

4. Gulf Migratory Group Spanish Mackerel

Landings and History of Management

Landings of Spanish mackerel from U.S. catches have ranged from 4.0 to 9.6 million pounds between fishing years 1984/85 and 1994/95 (Table 6) (Figure GS-1). The total U.S. landings for this group in the last two fishing years were substantially less than previous landings, averaging only 2.7 million pounds due to the elimination of gill nets in Florida waters from July 1995.

This fishery has been fully regulated since 1986/87. In 1987/88 and 1988/89, catches were greater than the TAC. Over the period 1989/90 through 1997/98, catches have been below TAC and the mid point of the ABC range.

Estimates of Fishing Mortality Rate

Since the 1995/96 fishing year, the median fishing mortality rates, pooled F on adults ages 2+, were lower than the target of $F_{30\%}$ SPR (Figure GS-2). The reductions came primarily from the commercial sector after gill nets were eliminated from Florida state waters in July 1995. The median pooled F on ages 2+ for 1997/98 was 0.14 per year within the 10^{th} percentile to 90^{th} percentile range of 0.10 to 0.18.

Trends in Recruitment and Biomass

Age 0 recruits have varied between 10 and 20 million fish since the early 1980's (Figure GS-3). The apparent cyclic trends in recruitment during the 1980's are reflected in similar trends in biomass, which is characteristically true among short-lived species (Figure GS-4). However, since the 1993/94 fishing year recruitment has been steady and adult biomass has increased in each year with last year's biomass levels being the highest in the data series. Total biomass has been increasing since about 1992 (Figure GS-5).

Acceptable Biological Catch (ABC)

For the 1997/98 fishing year, given the Council's objective not to exceed $F_{30\%}$ SPR, the Panel recommends the best estimate of yield to be 10.3 million pounds. There is a 50 percent chance that a TAC of 10.3 million pounds will achieve a $F_{30\%}$ SPR level, a 16 percent chance that a 14.1 million pound TAC would reach an $F_{30\%}$ SPR level, and an 84% that a TAC of 7.3 million pounds would provide a $F_{30\%}$ SPR level. As previously noted the lower the TAC is set, the lower the probability of overfishing in the 1998/99 fishing year, and there is much greater uncertainty about estimates above the median level of ABC.

Table 6. Spanish mackerel Gulf stock catch summary.

Fishing Year	US Gulf - thousands of fish			US Gulf - thousands of pounds		
	Com	Rec	Total	Com	Rec	Total
1984/85	1857	865	2722	3445	1178	4623
1985/86	1706	1060	2766	3298	1355	4653
1986/87	1250	6334	7584	2053	7520	9573
1987/88	1488	1882	3370	2581	3124	5705
1988/89	2466	1340	3806	3902	2177	6079
1989/90	1101	1250	2351	2145	1856	4001
1990/91	1124	1596	2720	2074	2138	4213
1991/92	2075	2014	4089	4163	2889	7053
1992/93	1804	2008	3812	3113	3130	6243
1993/94	1432	1795	3227	2614	2696	5309
1994/95	1532	1136	2668	2544	1556	4100
1995/96	731	1092	1823	1075	1575	2650
1996/97	316	1260	1576	617	2054	2671
1997/98						

Table 6. (cont.) Spanish mackerel US Gulf stock management regulations. Pounds are in millions. Prior to fishing year 1990, management was based upon a July-June fishing year. The regulations shown for fishing year 1987 and later are relative to the July-June fishing year.

Fishing Year	ABC (lbs)	TAC (lbs)	Rec. Alloc./Quota[4] (lbs / numbers)	Rec. Bag Limit	Com. Alloc. (lbs)
1987/88	1.9 - 4.0	2.50	1.08	3	1.42
1988/89	1.9 - 7.1	5.00	2.15	4 FL, 10 AL-TX	2.85
1989/90	4.9 - 6.5	5.25	2.26 / 1,614,000	4 FL, 10 AL-TX	2.99
1990/91	3.9 - 7.4	5.25	2.26 / 1,569,000	3 TX, 4 FL[5], 10 AL-LA	2.99
1991/92	7.1 -12.2	8.60	3.70 / 2,721,000	3 TX, 5 FL, 10 AL-LA	4.90
1992/93	5.1 - 9.8	8.60	3.70 / 3,274,000[6]	7 TX, 10 FL-LA	4.90
1993/94	4.7 - 8.7	8.60	3.70 / 3,274,000	7 TX, 10 FL-LA	4.90
1994/95	4.4 - 8.7	8.60	3.70 / 2,202,000	7 TX, 10 FL-LA	4.90
1995/96	4.0 -10.7	8.60	3.70 / 2,782,000	7 TX, 10 FL-LA	4.90
1996/97	1.6 - 9.5	7.00	3.01 /	7 TX, 10 FL-LA	3.99
1997/98	5.5 -13.9	7.00	3.01/	7 TX, 10 FL-LA	3.99

[1]Fishing year 1979 begins on 1 April 1979 and ends on 31 March 1980.
[2]Sums within rows may not appear to equal the Total value shown due to rounding of numbers before printing.
[3]Information on Mexico catch and size distributions for some years was not sufficient for inclusion.
[4]Recreational quota in numbers is the allocation divided by an estimate of annual average weight (not used prior to fishing year 1989).
[5]Rec. bag limit in FL changed from 4 to 5 on 1/1/91, and changed from 5 to 10 on 1/1/93.
[6]Bag limit will not be reduced to zero when allocation reached ,beginning fishing year 1992.

Status of the Stock

As with Atlantic migratory group Spanish mackerel, the Panel believes that the reductions in harvest in recent years reflect the elimination of gill nets in Florida state waters in 1995 and are not due to reduced stock sizes. The current operation of the fishery will most likely harvest less than the estimated median ABC value of 10.3 million pounds. The low level of harvest relative to stock size has accelerated the rebuilding of this stock which is reflected in the marked increase in transitional SPR. The Council's definition of optimum yield (OY) is a target of 30% SPR, and this fishery exceeded the OY target in the 1997/98 fishing year (Figure GS-6).

Overfishing

Static SPR was estimated at 47 percent based on the F multiplier of 0.20 for 1996-97. Consequently, the Panel concluded that the Gulf group Spanish mackerel fishery was not overfishing the available stock because the static SPR value is greater than 30 percent.

Overfished Status

The median estimate of transitional SPR is 35 percent (Figure GS-6). Since transitional SPR for Gulf group Spanish mackerel is greater that 30 percent, the Panel concludes that this stock is not overfished.

V. FUTURE RESEARCH AND ASSESSMENT CONSIDERATIONS

During the 1998 mackerel stock assessment review, the Panel identified several areas where additional research is needed to improve the quality, cost-effectiveness, and reliability of future stock assessments. The Panel's research recommendations fall into three categories: (1) theory of sampling strategies; (2) age, growth, and mortality; and, (3) analytical studies and management perspectives. The Panel recommends that in the odd years, when a full assessment is not completed, rather than update the projections, time be spent addressing these analytical items as identified below. In this way, the precision of assessments will improve.

Theory of Sampling Strategies

A simple matrix of survey strategy by fishery type clearly shows that the amount of variance described by GLM multiple regression is low for almost all of the auxiliary stock indices. This is very disconcerting since these GLM models are then used to tune the principal index of stock abundance/biomass in the FADAPT VPA model, and error intrinsic to the data likely exacerbates the extent of uncertainty associated with the recommended ABCs. To ameliorate these problems, we recommend several strategies to improve data collection systems for relative abundance (i.e., CPUE) for Gulf and Atlantic king and Spanish mackerels, particularly in Florida waters. We recommend that analytical research be directed towards optimizing sampling survey designs associated with these indices, and that some effort be applied to identifying and promoting those indices that are both accurate and precise.

There is also an historical component contributing to uncertainty in population estimates. The techniques and methodologies used to generate length compositions in landings may not lead to representative estimates of the stock in question, we recommend an evaluation of the impacts of unbalanced sampling designs on the estimated landings at size (and age). These analyses should address the impacts of varying biostatistical sampling levels on assessment results. Based on these analyses, sampling designs and survey effort levels should be recommended to achieve specified precision bounds.

Annual bycatch estimates also suffer from problems in both accuracy and precision. To improve bycatch estimates, we recommend a program to monitor the Atlantic coast directed shrimp fishery to refine bycatch estimates of Atlantic-group king and Spanish mackerels.

The Panel feels that greater emphasis should be placed on the temporal and spatial resolution of the distribution of nominal fishing effort and its relationship to CPUE estimates. We recommend That a comprehensive program of log-book and trip-intercept survey methodologies be developed for coastal pelagics.

In addition, we recommend development of innovative fishery-independent monitoring methods to assess stock size for both Gulf and Atlantic group king and Spanish mackerels. These methods should examine the feasibility of alternative assessment methods such as aerial surveys in south Florida during winter. These new fishery-independent methodologies should integrate and help to calibrate extant fishery-dependent methodologies.

Age, Growth, and Natural Mortality

Potentially biased length frequencies applied to uncertain catch data may be creating artifacts in the data that could deleteriously affect the results of stock assessments. The Panel notes that stratified age-length keys are not equally sampled (i.e., selected) by all gear types for all ages. In some cases strata are not adequately sampled. These conditions, coupled with natural recruitment effects on age-length keys, need to be systematically evaluated to ensure that they do not deleteriously affect the results and conclusions of stock assessments. Therefore, we recommend an evaluation of the potential biases associated with inappropriate stratifications of data used to generate age-length keys for Atlantic and Gulf group king and Spanish mackerels.

We also recommend an evaluation of the implications of using alternative values of the natural mortality rate (M) on estimates of stock size and attendant ABC recommendations. We suggest that the distribution around the M values be minimized in the Monte Carlo/bootstrap simulations to reflect the certitude of maximum age from relatively extensive age-and-growth studies on mackerels. Overall, we feel this action de facto would reduce the range of ABCs provided.

Analytical Studies and Management Perspectives

The Panel noted several lines of analysis needed to refine the quality of management decision- making advice provided to the Councils.

First, we recommend an analysis of the implications to fishery productivity of changing the minimum size of first capture to protect immature fish for Gulf group king mackerel.

Second, we recommend an evaluation of the effects of gear fishing power standardization using GLM techniques on temporal and spatial trends in bycatch, paying particular attention to before and after the implementation of TEDs in the directed shrimp fisheries.

Third, we recommend an evaluation of alternative stock assessment methods for Spanish mackerel such as non-equilibrium age-structured production models. Models that aggregate age structure have the added advantage of specifying a recruitment boundary condition, and may be particularly useful when assessments are projected from incomplete or imprecise catch-at-age data.

Finally, we recommend that management invert the onus with respect to the probability of a fishery being in compliance with an established SPR threshold. That is, place the responsibility on the participants in the fishery to demonstrate that no part of the estimated probability range of SPR is below the established minimum.

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VII. LIST OF PANEL MEMBERS AND ATTENDEES

Doug Gregory, Chairman
Gregg Waugh, V. Chairman
Jerry Ault
Jerry Scott (designee for Joe Powers)
Robert Muller
William Patterson

Observers:

Roy Williams - Gulf Council/Florida Marine Fisheries Commission
Rick Leard - Gulf of Mexico Fishery Management Council
Chuck Hawkins - South Atlantic Fishery Management Council, Mackerel AP
Nancie Cummings - NMFS/SEFSC - Miami
Patricia Phares - NMFS/SEFSC -Miami
Michael Schirripa - NMFS/SEFSC - Miami
Mark Godcharles - NMFS/SERO - St. Petersburg
Mauricio Ortiz - University of Miami, RSMAS, Miami, Florida
Chris Legault - NMFS/SEFSC - Miami
John Sanchez - Monroe County Commercial Fishermen, Inc., Marathon, Florida
John Vondruska - NMFS/SERO - St. Petersburg
Guy Davenport - NMFS/SEFSC - Miami-
Tom McIlwain - NMFS - Pascagoula
John Ward - NMFS - Silver Spring
John Poffenberger - NMFS/SEFSC - Miami
John Merriner - NMFS/SEFSC - Beaufort
Joe O'Hop - Florida Department of Environmental Protection - St. Petersburg
John Carmichael - North Carolina Department of Environment and Natural Resources - Morehead City
Dave VanVoorhees - NMFS - Silver Spring
Priscilla Weeks - University of Houston Clear Lake - Houston
Michael Jepson - SAFMC - Charleston
Michael Travis - NMFS/SERO - St. Petersburg

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Atlantic King mackerel

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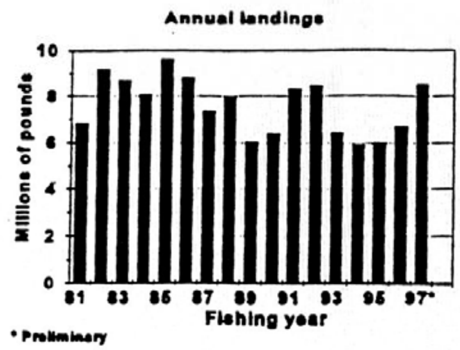

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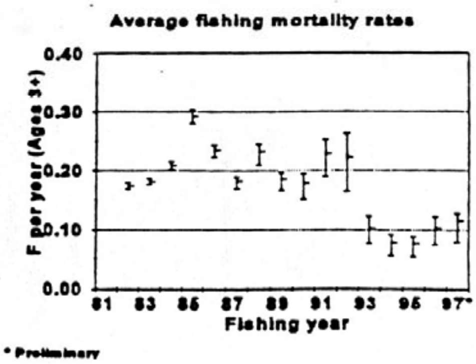

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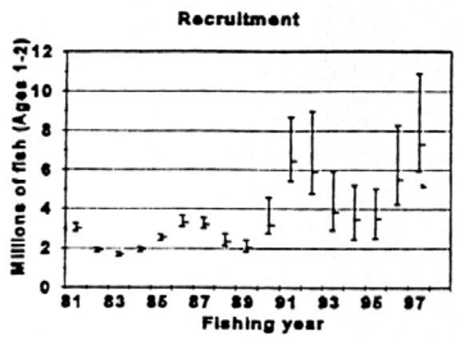

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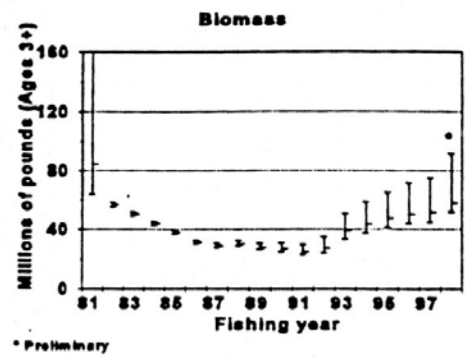

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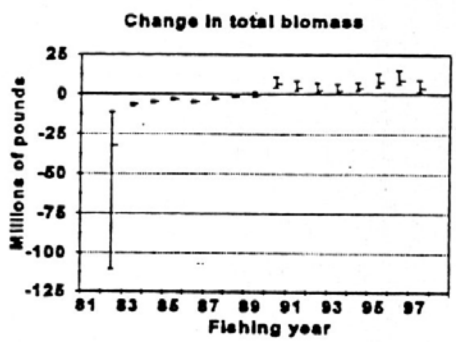

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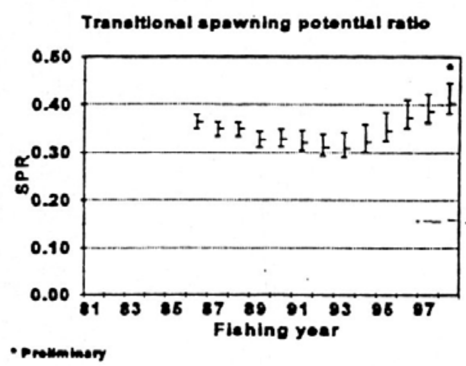

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Gulf king mackerel

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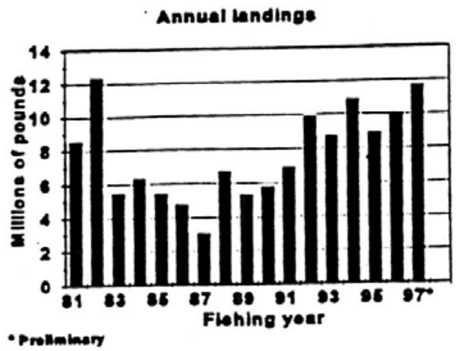

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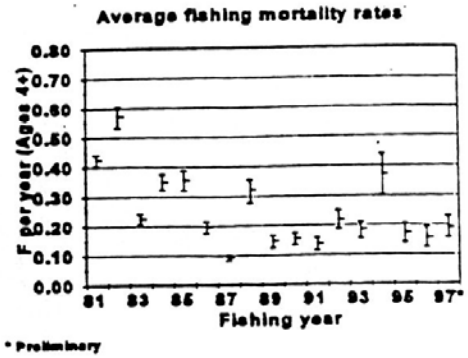

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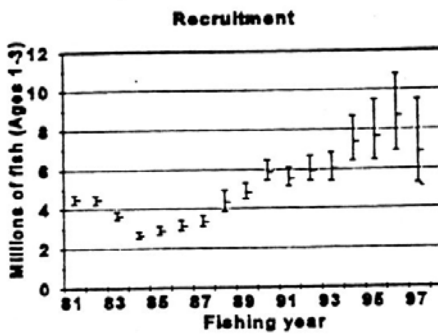

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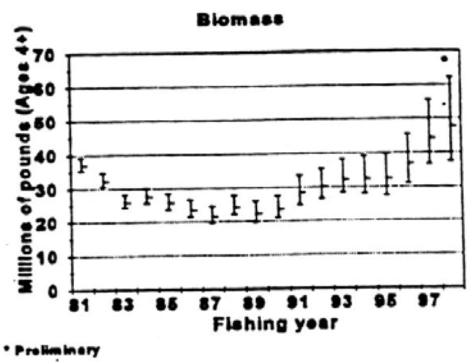

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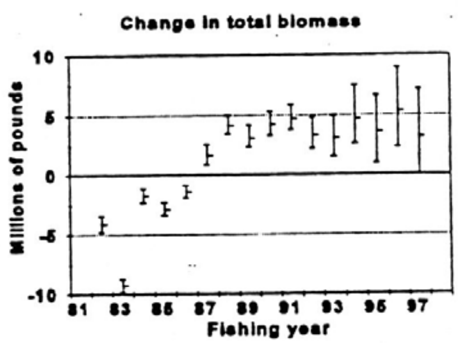

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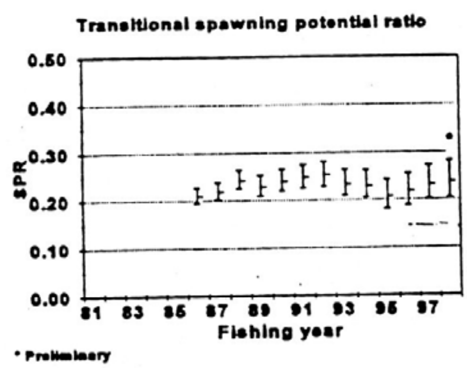

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Atlantic Spanish mackerel

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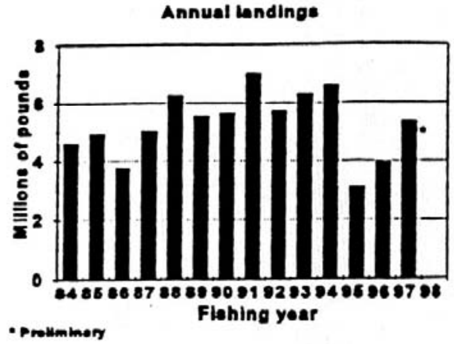

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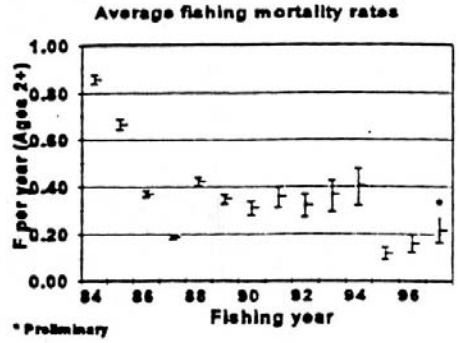

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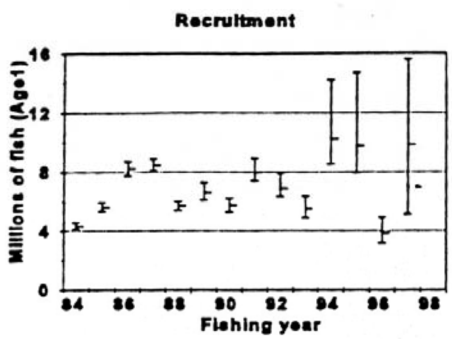

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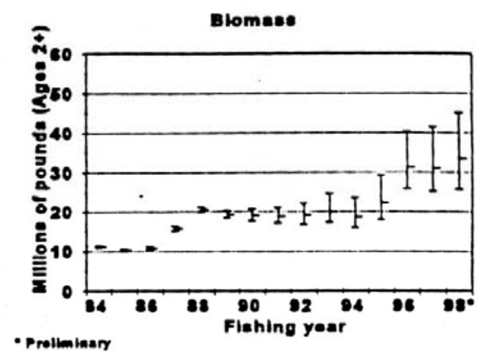

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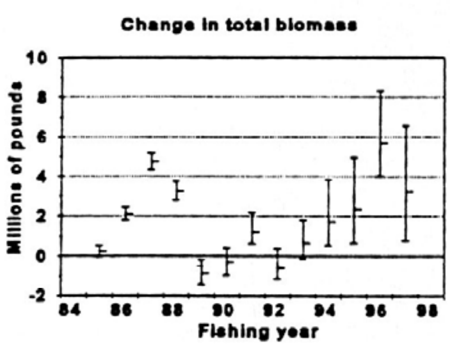

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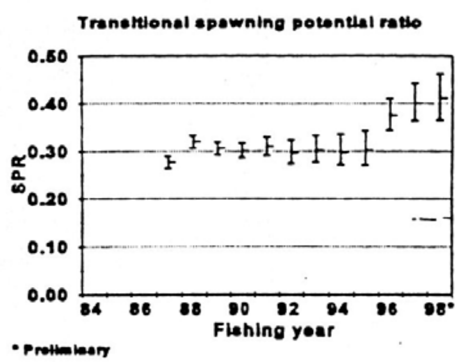

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Gulf Spanish mackerel

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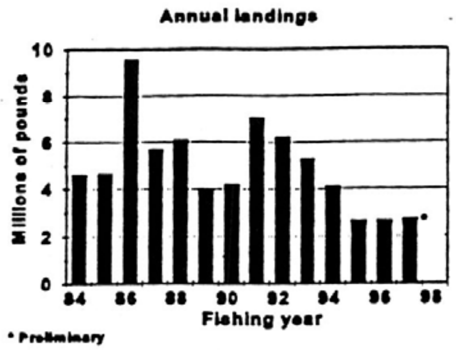

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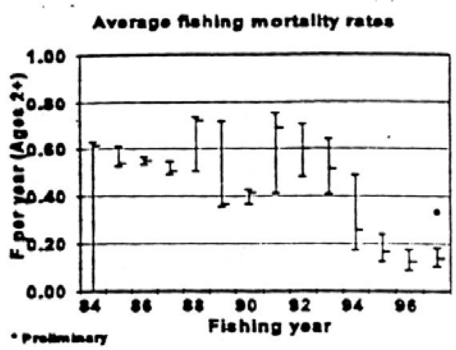

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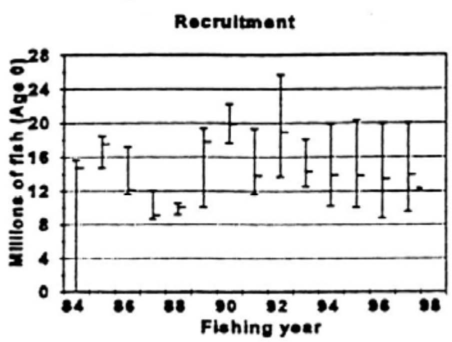

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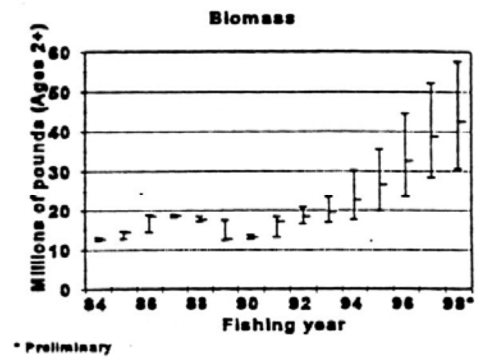

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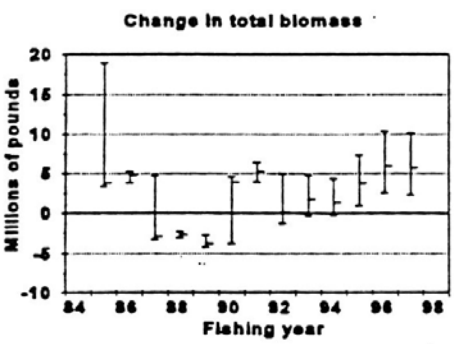

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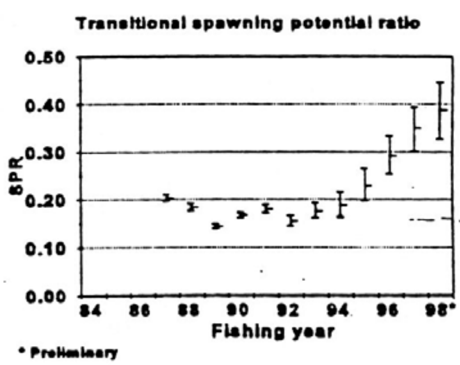

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APPENDIX A

Section 6.1.1: Mechanism for Determination of Framework Adjustments, as modified by this and previous amendments is as follows:

Section 12.6.1.1

A. An assessment panel (Panel) appointed by the Councils will normally reassess the condition of each stock or migratory group of king and Spanish mackerel and cobia in alternate (even numbered) years for the purpose of providing for any needed preseason adjustment of TAC and other framework measures. However, in the event of changes in the stocks or fisheries, the Councils may request additional assessments as may be needed. The Councils, however, may make annual seasonal adjustments based on the most recent assessment. The Panel shall be composed of NMFS scientists, Council staff, Scientific and Statistical Committee members, and other state, university, and private scientists as deemed appropriate by the Councils.

The Panel will address the following items for each stock:

1. Stock identity and distribution. This should include situations where there are groups of fish within a stock which are sufficiently different that they should be managed as separate units. If several possible stock divisions exist, the Panel should describe the likely alternatives.

2. MSY for each identified stock. If more than one possible stock division exists, MSY for each possible combination should be estimated.

3. Condition of the stock(s) or groups of fish within each stock which could be managed separately. For each stock, this should include but not be limited to:

    a. Fishing mortality rate relative to F_{msy} and $F_{0.1}$ as well as $F_{20\%SPR,}$ $F_{30\%SPR,}$ and $F_{40\%SPR}$.
    b. Spawning potential ratio (SPR).
    c. Abundance relative to an adequate spawning biomass.
    d. Trends in recruitment.
    e. Acceptable Biological Catch (ABC) which will result in long-term yield as near MSY as possible.
    f. Calculation of catch ratios based on catch statistics using procedures defined in the FMP as modified.
    g. Estimate of current mix of Atlantic and Gulf migratory group king mackerel in the mixing zone for use in tracking quotas.

4. Overfishing:

    a. A mackerel stock or migratory group is considered to be overfished when the transitional spawning potential ratio (SPR) is below 30 percent.

A-1

b. The South Atlantic Council's target level or optimum yield (OY) is 40 percent static SPR. The Gulf Council's target level or optimum yield (OY) is 30 percent static SPR. ABC is calculated based on the target level or optimum yield (SAFMC = 40 percent static SPR and GMFMC = 30 percent static SPR).
c. When a stock or migratory group is overfished (transitional SPR less than 30 percent), a rebuilding program that makes consistent progress towards restoring stock condition must be implemented and continued until the stock is restored beyond the overfished condition. The rebuilding program must be designed to achieve recovery within an acceptable time frame as specified by the Councils. The Councils will continue to rebuild the stock until the stock is restored to the management target (OY) within an unspecified time frame.
d. When a stock or migratory group is not overfished (transitional SPR equal to or greater than 30 percent), the act of overfishing is defined as a static SPR that exceeds the threshold of 30 percent (i.e., $F_{30\ percent}$). If fishing mortality rates that exceed the level associated with the static SPR threshold are maintained, the stock may become overfished. Therefore, if overfishing is occurring, a program to reduce fishing mortality rates toward management target levels (OY) will be implemented, even if the stock or migratory group is not in an overfished condition.
e. The Councils have requested the Mackerel Stock Assessment Panel (MSAP) provide a range of possibilities and options for specifying an absolute biomass level which could be used to represent a depleted condition or state. In a future amendment, the Councils will describe a process whereby if the biomass is below such a level, the Councils would take appropriate action, including but not limited to, eliminating directed fishing mortality and evaluating measures to eliminate any bycatch mortality in a timely manner through the framework procedure.
f. For species like cobia, when there is insufficient information to determine whether the stock or migratory group is overfished (transitional SPR), overfishing is defined as a fishing mortality rate in excess of the fishing mortality rate corresponding to a default threshold static SPR of 30 percent. If overfishing is occurring, a program to reduce fishing mortality rates to at least the level corresponding to management target levels will be implemented.

5. Management options. If recreational or commercial fishermen have achieved or are expected to achieve their allocations, the Panel may delineate possible options for nonquota restrictions on harvest, including effective levels for such actions as:

   a. Bag limits.
   b. Size limits.
   c. Gear restrictions.
   d. Vessel trip limits.
   e. Closed season or areas, and
   f. Other options as requested by the Councils.

6. Other biological questions as appropriate.

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B. The Panel will prepare a written report with its recommendations for submission to the Councils each year (even years - full assessment, odd years - mini assessments) by such date as may be specified by the Councils. The report will contain the scientific basis for their recommendations and indicate the degree of reliability which the Council should place on the recommended stock divisions, levels of catch, and options for nonquota controls of the catch.

C. The Councils may take action based on the panel report or may take action based on issues/information that surface separate from the assessment group. The steps are as follows:

1. Assessment panel report: The Councils will consider the report and recommendations of the Panel and such public comments as are relevant to the Panel's report. A public hearings will be held at the time and place where the Councils consider the Panel's report. The Councils will consult their Advisory Panels and scientific and Statistical Committees to review the report and provide advice prior to taking final action. After receiving public input, the Councils will make findings on the need for changes.

2. Information separate from assessment panel reports: The Councils will consider information that surfaces separate from the assessment group. Council staff will compile the information and analyze the impacts of likely alternatives to address the particular situation. The Council staff report will be presented to the Council. A public hearing will be held at the time and place where Councils consider the Council staff report. The Councils consult their Advisory Panels and Scientific and Statistical Committees to review the report and provide advice prior to taking final action. After receiving public input, the Councils will make findings on the need for changes.

D. If changes are needed in the following, the Councils will advise the Regional Administrator (RA) of the Southeast Region of the National Marine Fisheries Service in writing of their recommendations, accompanied by the assessment panel's report, relevant background material, and public comment:

a. MSYs,
b. overfishing levels,
c. TACs,
d. quotas (including zero quotas),
e. trip limits,
f. bag limits (including zero bag limits),
g. minimum sizes,
h. reallocation of Atlantic group Spanish mackerel,
i. gear restriction (ranging from modifying current regulations to a complete prohibition),
j. permit requirements, or
k. season/area closure and reopening (including spawning closure).

Recommendations with respect to the Atlantic migratory groups of king and Spanish mackerel will be the responsibility of the South Atlantic Council, and those for the Gulf

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migratory groups of king and Spanish mackerel will be the responsibility of the Gulf Council. Except that the SAFMC will have responsibility to set vessel trip limits, closed seasons or areas, or gear restrictions for the northern area of the Eastern Zone (Dade through Volusia Counties, Florida) for the commercial fishery for Gulf group king mackerel. This report shall be submitted by such data as may be specified by the Councils.

E. The RA will review the Councils' recommendation, supporting rationale, public comments and other relevant information, and if he concurs with the recommendation, he will draft regulations in accordance with the recommendation. He may also reject the recommendation, providing written reasons for rejection. In the event the RA rejects the recommendation, existing regulations shall remain in effect until resolved. However, if the RA finds that a proposed recreational bag limit for Gulf migratory group or groups of king mackerels is likely to exceed the allocation and rejects the Councils' recommendation, the bag limit reverts to one fish per person per day.

F. If the RA concurs that the Councils' recommendations are consistent with the goals and objectives of the plan, the National Standards, and other applicable law, he shall implement the regulations by proposed and final rules in the Federal Register prior to the appropriate fishing year or such dates as may be agreed upon with the Councils. A reasonable period for public comment shall be afforded, consistent with the urgency, if any, of the need to implement the management measure.

Appropriate regulatory changes that may be implemented by the RA by proposed and final rules in the Federal Register are:

1. Adjustment of the point estimates of MSY for cobia, for Spanish mackerel within a range of 15.7 million pounds to 19.7 million pounds, and for king mackerel within a range of 21.9 million pounds to 35.2 million pounds. Adjustment of the overfishing level for king and Spanish mackerels.

2. Setting total allowable catches (TACs) for each stock or migratory group of fish which should be managed separately, as identified in the FMP provided:
   a. No TAC may exceed the best point estimate of MSY by more than 10 percent.
   b. No TAC may exceed the upper range of ABC if it results in overfishing as defined in Section 12.6.1.1(A)(4).
   c. Downward adjustments of TAC of any amount are allowed in order to protect the stock and prevent overfishing.
   d. Reductions or increases in allocations as a result of changes in the TAC are to be as equitable as may be practical utilizing similar percentage changes to allocations for participants in a fishery.

3. Adjusting user group allocations in response to changes in TACs according to the formula specified in the FMP.

4. The reallocation of Spanish mackerel between recreational and commercial fishermen may be made through the framework after consideration of changes in the social and/or economic characteristics of the fishery. Such allocation adjustments shall not be greater than a ten percent change in one year to either sector's allocation. Changes may be implemented over several years to reach a desired goal, but must be assessed each year relative to changes in TAC and social and/or economic impacts to either sector of the fishery.

5. Modifying (or implementing for a particular species):
   a. quotas (including zero quotas)
   b. trip limits
   c. bag limits (including zero bag limits)
   d. minimum sizes
   e. re-allocation of Atlantic group Spanish mackerel by no more than 10 percent per year to either the commercial or recreational sector.
   f. gear restriction (ranging from modifying current regulations to a complete prohibition)
   g. permit requirements, or
   h. season/area closures and reopenings (including spawning closure)

Authority is also granted to the RA to close any fishery, i.e., revert any bag limit to zero, and close and reopen any commercial fishery, once a quota has been established through the procedure described above; and such quota has been filled. When such action is necessary, the RA will recommend that the Secretary publish a notice in the Federal Register as soon as possible.

APPENDIX B

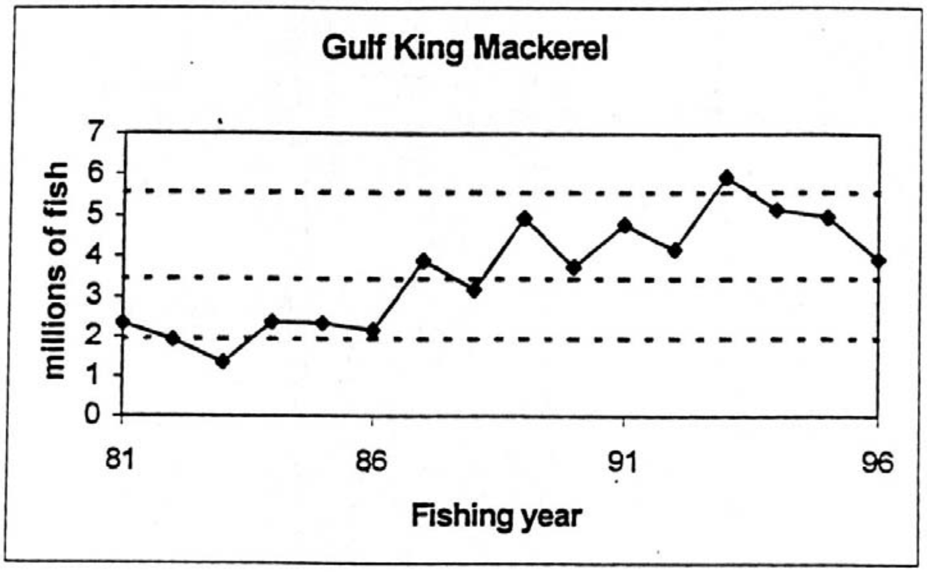
With Amendment 5, the Council approved a definition of "overfished" as a Spawning Stock Biomass Per Recruit (SSBR) target level, but no lower than 20 percent. Amendment 6 changed the basis to an SPR percentage. This target SPR for purposes of determining the "overfished" status is presumed to be a transitional SPR. Since Gulf group king mackerel were considered to be overfished, the Council adopted a rebuilding schedule that required a rebuilding of the stock to the 30 percent transitional SPR in 12 years beginning in 1985.

Mace et al. (1996) recommended that the overfished criterion be changed to a transitional SPR less than 20 percent, and the Gulf Council approved this recommendation as a part of Amendment 8. The NMFS subsequently disapproved this portion of Amendment 8 that would have changed the criterion from 30 percent transitional SPR to 20 percent. Since the current estimate of transitional SPR is only 23 percent, the Gulf Council must revise the rebuilding schedule to reach the 30 percent transitional SPR target level. Additionally, the Sustainable Fisheries Act requires that a stock that is considered to be overfished be rebuilt as soon as possible but within 10 years, unless the biology of the species involved precludes a 10-year rebuilding schedule.

The following tables and figures provide 3 scenarios of recruitment and 4 scenarios of bycatch reduction for use by the Council in projecting a recovery period based on various yields.

Gulf Group Projections - Deterministic with three levels of assumed constant recruitment.

Deterministic recruitment estimates for Gulf King Mackerel - The upper dashed line is the assumed high recruitment level for projections; the center dashed line is the medium assumed recruitment for projections; and the lower dashed line is the low assumed recruitment for projections.


Gulf King Mackerel
millions of fish
0
1
2
3
4
5
6
7
81
86
91
96
Fishing year

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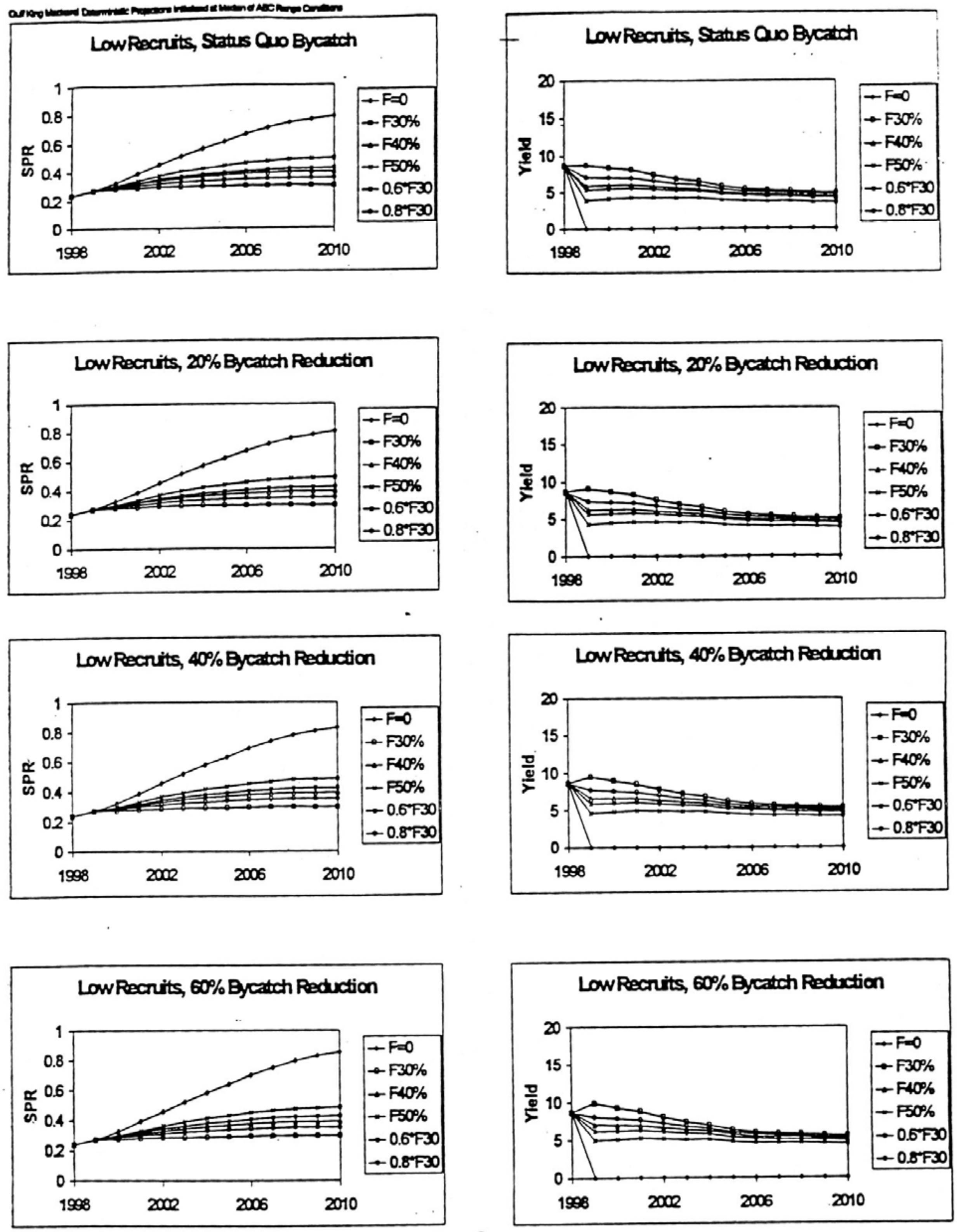
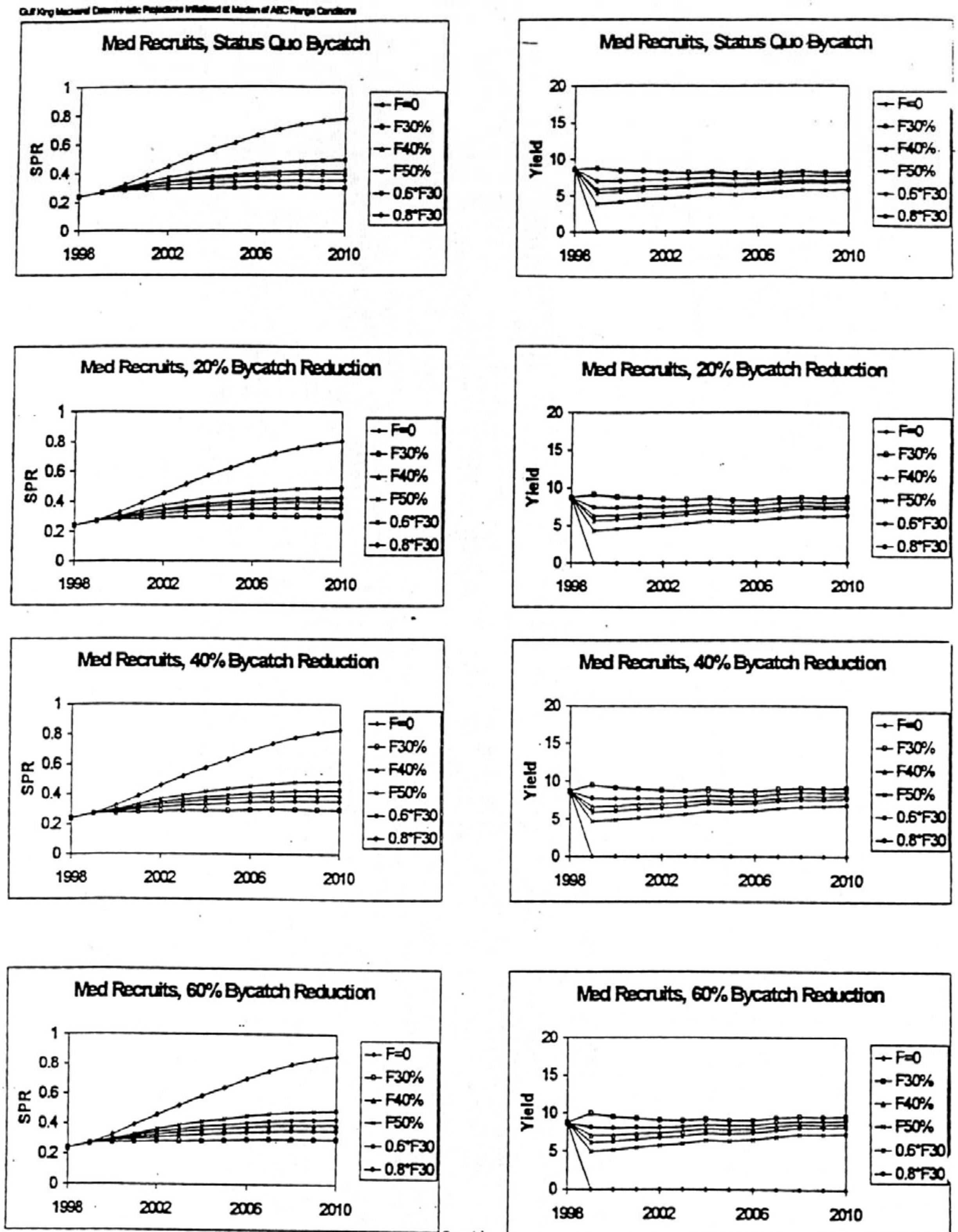
Gulf King Mackerel Deterministic Projections Initialized at Median of ABC Range Conditions

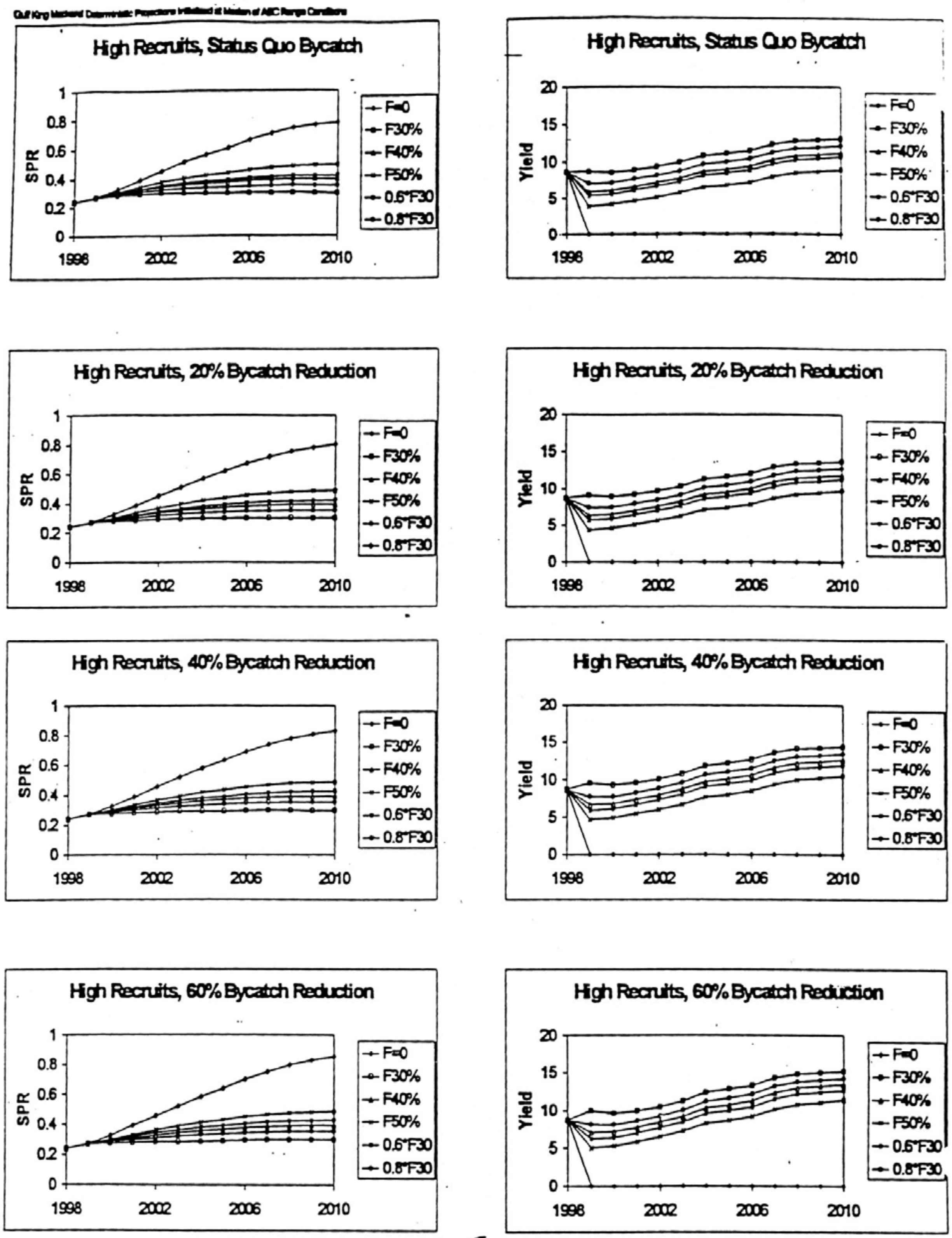


B-3

Gulf King Mackerel Deterministic Projections Initialized at Median of ASC Range Conditions



B-4


Gulf King Mackerel Deterministic Projections Initialized at Median of ABC Range Conditions
High Recruits, Status Quo Bycatch
SPR
Yield
High Recruits, 20% Bycatch Reduction
High Recruits, 40% Bycatch Reduction
High Recruits, 60% Bycatch Reduction
F=0
F30%
F40%
F50%
0.6*F30
0.8*F30
1998
2002
2006
2010

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Low Recruits, Status Quo Bycatch

	SPR						Yield					
year	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30
1998	0.2387	0.2387	0.2387	0.2387	0.2387	0.2387	8.66308	8.66308	8.66308	8.66308	8.66308	8.66308
1999	0.2701	0.2701	0.2701	0.2701	0.2701	0.2701	0	8.67055	5.90612	3.94121	5.37315	7.04869
2000	0.3254	0.2789	0.2937	0.3042	0.2965	0.2876	0	8.34305	5.97413	4.12445	5.49404	6.99117
2001	0.3872	0.2883	0.3181	0.3402	0.3239	0.3055	0	8.0087	6.02029	4.29782	5.58941	6.90735
2002	0.4507	0.2958	0.34	0.3743	0.3489	0.3211	0	7.39527	5.82069	4.29173	5.449	6.55109
2003	0.5099	0.2994	0.3563	0.4023	0.3681	0.3316	0	6.83539	5.59497	4.24525	5.27619	6.19339
2004	0.5647	0.3011	0.3688	0.4255	0.3832	0.3391	0	6.44813	5.46907	4.26887	5.1944	5.96118
2005	0.6115	0.3008	0.3767	0.4426	0.3933	0.343	0	5.81983	5.01618	3.96714	4.78067	5.42892
2006	0.6623	0.3027	0.3866	0.4616	0.4053	0.349	0	5.44853	4.77734	3.84336	4.56997	5.12772
2007	0.7049	0.3034	0.393	0.4755	0.4134	0.3525	0	5.24573	4.63382	3.7611	4.43956	4.95368
2008	0.7407	0.3029	0.3968	0.4853	0.4186	0.3541	0	5.1358	4.59491	3.78913	4.4169	4.8797
2009	0.7632	0.3006	0.3967	0.489	0.4193	0.3528	0	4.9631	4.43789	3.6707	4.26927	4.71202
2010	0.7819	0.2993	0.397	0.4921	0.4202	0.3522	0	4.88431	4.38588	3.6588	4.22738	4.64495

Low Recruits, 20% Bycatch Reduction

year	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30
1998	0.2387	0.2387	0.2387	0.2387	0.2387	0.2387	8.66308	8.66308	8.66308	8.66308	8.66308	8.66308
1999	0.2701	0.2701	0.2701	0.2701	0.2701	0.2701	0	9.07467	6.27004	4.27978	5.63233	7.3829
2000	0.3254	0.2769	0.2918	0.3025	0.2952	0.2859	0	8.66999	6.30397	4.45456	5.73535	7.28154
2001	0.3878	0.2847	0.3147	0.3369	0.3216	0.3025	0	8.27794	6.32347	4.62257	5.81842	7.16461
2002	0.4524	0.2913	0.3355	0.3699	0.3462	0.3174	0	7.61695	6.09409	4.60211	5.6631	6.77729
2003	0.5135	0.2948	0.3515	0.3973	0.3654	0.3278	0	7.03072	5.84821	4.54435	5.48194	6.40145
2004	0.5708	0.297	0.3642	0.4206	0.3812	0.3358	0	6.63356	5.71247	4.56378	5.39936	6.16263
2005	0.6205	0.2973	0.3726	0.438	0.3922	0.3404	0	6.00455	5.25031	4.2484	4.98213	5.62722
2006	0.6743	0.2998	0.3829	0.4573	0.4049	0.3471	0	5.63413	5.00486	4.11586	4.76918	5.32413
2007	0.7199	0.3011	0.3899	0.4716	0.4139	0.3513	0	5.44874	4.87281	4.04077	4.65154	5.165
2008	0.7586	0.3011	0.3941	0.4818	0.4198	0.3534	0	5.34421	4.83497	4.06897	4.6325	5.09488
2009	0.7837	0.2992	0.3945	0.486	0.4212	0.3526	0	5.17804	4.68013	3.9487	4.48765	4.93177
2010	0.8048	0.2983	0.3952	0.4896	0.4227	0.3524	0	5.10323	4.62864	3.9352	4.44738	4.86725

Low Recruits, 40% Bycatch Reduction

year	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30
1998	0.2387	0.2387	0.2387	0.2387	0.2387	0.2387	8.66308	8.66308	8.66308	8.66308	8.66308	8.66308
1999	0.2701	0.2701	0.2701	0.2701	0.2701	0.2701	0	9.48502	6.63902	4.62252	5.89637	7.72281
2000	0.3255	0.2748	0.2899	0.3007	0.2939	0.2842	0	8.99644	6.63392	4.7849	5.97897	7.57313
2001	0.3884	0.2811	0.3112	0.3337	0.3193	0.2995	0	8.54345	6.62381	4.94483	6.04838	7.42074
2002	0.4543	0.2869	0.3312	0.3655	0.3434	0.3137	0	7.83456	6.3636	4.90855	5.87789	7.00185
2003	0.5172	0.2903	0.3467	0.3925	0.3628	0.3241	0 -	7.22358	6.09808	4.83931	5.68897	6.60877
2004	0.5772	0.293	0.3597	0.4158	0.3793	0.3326	0	6.81887	5.95381	4.85496	5.60675	6.36502
2005	0.6298	0.294	0.3688	0.4337	0.3912	0.338	0	6.1917	5.48456	4.52785	5.18751	5.82843
2006	0.6867	0.2972	0.3795	0.4533	0.4048	0.3454	0	5.82425	5.23417	4.38767	4.97343	5.52507
2007	0.7355	0.2991	0.3871	0.4681	0.4147	0.3503	0	5.65789	5.11571	4.32199	4.87026	5.38257
2008	0.7772	0.2995	0.3918	0.4787	0.4212	0.3529	0	5.55968	5.07998	4.35106	4.85561	5.31721
2009	0.8051	0.2981	0.3926	0.4833	0.4232	0.3526	0	5.40048	4.9282	4.23004	4.71415	5.15925
2010	0.8287	0.2975	0.3938	0.4874	0.4253	0.3528	0	5.33002	4.87788	4.2155	4.67592	5.09775

Low Recruits, 60% Bycatch Reduction

year	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30
1998	0.2387	0.2387	0.2387	0.2387	0.2387	0.2387	8.66308	8.66308	8.66308	8.66308	8.66308	8.66308
1999	0.2701	0.2701	0.2701	0.2701	0.2701	0.2701	0	9.90179	7.01321	4.96959	6.16542	8.0686
2000	0.3256	0.2726	0.288	0.299	0.2926	0.2824	0	9.32228	6.96396	5.11547	6.22492	7.86586
2001	0.3891	0.2775	0.3078	0.3304	0.317	0.2965	0	8.8052	6.92134	5.26464	6.27931	7.67567
2002	0.4562	0.2825	0.3268	0.3612	0.3406	0.31	0	8.04835	6.62941	5.21126	6.0934	7.22487
2003	0.5211	0.2859	0.3422	0.3877	0.3603	0.3205	0	7.41441	6.34496	5.13054	5.89751	6.81568
2004	0.5838	0.2892	0.3555	0.4113	0.3775	0.3296	0	7.00478	6.19372	5.14307	5.81694	6.56882
2005	0.6395	0.2909	0.3652	0.4297	0.3904	0.3358	0	6.38199	5.71966	4.80624	5.39725	6.0331
2006	0.6997	0.2948	0.3765	0.4497	0.4048	0.3438	0	6.01961	5.46811	4.65967	5.18323	5.73116
2007	0.7518	0.2974	0.3847	0.465	0.4156	0.3495	0	5.8738	5.36328	4.60567	5.09623	5.60697
2008	0.7965	0.2982	0.3897	0.4759	0.4228	0.3526	0	5.78271	5.33071	4.63639	5.08672	5.54721
2009	0.8273	0.2971	0.391	0.481	0.4254	0.3527	0	5.63085	5.18279	4.51586	4.94926	5.39494
2010	0.8536	0.2968	0.3925	0.4855	0.428	0.3534	0	5.56504	5.13425	4.50066	4.91348	5.33688

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Medium Recruits, Status Quo Bycatch

year	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30
1998	0.2387	0.2387	0.2387	0.2387	0.2387	0.2387	8.66308	8.66308	8.66308	8.66308	8.66308	8.66308
1999	0.2701	0.2701	0.2701	0.2701	0.2701	0.2701	0	8.69079	5.91965	3.95012	5.38532	7.0649
2000	0.3254	0.2789	0.2937	0.3042	0.2965	0.2876	0	8.42489	6.02887	4.16053	5.54354	7.0569
2001	0.3872	0.2883	0.3181	0.3402	0.3239	0.3055	0	8.36859	6.26446	4.46023	5.81191	7.1996
2002	0.4507	0.2958	0.34	0.3743	0.3489	0.3211	0	8.16934	6.35794	4.65469	5.94175	7.18884
2003	0.5099	0.2994	0.3563	0.4023	0.3681	0.3316	0	8.08423	6.48526	4.85806	6.097	7.23861
2004	0.5647	0.3011	0.3687	0.4255	0.3832	0.339	0	8.2222	6.77191	5.18481	6.40114	7.47119
2005	0.6115	0.3007	0.3767	0.4426	0.3932	0.343	0	7.9638	6.62855	5.11805	6.27822	7.27744
2006	0.6623	0.3027	0.3865	0.4615	0.4051	0.3489	0	7.88538	6.64279	5.19557	6.30885	7.25059
2007	0.7049	0.3033	0.393	0.4754	0.4133	0.3524	0	8.11674	6.90376	5.44699	6.56581	7.50001
2008	0.7407	0.3028	0.3968	0.4853	0.4184	0.354	0	8.24018	7.10488	5.68647	6.777	7.66745
2009	0.7632	0.3006	0.3967	0.489	0.4192	0.3527	0	8.17833	7.075	5.68809	6.75728	7.62313
2010	0.7819	0.2993	0.397	0.4921	0.4201	0.3521	0	8.19699	7.14124	5.791	6.83467	7.66873

Medium Recruits, 20% Bycatch Reduction

year	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30
1998	0.2387	0.2387	0.2387	0.2387	0.2387	0.2387	8.66308	8.66308	8.66308	8.66308	8.66308	8.66308
1999	0.2701	0.2701	0.2701	0.2701	0.2701	0.2701	0	9.09628	6.28471	4.28986	5.64533	7.40021
2000	0.3254	0.2769	0.2918	0.3025	0.2952	0.2859	0	8.75888	6.36427	4.4952	5.78914	7.35295
2001	0.3878	0.2847	0.3147	0.3369	0.3217	0.3025	0	8.66954	6.59299	4.80595	6.06091	7.48289
2002	0.4524	0.2913	0.3355	0.3699	0.3462	0.3174	0	8.45655	6.68551	5.01093	6.19912	7.47002
2003	0.5135	0.2947	0.3514	0.3973	0.3654	0.3278	0	8.37964	6.82461	5.23217	6.37232	7.5328
2004	0.5706	0.2969	0.3641	0.4205	0.3811	0.3357	0	8.54202	7.13593	5.58824	6.70488	7.79152
2005	0.6205	0.2972	0.3726	0.438	0.3921	0.3404	0	8.30394	7.00471	5.53209	6.59892	7.6161
2006	0.6743	0.2998	0.3829	0.4572	0.4048	0.347	0	8.24161	7.03274	5.62096	6.64369	7.60379
2007	0.7199	0.3011	0.3899	0.4716	0.4138	0.3512	0	8.50777	7.33051	5.91008	6.9372	7.8896
2008	0.7586	0.3011	0.3941	0.4818	0.4197	0.3533	0	8.64203	7.54431	6.16637	7.164	8.06989
2009	0.7837	0.2992	0.3945	0.486	0.4211	0.3526	0	8.58723	7.52084	6.17397	7.15232	8.03302
2010	0.8048	0.2983	0.3953	0.4896	0.4226	0.3524	0	8.61188	7.59097	6.28223	7.23581	8.08335

Medium Recruits, 40% Bycatch Reduction

year	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30
1998	0.2387	0.2387	0.2387	0.2387	0.2387	0.2387	8.66308	8.66308	8.66308	8.66308	8.66308	8.66308
1999	0.2701	0.2701	0.2701	0.2701	0.2701	0.2701	0	9.5081	6.65488	4.63342	5.91025	7.74129
2000	0.3255	0.2748	0.2899	0.3007	0.2939	0.2842	0	9.09285	6.70018	4.83044	6.03735	7.6506
2001	0.3884	0.2811	0.3112	0.3337	0.3193	0.2995	0	8.96903	6.92053	5.15078	6.31232	7.76687
2002	0.4543	0.2869	0.3312	0.3655	0.3434	0.3137	0	8.74397	7.01291	5.36653	6.46017	7.75325
2003	0.5172	0.2902	0.3467	0.3924	0.3628	0.3241	0	8.67846	7.16592	5.60711	6.65348	7.83159
2004	0.5772	0.2929	0.3597	0.4158	0.3792	0.3326	0	8.86892	7.50481	5.99452	7.01712	8.11957
2005	0.6298	0.2939	0.3687	0.4337	0.3911	0.338	0	8.6541	7.39061	5.95181	6.9305	7.96518
2006	0.6867	0.2972	0.3795	0.4533	0.4047	0.3453	0	8.60997	7.4325	6.05372	6.99119	7.96941
2007	0.7355	0.2991	0.3871	0.4681	0.4145	0.3502	0	8.91208	7.76916	6.3832	7.3235	8.29333
2008	0.7772	0.2995	0.3918	0.4787	0.4211	0.3529	0	9.05754	7.99626	6.65674	7.56671	8.48707
2009	0.8051	0.2981	0.3927	0.4833	0.4231	0.3526	0	9.00972	7.97962	6.67102	7.56358	8.45789
2010	0.8287	0.2975	0.3938	0.4874	0.4252	0.3528	0	9.03835	8.05385	6.78474	7.65344	8.51305

Medium Recruits, 60% Bycatch Reduction

year	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30
1998	0.2387	0.2387	0.2387	0.2387	0.2387	0.2387	8.66308	8.66308	8.66308	8.66308	8.66308	8.66308
1999	0.2701	0.2701	0.2701	0.2701	0.2701	0.2701	0	9.92643	7.03032	4.98155	6.18024	8.08834
2000	0.3256	0.2726	0.288	0.299	0.2926	0.2824	0	9.42679	7.03659	5.16627	6.28821	7.94988
2001	0.3891	0.2775	0.3078	0.3304	0.317	0.2965	0	9.2671	7.24727	5.49486	6.56624	8.05164
2002	0.4562	0.2825	0.3268	0.3612	0.3406	0.31	0	9.03206	7.34055	5.72191	6.72518	8.03887
2003	0.5211	0.2859	0.3422	0.3877	0.3603	0.3204	0	8.98142	7.50996	5.98357	6.94092	8.13557
2004	0.5838	0.2891	0.3555	0.4113	0.3775	0.3295	0	9.2038	7.87947	6.40466	7.33857	8.45616
2005	0.6395	0.2909	0.3651	0.4297	0.3903	0.3357	0	9.01524	7.78532	6.3783	7.27377	8.32555
2006	0.6997	0.2948	0.3764	0.4496	0.4047	0.3438	0	8.99149	7.84324	6.49513	7.35219	8.34835
2007	0.7518	0.2974	0.3847	0.465	0.4155	0.3494	0	9.33043	8.22071	6.86753	7.72555	8.71201
2008	0.7965	0.2982	0.3898	0.4759	0.4227	0.3526	0	9.48719	8.46161	7.15879	7.98593	8.91964
2009	0.8273	0.2971	0.391	0.481	0.4253	0.3527	0	9.44637	8.45219	7.18038	7.99178	8.89634
2010	0.8536	0.2968	0.3925	0.4855	0.4279	0.3534	0	9.4789	8.53067	7.29969	8.08826	8.95842

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Yields (million lbs)

High Recruits, Status Quo Bycatch

year	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30
1998	0.2387	0.2387	0.2387	0.2387	0.2387	0.2387	8.66308	8.66308	8.66308	8.66308	8.66308	8.66308
1999	0.2701	0.2701	0.2701	0.2701	0.2701	0.2701	0	8.71999	5.93918	3.96299	5.40288	7.08829
2000	0.3254	0.2789	0.2937	0.3042	0.2965	0.2876	0	8.54306	6.10795	4.21264	5.61502	7.15183
2001	0.3872	0.2883	0.3181	0.3402	0.3239	0.3055	0	8.88925	6.61771	4.69518	6.13382	7.6224
2002	0.4507	0.2958	0.34	0.3743	0.3489	0.3211	0	9.28356	7.13099	5.17682	6.65067	8.10657
2003	0.5099	0.2993	0.3563	0.4022	0.3681	0.3316	0	9.87298	7.75888	5.73403	7.27082	8.73453
2004	0.5647	0.3011	0.3687	0.4255	0.3831	0.339	0	10.7702	8.63947	6.49606	8.13016	9.63741
2005	0.6115	0.3007	0.3767	0.4426	0.3932	0.3429	0	11.0496	8.93868	6.76749	8.42726	9.93425
2006	0.6623	0.3027	0.3865	0.4615	0.405	0.3488	0	11.4057	9.33271	7.14236	8.81523	10.3142
2007	0.7049	0.3033	0.3929	0.4754	0.4131	0.3524	0	12.2747	10.1889	7.88496	9.64225	11.1863
2008	0.7407	0.3028	0.3967	0.4853	0.4183	0.354	0	12.7371	10.7397	8.43278	10.1943	11.7051
2009	0.7632	0.3006	0.3967	0.489	0.4191	0.3527	0	12.834	10.8928	8.60748	10.3588	11.8381
2010	0.7819	0.2993	0.397	0.4921	0.4201	0.3521	0	12.9977	11.1301	8.87688	10.6089	12.0464

High Recruits, 20% Bycatch Reduction

year	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30	Yields) F=0	F30%	F40%	F50%	0.6*F30	0.8*F30
1998	0.2387	0.2387	0.2387	0.2387	0.2387	0.2387	8.66308	8.66308	8.66308	8.66308	8.66308	8.66308
1999	0.2701	0.2701	0.2701	0.2701	0.2701	0.2701	0	9.12752	6.30589	4.30393	5.66412	7.42523
2000	0.3254	0.2769	0.2918	0.3025	0.2952	0.2859	0	8.8872	6.45135	4.5539	5.86681	7.45609
2001	0.3878	0.2847	0.3146	0.3369	0.3217	0.3025	0	9.2361	6.9829	5.07124	6.41172	7.94331
2002	0.4524	0.2913	0.3355	0.3699	0.3462	0.3174	0	9.66511	7.53644	5.59898	6.97024	8.46686
2003	0.5135	0.2947	0.3514	0.3973	0.3654	0.3278	0	10.3123	8.22156	6.21546	7.64578	9.15228
2004	0.5708	0.2969	0.3641	0.4205	0.3811	0.3357	0	11.2845	9.17729	7.05537	8.57614	10.1293
2005	0.6205	0.2972	0.3726	0.438	0.392	0.3403	0	11.6154	9.52511	7.37289	8.9202	10.4762
2006	0.6743	0.2998	0.3828	0.4572	0.4047	0.3469	0	12.0097	9.95813	7.78887	9.34659	10.8949
2007	0.7199	0.3011	0.3899	0.4715	0.4137	0.3512	0	12.9383	10.8879	8.61384	10.2447	11.8344
2008	0.7586	0.3011	0.3941	0.4818	0.4196	0.3533	0	13.4191	11.468	9.20257	10.8296	12.3788
2009	0.7837	0.2992	0.3946	0.486	0.421	0.3525	0	13.5237	11.6336	9.39452	11.0097	12.5233
2010	0.8048	0.2983	0.3953	0.4896	0.4225	0.3524	0	13.6912	11.8795	9.67924	11.2723	12.7393

High Recruits, 40% Bycatch Reduction

year	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30	Yield F=0	F30%	F40%	F50%	0.6*F30	0.8*F30
1998	0.2387	0.2387	0.2387	0.2387	0.2387	0.2387	8.66308	8.66308	8.66308	8.66308	8.66308	8.66308
1999	0.2701	0.2701	0.2701	0.2701	0.2701	0.2701	0	9.54144	6.67778	4.64915	5.9303	7.768
2000	0.3255	0.2748	0.2899	0.3007	0.2939	0.2842	0	9.23209	6.79585	4.8962	6.12165	7.7625
2001	0.3884	0.2811	0.3112	0.3337	0.3194	0.2995	0	9.58471	7.34982	5.44871	6.69414	8.26761
2002	0.4543	0.2869	0.3311	0.3655	0.3434	0.3137	0	10.053	7.94707	6.02525	7.29782	8.83449
2003	0.5172	0.2902	0.3467	0.3924	0.3628	0.324	0	10.7635	8.69409	6.70489	8.03314	9.5824
2004	0.5772	0.2929	0.3597	0.4158	0.3792	0.3325	0	11.8162	9.73005	7.62714	9.03943	10.6388
2005	0.6298	0.2939	0.3687	0.4337	0.391	0.3379	0	12.2023	10.1305	7.99496	9.43427	11.0396
2006	0.6867	0.2972	0.3795	0.4533	0.4046	0.3452	0	12.6369	10.6051	8.45461	9.9017	11.4995
2007	0.7355	0.2991	0.3871	0.4681	0.4144	0.3502	0	13.6254	11.6103	9.36508	10.8739	12.5079
2008	0.7772	0.2996	0.3918	0.4787	0.421	0.3528	0	14.124	12.2198	9.99478	11.4925	13.0782
2009	0.8051	0.2981	0.3927	0.4834	0.4231	0.3525	0	14.2356	12.3976	10.2041	11.6885	13.234
2010	0.8287	0.2975	0.3938	0.4874	0.4251	0.3528	0	14.4065	12.6517	10.5036	11.9637	13.4572
2011	0.8486	0.2975	0.3951	0.491	0.4271	0.3534	0	14.5054	12.7913	10.6639	12.114	13.5825

High Recruits, 60% Bycatch Reduction

year	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30	F=0	F30%	F40%	F50%	0.6*F30	0.8*F30
1998	0.2387	0.2387	0.2387	0.2387	0.2387	0.2387	8.66308	8.66308	8.66308	8.66308	8.66308	8.66308
1999	0.2701	0.2701	0.2701	0.2701	0.2701	0.2701	0	9.96199	7.05502	4.99883	6.20163	8.11682
2000	0.3256	0.2726	0.288	0.299	0.2926	0.2824	0	9.57766	7.14147	5.23963	6.3796	8.07114
2001	0.3891	0.2775	0.3078	0.3304	0.317	0.2965	0	9.93536	7.71876	5.82792	6.98133	8.59557
2002	0.4562	0.2825	0.3268	0.3612	0.3406	0.31	0	10.4481	8.36366	6.45635	7.63396	9.21019
2003	0.5211	0.2858	0.3421	0.3877	0.3602	0.3204	0	11.228	9.17759	7.20342	8.43374	10.0259
2004	0.5838	0.2891	0.3555	0.4113	0.3774	0.3295	0	12.3669	10.2992	8.21287	9.52123	11.1673
2005	0.6395	0.2909	0.3651	0.4297	0.3902	0.3357	0	12.8116	10.7564	8.6353	9.97075	11.6258
2006	0.6997	0.2948	0.3764	0.4496	0.4046	0.3437	0	13.2887	11.2752	9.1413	10.4819	12.1293
2007	0.7518	0.2974	0.3847	0.465	0.4154	0.3494	0	14.337	12.3576	10.1402	11.5312	13.2062
2008	0.7965	0.2982	0.3898	0.4759	0.4226	0.3525	0	14.8528	12.9961	10.8109	12.1842	13.8041
2009	0.8273	0.2971	0.3911	0.481	0.4253	0.3527	0	14.9706	13.1858	11.0376	12.3964	13.9708
2010	0.8536	0.2968	0.3926	0.4856	0.4279	0.3533	0	15.1443	13.4475	11.3513	12.684	14.201

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Appendix D. 1999 Report of the Mackerel Stock Assessment Panel

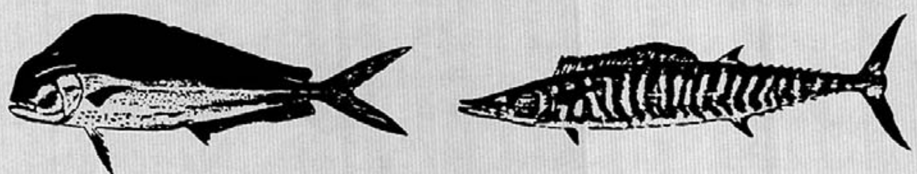
DOLPHIN WERE NOT ADDRESSED IN THE 1999 ASSESSMENT

Appendix E. Economic and Social Assessment for Dolphin/Wahoo

NO DELIVERABLE WAS RECEIVED.

Appendix F. SAFMC Workshop Proceedings

SAFMC DOLPHIN/WAHOO WORKSHOP PROCEEDINGS



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1.0 Introduction

This report is based on the discussions and consensus reached at this workshop regarding the biological characteristics and management options most appropriate for management of dolphin and wahoo in the Atlantic and Gulf of Mexico under U.S. jurisdiction. The final agenda used at the workshop is included as Appendix A. The list of attendees is included as Appendix B. Summary minutes of the question & answer and discussion sessions are also included in the Workshop Proceedings (Appendix C). The papers presented and/or used at the workshop are included in the Workshop Proceedings (Appendix D). Copies of the Workshop Proceedings are available from the South Atlantic Fishery Management Council.

The workshop was open to the public; the workshop was advertised through contacts with individuals interested in dolphin/wahoo, publication of a notice in the federal register, publication in the South Atlantic Update, and direct contacts with local press in Charleston. Researchers working on dolphin and wahoo were requested to contribute presentations.

Given the controversy surrounding the issue of dolphin management, the Council invited three researchers from the Caribbean area to help develop a factual information base to be used throughout development of a dolphin/wahoo fishery management plan. The Council relied on the recognized expertise of these three individuals, and their lack of any direct involvement with the Councils, to ensure the material developed would not be biased in any way. Dr. Hazel A. Oxenford, MAREMP, University of the West Indies, Barbados; Dr. Brian Luckhurst, Division of Fisheries, Bermuda; and Mr. Peter A. Murray, OECS, St. Lucia, West Indies served as editors of this report. South Atlantic Council Staff provided administrative support by serving as moderators, recording the workshop, transcribing summary minutes, typing the report, and providing funding for the three invited researchers. The proceedings were prepared by Gregg Waugh, Mike Jepson, and Kerry O'Malley. Deb Buscher transcribed the minutes.

The dolphin and wahoo graphics are used with the permission of Charles S. Manooch III and Duane Raver, Jr. from their book, Fishes of the Southeastern United States.

2.0 Recommendations on Data, Input Parameters, and Stock Status

2.1 Stock Structure

2.1.1 Dolphin

The common dolphin (*Coryphaena hippurus*), subsequently referred to as dolphin, is an oceanic pelagic fish found worldwide in tropical and subtropical waters. The range for dolphin in the western Atlantic is from George's Bank, Nova Scotia to Rio de Janeiro, Brazil. They are generally restricted to the 20° C isotherm. They support economically important fisheries from North Carolina through the Gulf of Mexico, and within the Caribbean Sea including the northeast coast of Brazil.

There is pronounced seasonal variation in abundance. Dolphin are caught off North and South Carolina with the majority being landed from May through July. Dolphin are caught off Florida's east coast mainly between April and June. February and March are the peak months off Puerto Rico's coast. They are caught in the Gulf of Mexico from April to September with peak catches in May through August.

There has been one preliminary investigation of dolphin stock structure within the western central Atlantic. Results suggest that there are at least two separate unit stocks located in the northeast and southeast regions of the western central Atlantic. The hypothesis was based on: observed seasonality (months of peak abundance) and mean size of dolphin from commercial and sport fisheries (which suggested two different migratory circuits; see Figure 1); a comparison of life history characteristics of dolphin from North Carolina, Florida, and Barbados (which showed marked differences in average first year growth rates, fecundity-length relationships, size and age at first maturity, and mean mature egg size); and on observed differences in allelic frequencies at the IDH-2 locus determined through electrophoresis.

Figure 1. Working stock hypothesis.

Possible alternative hypotheses of (1) a generalized north-south movement of a broadly distributed population, and (2) a seasonal onshore-offshore movement, have been suggested.

However, no alternative stock structure hypothesis has yet been tested.

Therefore, it was agreed that the working hypothesis should be a two stock model for the Western Central Atlantic and that the northern stock should include dolphin from the Gulf of Mexico, the U.S. South Atlantic including Puerto Rico and the U.S. Virgin Islands, the Mid-Atlantic, and the New England coasts.

Given this working hypothesis, estimates of biological parameters for dolphin from the northern area were used in preference to those from the southern area.

2.1.2 Wahoo

The wahoo (*Acanthocybium solandri*) is an oceanic pelagic fish found worldwide in tropical and subtropical waters. Wahoo are present throughout the Caribbean area, especially along the north coast of western Cuba where it is abundant during the winter (from FAO species guide). Wahoo are known to support economically important fisheries in the U.S., Bermuda, and through the Caribbean to Tobago.

There is pronounced seasonal variation in abundance. They are caught off North and South Carolina primarily during the spring and summer (April-June and July-September), off Florida's east coast year-round, off Puerto Rico and the U.S. Virgin Islands year-round with peak catches between September and March, in the Gulf of Mexico year-round, in the eastern Caribbean between December and June, and in Bermuda between April and September.

There have been no investigations of wahoo stock structure. Given this, it was agreed that the working hypothesis should be a single stock model for the Western Central Atlantic.

2.2 Mortality Rates and Longevity

2.2.1 Dolphin

There is one study reporting total instantaneous mortality estimates for dolphin from the northern area. These come from the Gulf of Mexico and are given below:

Mortality Model Used	Total Mortality (Z)	Actual Annual Mortality (A)
Robsen & Chapman (1961)	8.18	99.97%
	8.23	99.97%
	8.67	99.98%

There are no natural mortality estimates for the northern area, however, natural mortality estimates from the southern area range from M=0.66 to M=3.3 (A=48% to 96%).

Dolphin in the northern area have a maximum longevity of 4 years but most die before age 2. In North Carolina 96% die before age 2. In Florida 98% die before age 2, and in the Gulf of Mexico 100% die before age 2.

2.2.2 Wahoo

The only mortality estimates available are from a study conducted in St. Lucia. The values are listed below for five different years

Mortality Model Used	Total Mortality (Z)	Annual Mortality (A)
Length based catch curve	1.17	68.96%
	1.52	78.13%
	1.45	76.54%
	1.75	82.62%
	2.34	90.37%

Longevity is believed to be at least 5 years based on work from North Carolina (Source: Hogarth, W.T. 1976. Life history aspects of the wahoo, *Acanthocybium solandri*, (Cuvier and Valenciennes) from the coast of North Carolina. NC State Univ. Dissertation. 107p.)

2.3 Growth Rates

2.3.1 Dolphin

Dolphin grow rapidly and show average first year daily growth rates ranging from 4.2 mm FL (Gulf of Mexico) to 1.6 mm FL (North Carolina). There are a number of estimates of L_∞ from the northern area. It was agreed that values of 1400 to 1500 mm FL are appropriate for this stock. Estimates of k ranged from 0.31 to 3.13 annually.

2.3.2 Wahoo

Wahoo appear to be very fast growing in their first year. Estimates of L_∞ range from 2210 mm FL (North Carolina) to 1560 mm FL (St. Lucia). Estimates of k (annual) range from 0.152 (North Carolina) to 0.37 (St. Lucia).

2.4 Reproductive Characteristics

2.4.1 Dolphin

Dolphin are batch spawners and have a protracted spawning season. Size at first maturity ranges from 350 mm FL (Florida) to 530 mm FL (Gulf of Mexico) for sexes combined.

Males first mature at a larger size than females. Size at full maturity ranges from 550 mm FL (Florida) to 600 mm FL (Puerto Rico) for females.

The sex ratios in the catch tend to be female-biased although they vary with size of fish captured. The batch-fecundity-length relationship is strongly exponential ranging from 85,000 (approximately 400-600 mm FL) to 1.5 million (approximately 1300-1400 mm FL) eggs per batch.

2.4.2 Wahoo

Estimates of size at first maturity from North Carolina are 86 cm FL for males and 101 cm FL for females. Preliminary estimates from Bermuda are similar (males = 102 cm FL; females = 95 cm FL).

Fecundity estimates from North Carolina range from 560,000 eggs (for a 6.13 kg wahoo) to 45 million eggs (for a 39.5 kg wahoo).

2.5 Trophic Relationships

2.5.1 Dolphin

Dolphin are voracious, surface water, day-time predators. They eat a wide variety of fish species including: small oceanic pelagic species (e.g., flying fish, halfbeaks, man-o-war fish, sargassum fish and rough triggerfish); juveniles of large oceanic pelagic species (e.g., tunas, billfish, jacks, dolphin); and pelagic larvae of neritic, benthic species (e.g., flying gurnards, triggerfish, pufferfish, grunts). They also eat invertebrates (e.g., cephalopods, mysids, scyphozoans) suggesting that they are essentially non-selective, opportunistic foragers. Rose (1966) examined the stomach contents of 373 dolphin off North Carolina and found the following food items by relative weight: Exocoetidae - 24%, Scombridae - 22%, Carangidae - 12%, Invertebrates - 12%, Miscellaneous Fish Families - 11%, Monacanthidae - 7%, Coryphaenidae - 5%, Unidentified Fish - 4%, and Balistidae - 3% (Source: Rose, C.D. 1966. The biology and catch distribution of the dolphin, *Coryphaena hippurus* (Linnaeus), in North Carolina waters. Ph.D. Thesis. North Carolina State Univ. at Raleigh, 153 p.)

2.5.2 Wahoo

Wahoo are essentially piscivorous. Based on work in North Carolina, fish accounted for 97.4% of all food organisms. These fish included mackerels, butterfishes, porcupine fishes, round herrings, scads, jacks, pompanos, and flying fishes. Invertebrates, squid and the paper nautilus comprised 2.6% of the total food.

2.6 Stock Status and Management Implications

2.6.1 Dolphin

To date there has been no attempt at a comprehensive stock assessment for dolphin from the northern area. There are, however, time-series data from which there are no indicators of a decline in stock abundance nor a decrease in mean size of individual fish.

A preliminary stock assessment has been conducted for dolphin from the southern area (Barbados). The key implications of this assessment for management of dolphin in the northern area are given below:

A. There is a high risk of stock depletion with little warning given that the fishery may remain feasible at low stock levels because of the tendency of the fish to aggregate, and the current trends for increasing fishing effort.

B. There is a potential for recruitment overfishing given that fish are economically valuable before size at first maturity, and the high interannual variability in abundance apparently driven by environmental factors.

C. That a yield-per-recruit (YPR) approach to selecting a management target is probably inappropriate since even the more conservative $F_{0.1}$ values are likely to lead to a significant reduction in spawning stock biomass.

D. A precautionary approach to management which in the first instance attempts to maintain the status quo of the fishery is recommended. This will require that current catch levels not be exceeded and that recent conflict between sectors of the fishery (commercial longliners and recreational fishers) be resolved. Status quo might reflect trends (average catch and effort levels) in the fishery over the last five years (through 1997).

2.5.2 Wahoo

There has been no attempt at a stock assessment to date.

2.6 Data Collection & Research Needs

A regional Working Group should be formed to develop and implement a coordinated research program for dolphin and wahoo. The Gulf and Caribbean Fisheries Institute or the FAO/WECAFC working party on resource assessment may be appropriate forums for such a group. Research needs include but are not limited to the following:

In the short-term effort should be directed at examining all existing seasonality (effort and landings), mean size, and life history data for dolphin from the northern area.

Long-term work should continue and expand on current research investigating genetic variability of dolphin populations in the western central Atlantic.

An overall design should be developed for future tagging work. This could be done by the Working Group. In addition, existing tagging databases should be examined.

The SAFMC should establish a list serve for dolphin/wahoo which would facilitate the activities of the Working Group and would also be useful for exchanging information.

Additional data are needed to develop and/or improve estimates of growth, fecundity, etc. Research in this area is encouraged.

There are limited social and economic data available. Additional data need to be obtained and evaluated to better understand the implications of fishery management options.

Trophic data should be considered in support of an ecosystem management approach.

High levels of uncertainty in inter-annual variation in abundance of dolphin should be investigated through an examination of oceanographic and other environmental factors.

Release mortality should be investigated as a part of the evaluation of the effectiveness of current minimum size limits in the dolphin fishery.

Essential fish habitats for dolphin and wahoo need to be identified.

Observer programs should place observers on longline trips directed on dolphin. Catch and bycatch characterization, condition released (alive or dead), etc. should be collected. Observers could also be used to collect bioprofile data (size, sex, hard parts for aging, etc.).

2.7 Annotated Bibliography

A preliminary list of papers was developed by Dr. John Dean and distributed at the meeting (included in Appendix D). Workshop attendees were encouraged to review the list and provide additional references (and copies or describe how copies could be obtained) to the South Atlantic Fishery Management Council.

3.0 Alternatives for Council's Management Program

3.1 Management Unit.

3.1.1 Dolphin

As indicated in Section 2.1.1 the working stock structure hypothesis is a two stock model for the western central Atlantic, and the northern stock includes all dolphin (*Coryphaena hippurus*) occurring in Puerto Rico and the U.S. Virgin Islands, the Virgin Islands, the Bahamas, the Gulf of Mexico, the southeastern United States, the waters offshore the States of Virginia through Maine, and Bermuda. The management unit could be those dolphin occurring in the U.S. EEZ (Caribbean FMC, Gulf of Mexico FMC, South Atlantic FMC, Mid-Atlantic FMC, and New England FMC).

3.1.1 Wahoo

As indicated in Section 2.1.2 the working stock structure hypothesis is a one stock model which includes all wahoo (*Acanthocybium solandri*) occurring within the Western Central Atlantic. The management unit could be wahoo occurring in the U.S. EEZ (Caribbean FMC, Gulf of Mexico FMC, South Atlantic FMC, Mid-Atlantic FMC, and New England FMC).

3.2 Size Limits

3.2.1 Dolphin

Size limits appear to be more appropriate for active fisheries (e.g., hook-and-line and trolling) than for passive fisheries (e.g., pelagic longline) since the majority of dolphin are dead when passive gear is retrieved such that undersize fish cannot be released alive. There may be some benefit from size limits in the longline fishery which primarily targets dolphin given the reduced length of gear and reduced soak time characteristic of this targeted effort. Furthermore, there may be some benefit from setting a minimum size limit for commercial sale from vessels using passive gear. This should prevent discarding of undersized fish taken as bycatch and reduce targeted effort on schooling dolphin.

A biologically sensible minimum size limit for the active fisheries would be size at first maturity (400-500 mm FL) or even full maturity (550-600 mm FL). However, the intention is not to reduce current catch levels and/or cause a negative economic impact. Hence, the use of recently imposed minimum size limits should be monitored and evaluated for their effectiveness in maintaining current levels of fishing mortality and stock abundance.

3.2.2 Wahoo

Minimum size limits are considered a possibility but further information is required to evaluate impacts.

3.3 Bag limits

3.3.1 Dolphin

Recreational bag limits for dolphin appear to be effective in controlling fishing effort. A reasonable bag limit (e.g., 5-10 fish per person per trip) will serve to reduce excessive catches and will assist in preventing the current recreational catch from increasing.

3.3.2 Wahoo

There are insufficient data to address whether or not bag limits should be recommended at this time as these would be based on unverified assumptions.

Expansion of the fishery should not be encouraged while area-specific bag limits are considered.

3.4 Commercial trip limits.

3.4.1 Dolphin

Trip limits were deemed problematic because of the difficulty of monitoring trip length. However, trip limits which are based on limiting the proportion of the catch which is dolphin may have some merit in preventing conflict between the different sectors of the commercial fishery. For example, levels for the longline fishery should reflect current proportions landed by a pelagic longline operation; levels for the troll fishery should reflect current proportions landed by that fishery. Note that these may need seasonal qualification.

Trip limits for commercial sale imposed on the pelagic longline fishery may have some merit in preventing a switch in target species to dolphin. This should address the conflict issue but may not prevent expansion of the pelagic longline fishery with its dolphin bycatch.

3.4.2 Wahoo

There are insufficient data to address whether or not trip limits should be recommended at this time as these would be based on unverified assumptions.

Expansion of the fishery should not be encouraged while area-specific trip limits are considered.

3.5 Control Date

3.5.2 Dolphin

A control date can be used to allow for future limited entry into the commercial fishery when the appropriate information has been considered.

3.5.2 Wahoo

A control date can be used to allow for future limited entry into the commercial fishery when the appropriate information has been considered.

3.6 Closed Seasons and/or Areas

3.6.1 Dolphin

The use of time/area closures may have some utility in managing the fishery especially when essential fish habitats have been further qualified. Time/area closures may be an appropriate method to prevent exploitation of juvenile fish.

3.6.2 Wahoo

The use of time/area closures may have some utility in managing the fishery especially when essential fish habitats have been further qualified. Time/area closures may be an appropriate method to prevent exploitation of juvenile fish.

3.7 Allocations between Recreational and Commercial Harvesters

3.7.1 Dolphin

Given the current conflict situation and the goal to prevent further expansion, the use of allocation between different sectors of the fishery may be necessary.

3.7.2 Wahoo

Given the goal of preventing further expansion and future conflict, the use of allocation between different sectors of the fishery may be necessary.

3.8 Allowable Gear

3.8.1 Dolphin

Given the goal of preventing further expansion and conflict, the designation of allowable gear may be necessary.

3.8.2 Wahoo

Given the goal of preventing further expansion and conflict, the designation of allowable gear may be necessary.

3.9 Alternative Approaches

Area-specific co-management or experimental management could be considered. Individual transferable quotas could also be considered.

Appendix A. Final Agenda used at the Workshop.

SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

ONE SOUTHPARK CIRCLE, SUITE 306

CHARLESTON, SOUTH CAROLINA 29407-4699

TEL 803/571-4366 FAX 803/769-4520

email: safmc@safmc.nmfs.gov

Benjamin C. Hartig, Chairman
Pete Moffitt, Vice-Chairman

Robert K. Mahood, Executive Director

FINAL AGENDA
DOLPHIN/WAHOO WORKSHOP
TOWN & COUNTRY INN
(803-571-1000)
CHARLESTON, SOUTH CAROLINA
MAY 6-8, 1998

1:00 - 6:00 P.M. WEDNESDAY, MAY 6, 1998

1. Opening and Charge to Participants — Dr. Russ Nelson, Chair SAFMC Dolphin/Wahoo Committee
2. Mechanics of Workshop — Gregg Waugh, SAFMC Staff
3. Status of South Atlantic Council's Plan Development — Mike Jepson, SAFMC Staff

SESSION I: DOLPHIN FISH BIOLOGY, POPULATION STRUCTURE, MIGRATION PATTERNS, FISHERIES & POPULATION DYNAMICS
(Moderator - Mike Jepson, SAFMC Staff)

1. Dr. Hazel Oxenford, University of West Indies (Barbados)
2. Dr. Brian Luckhurst, Division of Fisheries (Bermuda)
3. Dr. Jean Cramer, NMFS Miami Lab
4. Ms. Robin Wingrove, College of Charleston (Stock ID)

SESSION II: WAHOO BIOLOGY, POPULATION STRUCTURE, MIGRATION PATTERNS, FISHERIES & POPULATION DYNAMICS
(Moderator - Mike Jepson, SAFMC Staff)

1. Dr. Hazel Oxenford, University of West Indies (Barbados)
2. Mr. Peter Murray, Organization of Eastern Caribbean States (St. Lucia, West Indies)
3. Dr. Brian Luckhurst, Division of Fisheries (Bermuda)
4. Dr. Jean Cramer, NMFS Miami Lab

9:00 - 11:30 A.M. THURSDAY, MAY 7, 1998
SESSION III: CONSENSUS RECOMMENDATIONS ON DATA, INPUT PARAMETERS & STOCK STATUS (Moderator - Gregg Waugh, SAFMC Staff)

1. Stock Structure & Migratory Patterns
2. Natural Mortality
3. Growth Rate & Longevity
4. Age/Size at First Reproduction & Fecundity
5. Stock Status
6. Data Collection & Research Needs
7. Annotated Bibliography for Dolphin

1:30 - 4:00 P.M. THURSDAY, MAY 7, 1998
SESSION IV: DESCRIPTION OF CURRENT MANAGEMENT PROGRAMS & MANAGEMENT ISSUES
(Moderator - Mike Jepson)

1. Dr. Russ Nelson, State of Florida
2. Ms. Susan Shipman, State of Georgia
3. Mr. David Cupka, State of South Carolina
4. Dr. Louis Daniel, State of North Carolina
5. Mr. Jose Campos, Caribbean Fishery Management Council
6. Mr. Rick Leard, Gulf of Mexico Fishery Management Council
7. Mr. Charlie Bergman, Mid-Atlantic Fishery Management Council
8. New England Fishery Management Council
9. Status Report on Designation of SAFMC as Lead Council for FMP Development - Dr. Joe Kimmel, NMFS
10. Overview of Recent Mahi-Mahi Price Trends — Mr. Ray Rhodes, SC DNR
11. The Recreational Fishery for Dolphin/Wahoo — Mr. Don Hammond, SC DNR
12. The Commercial Fishery for Dolphin/Wahoo — Mr. Charlie Moore, SC DNR

4:30 - 6:00 P.M. THURSDAY, MAY 7, 1998
SESSION V: CONSENSUS RECOMMENDATIONS ON ALTERNATIVES FOR COUNCILS' MANAGEMENT PROGRAMS (Moderator - Gregg Waugh)

1. Management Unit
2. Size Limits — recreational & commercial
3. Bag Limits — recreational
4. Trip Limits — commercial
5. Control Date
6. Closed Seasons &/or Areas

8:30 A.M. - NOON FRIDAY, MAY 8, 1998
SESSION VI: COMPLETION OF WORKSHOP REPORT (Moderators - Gregg Waugh/Mike Jepson/SAFMC Staff)

1. Draft Report will be available at 8:30 a.m.
2. Group will review and discuss report
3. Approval of final report prior to adjourning workshop

NOON FRIDAY, MAY 8, 1998

1. Description of timeframe for action by Councils — Dr. Russ Nelson
2. Thanks to panel & participants — Dr. Russ Nelson

WORKSHOP ORGANIZATION

1. **Attendance** — This meeting is open to the public. Invited participants will be giving presentations, and there will be an opportunity for anyone attending the meeting to ask questions. There will also be an opportunity for participation during development of consensus recommendations. Please print your name, address, phone, FAX, & e-mail on the sign-in sheet as we will use this to produce a list of attendees. Also, please indicate if you would like to be sent a copy of the proceedings when they are available in July.

2. **Papers/Presentations** will be between 10 and 40 minutes. Immediately following each paper/presentation there will be a 5-10 minute question and answer period. Please use the microphone, and give your name and the name of any group you represent. Poster presentations will be used to convey results of the annotated bibliography work.

3. **Proceedings** — Written versions of all papers/presentations will be included in a proceedings of this meeting. These papers do not need to be "publication quality" and inclusion in the proceedings would not preclude presentation at other scientific meetings like GCFI. Question and answer sessions and discussions during development of consensus recommendations will be transcribed as summary minutes and included in the proceedings. The entire session will be recorded. Copies of the proceedings will be available from the South Atlantic Council after July 1, 1998.

4. **Workshop Report** — This report will be prepared by Dr. Oxenford, Mr. Murray, and Dr. Luckhurst. The South Atlantic Council is relying on the recognized expertise of these three individuals, and their lack of any direct involvement with the Councils, to develop a factual information base to be used throughout development of a dolphin/wahoo fishery management plan. SAFMC Staff will provide administrative support. The Workshop Report will be included in the Proceedings.

CHRONOLOGY OF SAFMC DOLPHIN MANAGEMENT PROPOSALS

Management of dolphin by the South Atlantic Fishery Management Council (SAFMC) has been considered previously in the Public Hearing Drafts for Amendment 5 and Amendment 8 to the Fishery Management Plan for Coastal Pelagic Resources, jointly managed with the Gulf of Mexico Fishery Management Council. During October of 1989 the Councils took to public hearing an action to impose a bag limit of 5 per person per day for recreational fishermen and a requirement of a coastal pelagics permit to be exempt from the bag limit. In addition, a proposed 18 inch minimum size limit was also included. Public hearings for Amendment 5 were held from Key West, Florida to Norfolk, Virginia in the South Atlantic and to Corpus Christi, Texas in the Gulf. Amendment 8 included several options for management of dolphin, including: 20 inch commercial size limit, 10 fish recreational bag limit, 5 fish per person per day limit (recreational & commercial), 10 fish per person per day limit (recreational & commercial), require coastal pelagics permit for over the bag limit fish, and establish a commercial trip limit of between 1,000 and 12,000 lbs. Amendment 8 was also taken to public hearing during January, 1996 throughout the Gulf of Mexico and South Atlantic regions. Hearings were also held throughout the Mid-Atlantic Councils area of jurisdiction in March, 1996. In each case after reviewing public hearing testimony the Councils chose to forego any management for this species due to lack of public support for any specific measures.

The South Atlantic Council received letters relating to dolphin again during the latter part of 1996 and early 1997 as state representatives were also being contacted concerning this issue. Concern was expressed over increased longline activity for dolphin and decreased recreational catch off South Carolina.

In August of 1997, the South Atlantic Council approved a motion to begin development of a fishery management plan for dolphin and wahoo. The council requested that a letter be sent to the Secretary of Commerce requesting true lead for the plan by the SAFMC. The Council also requested that a control date be set for dolphin and wahoo upon publication in the federal register. Alternatives to be considered in the plan were also discussed and motions to include the following were made: consider allocations between recreational and commercial harvesters (a complete range of allocation scenarios); develop a framework option to include other means of controlling fishing mortality, bag limits, trip limits, etc.; develop options to implement reporting requirements; and finally to organize a workshop on dolphin and wahoo management.

On September 11, 1997 the SAFMC notified the Regional Administrator through a letter requesting designation as true lead for a dolphin and wahoo management plan. A few days prior to that request, Council Chairmen from the New England, Mid-Atlantic, Gulf of Mexico and Caribbean Councils were also notified of the SAFMC's intent.

A Federal Register notice of the South Atlantic Council's request was published on March 9, 1998 with a comment period to end on April 8, 1997. On April 13, 1998 an additional 45 days were added to the comment period at the request of the Gulf of Mexico Fishery Management Council to allow more time to fully consider the issues and impacts at its May 1998 meeting and develop and submit more specific and extensive comments on the proposal.

The dolphin and wahoo workshop has been scheduled for May 6-8, 1998 at the Town & County Inn, Charleston, SC. Panel members from the Caribbean and Southeast United States will review and discuss the current status of dolphin and wahoo research. A report will be made available following the workshop and may be acquired from the South Atlantic Fishery Management Council, One Southpark Circle, Suite 306, Charleston, South Carolina, 29407, Tel. 843-571-4366, FAX 843-769-4520.

Appendix B. Dolphin/Wahoo Workshop List of Attendees.

DOLPHIN/WAHOO WORKSHOP SIGN-IN
MAY 6-8, 1998

NAME AND ORGANIZATION	AREA CODE AND PHONE NUMBER	STREET ADDRESS CITY, STATE, ZIP	EMAIL ADDRESS	WOU LIKE PROC
Mel Bell SCDNR	843-762-5066	P O Box 12559 Charleston SC 29422	bellm@mrd.dnr.state.sc.us	
Charlie Bergmann MAFMC Member	609-884-7600	1525 Yacht Avenue Cape May NJ 08204	lundsfish@jerseycape.com	
Susan Buchanan SAFMC FAX	843-571-4366 843-769-4520	One South Park Circle Charleston, SC 29407	susan_buchanan@safmc.nmfs.gov	
Jose L. Campos CFMC Chairman FAX:	787-724-2079 787-724-2340 787-722-4204 787-724-7335	Box 906-5622 San Juan PR 00906-5622	diana.martino@noaa.gov	
Jim Chambers Audubon	301-949-3003	9814 Kensington Parkway Kensington MD 20895	j.chambers@erols.com	Y
Bob Chapman	843-762-5402	217 Ft. Johnson Road Charleston SC 29412	chapmanr@mrd.dnr.state.sc.us	
Jean Cramer NMFS	305-361-4493	75 Virginia Beach Drive Miami FL 33149	jean.cramer@noaa.gov	
David Cupka SCDNR	843-762-5010	PO Box 12559 Charleston SC 29422	cupkad@mrd.dnr.state.sc.us	
Louis Daniel NC DEHNR	252-726-7021 Ext 261	PO Box 769 Morehead City, NC 28557	louis_daniel@mail.ehnr.state.nc.u	
Kay Davy SCDNR	843-762-5118	P O Box 12559 Charleston SC 29422	davyk@mrd.dnr.state.sc.us	

DOLPHIN/WAHOO WORKSHOP SIGN-IN
MAY 6-8, 1998

NAME AND ORGANIZATION	AREA CODE AND PHONE NUMBER	STREET ADDRESS CITY, STATE, ZIP	EMAIL ADDRESS	WOU LIKE PROC
John Dean USC	843-777-0075	Branch Institute USC Columbia SC 29208	jmdean@sc.edu	
Jodie E. Gay SAFMC Council Member	910-270-3718	105 Friendly Lane Hampstead, NC 28443	oldsmokey@worldnet.att.net	
Mark Godcharles NMFS/SERO	813-570-5305	9721 Executive Center Dr.N. St. Petersburg FL 33772	mark.godcharles@noaa.gov	
Don Hammond SCDNR	843-762-5025	P O Box 12559 Charleston SC 29422	hammondd@mrd.dnr.state.sc.us	
Bill Harrell SAFMC Mackerel AP	704-537-2042 704-537-0010(Fax)	5533 Monroe Rd. Charlotte NC 28212	bharrell@bellsouth.com	
Marsha E. Hass SAFMC Council Members	843-556-6555	1215 Pembroke Drive Charleston, SC 29407	hassm@cofc.edu	
Ken Hinman NCMC	703-777-0037	3 West Market Street Leesburg VA 20176	seancmc@aol.com	
Kim Iverson SCDRN	843-762-5088	P O Box 12559 Charleston SC 29422	iversonk@mrd.dnr.state.sc.us	
Joe Kimmel NMFS	813-570-5305	9721 Executive Center Dr.,N St. Petersburg FL 33702	joe.kimmel@noaa.gov	
Mike Jepson SAFMC	843-571-4366 FAX 843-769-4520	One South Park Circle Charleston, SC 29407	mike_jepson@safmc.nmfs.gov	

DOLPHIN/WAHOO WORKSHOP SIGN-IN
MAY 6-8, 1998

NAME AND ORGANIZATION	AREA CODE AND PHONE NUMBER	STREET ADDRESS CITY, STATE, ZIP	EMAIL ADDRESS	WO LIKE PRO
Fred Kinard, Jr. SC Wildlife Fed.	843-871-5000	c/o Westvaco P O Box 1950 Summerville SC 29484	fwkinar@westvaco.com	
Rick Leard GMFMC	813-228-2815	3018 US Highway 301 N. Suite 100 Tampa FL 33619	rick.leard@gulfcouncil.org	
Brian Luckhurst Fisheries Div, Bermuda	441-293-1785	Division of Fisheries P O Box CR52 Crawl CRBX, Bermuda	blucky@ibl.bm	
Micah LaRoche	843-559-0688	2789 Cherry Point Road Wadmalaw Island SC 29487		
Robert Mahood SAFMC FAX	843-571-4366 843-769-4520	One South Park Circle Charleston, SC 29407	robert_mahood@safmc.nmfs.gov	
John Merriner NMFS-Beaufort Lab	919-728-8708	101 Pivers Island Road Beaufort NC 28516-9722	john.merriner@noaa.gov	
Henks Mikell	843-738-8183	7297 Cabin Creek Hopkins SC 29061		
Charles Moore SCDNR	843-762-5037	P O Box 12559 Charleston SC 29422	moorec@mrd.dnr.state.sc.us	
Peter A. Murray O.E.C.S. Fax:	758-452-1847 c/o 758-453-6208 758-452-2194	Nat. Res. Mgmt. Unit P O Box 1383, Castries St Lucie West Indies	oecsnr@candw.lc oecss@candw.lc oecsnrmu@candw.lc	

DOLPHIN/WAHOO WORKSHOP SIGN-IN
MAY 6-8, 1998

NAME AND ORGANIZATION	AREA CODE AND PHONE NUMBER	STREET ADDRESS CITY, STATE, ZIP	EMAIL ADDRESS	WOU LIKE V PROC
Russ Nelson FL Marine Fisheries Commission	904-487-0554	2540 Executive Ctr. Circle W Tallahassee FL 32301	nelson_r@dep.state.fl.us	
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Hazel Oxenford UWI, Barbados	242-417-4571	MAREMP, UWI P O Box 64 Bridgetown Barbados	maremp@sunbeach.net	
Ray Rhodes SCDNR	843-762-5040	P O Box 12559 Charleston SC 29422	rhodesr@mrd.dnr.state.sc.us	
Bill Scott	843-762-2500			
Micky Scott	803-584-3451	Rt 1, Box 134 Allendale SC 29810		
Al Segars	843-522-0819	32 Fiddler Drive Beaufort SC	al@hargray.com	
Buck Sutter NMFS	813-570-5447	9721 Executive Center Dr.N. St. Petersburg FL 33702	buck.sutter@noaa.gov	
John Tortorici	843-767-9600	7195 Bayhawke Circle Charleston SC 29418	jtorto@aol.com	
Glenn Ulrich SCDNR	843-762-5080	P O Box 12559 Charleston SC 29422-2559	ulrichg@mrd.dnr.state.sc.us	

DOLPHIN/WAHOO WORKSHOP SIGN-IN
MAY 6-8, 1998

NAME AND ORGANIZATION	AREA CODE AND PHONE NUMBER	STREET ADDRESS CITY, STATE, ZIP	EMAIL ADDRESS	WOU LIKE V PROC
Wayne Waltz SCDNR	843-762-5094	P O Box 12559 Charleston SC 29422	waltzw@mrd.dnr.state.sc.us	
Gregg Waugh SAFMC	843-571-4366 FAX 843-769-4520	One South Park Circle Charleston, SC 29407	gregg_waugh@safmc.nmfs.gov	
David Whittaker SCDNR	843-762-5052	P O Box 12559 Charleston SC 29422-2559	whitakerd@mrd.dnr.sc.state.us	
Robyn Wingrove Grice Marine Lab	843-762-5406	Grice Marine Lab 205 Ft. Johnson Road Charleston SC 29412	rswingro@edisto.cofc.edu	

Appendix C. Workshop Summary Minutes.

SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

DOLPHIN/WAHOO WORKSHOP

TOWN & COUNTRY INN
CHARLESTON, SC
MAY 6-8 1998

SUMMARY MINUTES

Council Members:

Dr. Russ Nelson, SAFMC
Jodie Gay, SAFMC
Dr. Joe Kimmel, SAFMC
Jose Campos, CFMC
David Cupka, SAFMC
Marsha Hass, SAFMC
Dr. Louis Daniel, SAFMC
Charlie Bergmann, MAFMC

Staff Members:

Bob Mahood
Mike Jepson
Kerry O'Malley
Deb Buscher
Gregg Waugh
Susan Buchanan
Dr. Rick Leard, GMFMC

Presenters:

Dr. Jean Cramer, NMFS Miami Lab
Don Hammond, SC DNR
Charles Moore, SC DNR
Dr. Hazel Oxenford, U. of West Indies (Barbados)
Dr. John Dean, U SC (Columbia)
Dr. Brian Luckhurst, DOF (Bermuda)
Robyn Wingrove, Grice Marine Lab
Mr. Peter Murray, Org of Eastern Caribbean States (St. Lucia, West Indies)

Observers/Participants:

Mel Bell, SC DNR
Dr. Bob Chapman, SC DNR
Kay Davy, SC DNR
Mark Godcharles, NMFS/SERO
Ken Hinman, NCMC
Fred Kinard, Jr., SC Wildlife Fed.
Dr. John Merriner, NMFS-Beaufort Lab
Bill Scott
Al Segars
John Tortorici
Jim Chambers, Audubon Society
Glenn Ulrich, SC DNR
Wayne Waltz, SC DNR
Bill Harrell, SAFMC Mackerel AP
Kim Iverson, SC DNR
Micah LaRoche
Henks Mikell
Micky Scott
Buck Sutter, NMFS

OPENING AND CHARGE TO PARTICIPANTS

Dr. Nelson greeted all participants and attendees to the meeting. He explained the intent and purpose of the meeting and the need to work together to develop a range of recommendations for Dolphin/Wahoo management options. We have assembled people from around the country and the islands to summarize the expertise we have available to us on the dolphin.

Mr. Waugh welcomed everyone and added that this workshop will be working on putting together a summary of recommendations on dolphin/wahoo, with people who have been working in this area. They will be able to supply information as to what is going on in this fishery. He noted this meeting was going to be open to the public so there will be opportunities for questions and answers after each presentation. This will be limited to 5 or 10 minutes.

He stated that with the dolphin/wahoo there really isn't a lot of information available, but there will be reports from Dr. Oxenford, Mr. Murray, Dr. Luckhurst. We have used expert panels like this in the past to ensure that we get the types of information needed and it is presented in a factual manner which will alleviate some people's concerns that we may be trying to slant the information one way or the other. This is why we try to bring in people who have not been involved in the controversy on dolphin/wahoo.

SESSION I: DOLPHIN FISH BIOLOGY, POPULATION STRUCTURE, MIGRATION PATTERNS, FISHERIES & POPULATION DYNAMICS - (Moderator - Mike Jepson, SAFMC staff)

Mr. Jepson gave a more detailed outline of how the council got to where it is today in regard to the dolphin/wahoo management (copy included in the administrative records).

1. Dr. Hazel Oxenford, University of West Indies (Barbados)

Dr. Oxenford gave her presentation on the biological characteristics (paper included in proceedings).

Question and answers period. (Side b/tape 1 position 28)

Mr. Campos said he is the chairman of the CFMC and a recreational fisherman who targets Mahi in the winter months and early spring. He said they have a very large area which covers the western part of Puerto Rico and they have found that on the south coast of Puerto Rico the fish run comparatively smaller than the ones up north. They just completed two tournaments one on the south coast and the other on the southwest coast of Puerto Rico and the average size fish was around 15 pounds. The largest fish which was brought ashore weighed 30 plus pounds. On the north coast they are continually taking fish (females) in the 30 to 40 pound range and males in the 50 to 60 pound range. He questioned if there could there be another migratory pattern that more fish are on the south and smaller fish on the north?

Dr. Oxenford said certainly the boundary of these two stocks is very unclear and the work in Puerto Rico shows the fish on the north coast appear to be different from the dolphin fish on the south coast. In the work they did they really were not able to find any differences between them. Although they didn't do genetic or aging work. But, the fish on the south coast appear to be very small young fish and perhaps they are coming from these fish which are obviously spawning when they are going through this area. However, she really isn't sure.

Mr. Hinman with the NCMC was very impressed with the biological information on the growth rate. age of maturity, and mortality of the dolphin. He asked if she could comparable coastal pelagic species that have similar life history characteristics?

Dr. Oxenford said no, originally they were astounded by the very high growth rates, and natural mortality. However, in looking at the other characteristics of other large oceanic species this seems to be the life history strategy. If you are going to live in the ocean you have to grow very fast to get through this critical period, so the thing that is very different about dolphin fish is they don't live very long. Therefore, their whole life they are growing very fast and then they die, whereas in the other species, billfish and tuna who have very high growth rates at young ages, live longer and mature much later. So, the dolphin fish are really very special since they have this very short life span but do grow very large compared to some of the other near shore pelagics.

Mr. Moore from the SC DNR, questioned if it was fairly uniform in her area to have a fish grow 45 pounds or more in one year?

Dr. Oxenford said yes, if you take your average growth rate for the whole sample it is much faster than if you take the average growth rate for the larger size fish. So, the younger fish are definitely growing faster at 4 to 5 millimeters per day.

Ms. Hass, SAFMC Council member, questioned if a short lived fish became very popular and we slaughtered lots of them, could they become extent?

Dr. Oxenford said they are less likely to become extinct than what we call the "K" selected species which delay maturity until a much older age. Essentially if you are living in the fast land, maturing quickly, and dying fast, a fishery is less likely to damage this than perhaps sharks, who live a long time, don't mature until they are much older, and only produce very small litters.

Mr. Godcharles, NMFS/SERO, said he understands that cannibalism is an important feature of dolphin history. He asked how much cannibalism contributes to the very high natural mortality rate and the fact that not many fish get past age 1.

Dr. Oxenford said contrary to what is in the draft document she didn't think that cannibalism is a significant part of their diet. If you look at all the other studies done cannibalism has not been reported or only accounts for less than 2% of their deaths. So, it really isn't an important feature and probably is done by accident, and shouldn't be considered an important factor.

2. Dr. Brian Luckhurst, Division of Fisheries (Bermuda)

Dr. Luckhurst gave his presentation on dolphin fish biology.(paper included in proceedings).

Question and answers.

Mr. Campos said he is concerned regarding the longline data because there were no observers on board, especially because the number of fish caught per 1,000 hooks was really low. He questioned if there was anyone there when these boats unloaded. In Puerto Rico the longliners just don't give any data regarding bycatch, especially, Mahi and wahoo. They usually sell them at the dock and have about 2 or 3 thousand pounds of Mahi.

Dr. Luckhurst said he cannot give him a definite answer but he can suggest for the seasonality pattern. The sparse longliner data set is taken over the fall and the winter months. It may simply be a reflection of the fact that there aren't that many dolphin fish around the Bermuda area over the winter months. We will see as we progress into the summer months and into the peak third quarter period what happens with that bycatch. The longliners bring these fish in because it is a highly marketable species and they want to put everything on the dock they can sell.

Mr. Campos questioned if you will be putting observers on board these vessels?

Dr. Luckhurst said yes, but he does have some faith in this data, because when they initiate another kind of sampling program with them they have been extremely cooperative and willing to modify certain elements of their operations to accommodate his requests. At least, at this stage, when they are at the dock and these vessel come in they see what comes off those vessels.

Mr. Campos questioned if he thought due to the high tourism trade, will the taking of Mahi increase dramatically in the future?

Dr. Luckhurst said up to this point Mahi-mahi has always been targeted by the commercial and recreational fishermen, which he has no data for.

Mr. Campos said he is more worried about longliners.

Dr. Luckhurst said as far as the longliners are concerned the money for them is in catching their principal target species which is swordfish. However, whenever they can catch big eye they ship them out of Bermuda and sell them overseas. So, pound per pound and effort, they would rather catch swordfish and big eye than they would Mahi-mahi, to make a lot more money.

Mr. Campos asked if these fishermen were U.S. longliners?

Dr. Luckhurst said no, they are Bermuda longliners, local vessels.

3. Dr. Jean Cramer, NMFS Miami Lab

Dr. Cramer gave her presentation (paper included in proceedings).

Questions and answers.

Mr. Don Hammond, with the SC DNR, questioned on the CPUE you displayed, were you able to figure in trips where no dolphin were caught, but were in fact targeted, or were they strictly trips that successfully caught dolphin?

Dr. Cramer said in the case she displayed it was all hooks reported and she didn't limit it to the ones reporting only dolphin. Also, this is probably the way it was done in the earlier papers.

Mr. Hammond questioned what about the recreational?

Dr. Cramer said yes, it should have been done that way as well.

Mr. Hammond said then in the data they could identify trips that were in blue water as opposed to trips that may have stayed in the shallower water and not have been exposed?

Dr. Cramer said actually, she didn't believe in that paper they differentiated the quality of effort. It was one of the reasons the MRFSS survey CPUE was quite a bit higher than the headboat effort because the series was pretty much a nominal series rather than a developed CPUE series putting in variables. These are very nominal statistics without taking into account those quality differences.

Mr. Campos asked if in the overheads the peaks, etc., could be accounted to the strengthening of ENino?

Dr. Cramer said given the nature of the CPUE in the fishery there is some oceanography involved especially in the spawning area..

Mr. Jepson said in the MRFSS data, at times, some of the landing data from the Keys are all attributed to the Gulf, so in this information that she presented today has it been split out with regard to catches in the Atlantic and catches in the Gulf in the Keys?

Dr. Cramer said no.

Mr. Jepson said he has talked to various people down in the Keys and they have indicated that a large percentage of the catches in the Keys do come from the Atlantic.

Mr. Rick Leard, GMFMC Director, said he has that information and it has been split out he will give the SAFMC a copy.

Dr. Hazel Oxenford presented overviews on the CPUE landings from dolphin from the Caribbean and from Brazil and all the Caribbean countries for the last 35 years by countries (paper included in proceedings).

4. **Ms. Robyn Wingrove, College of Charleston (Stock (ID)**
Ms. Wingrove gave their presentation on stock identification (paper included in proceedings).

Questions and answers.

Dr. Dean asked how many markers will you need to be definitive on this?

Ms. Wingrove said Mitochondrial (mtDNA) is considered one because they are linked, but if there is one variation in one part of the molecule then there most likely will be a variation in the other parts. Most Mitochondrial (mtDNA) analysis will use one region of the Mitochondrial (mtDNA) for that reason, but they will use a number of restriction enzymes. By the time she completes this she should have at least 15 to 20 different restriction enzymes so that you will be able to come up with a composite. Then you would look for the differences in the frequencies of those composite haplotypes from different locations to see if differences are actually significant.

Dr. Dean noted there has been severe criticism directed at many of our colleagues who are using haplotype frequencies to do stock resolution. He asked her if she felt this as a problem with your approach?

Ms. Wingrove said she sees this as one molecular marker to use and that they have another proposal out for MARFIN to use micro-satellites as an additional marker. She believes her work is only one little part of the overall procedure. She noted that most tropical species have not been able to discriminate the stocks through Mitochondrial (mtDNA) alone, however this remains to be seen for dolphin consideration.

Dr. Oxenford stated she is delighted that Ms. Wingrove has done this and supports her work. She also believes that she does have an adequate number of enzymes and DNA to detect the differences if the stock is as complex as she thinks it is.

Ms. Wingrove noted she is in need of numerous samples and asked everyone for any assistance they could offer.

Mr. Murray noted among the 14 countries the Caribbean community there are 12 countries who comprise a group knows CFRAMP, and a lot of work is being done now on these species because of the relatively limited funds on personnel, etc. As the sample programs goes the whole chain in the 12 countries it may be useful for Robyn to contract the program coordinators and link up with them to see if she can make use of some of their samples.

SESSION II: WAHOO BIOLOGY, POPULATION STRUCTURE, MIGRATION PATTERNS, FISHERIES & POPULATION DYNAMICS - (Moderator - Mike Jepson, SAFMC staff)

1. **Dr. Hazel Oxenford, University of West Indies (Barbados)**
Dr. Oxenford presentation on wahoo biology is included in the dolphin presentation (paper included in proceedings).

2. **Dr. Peter Murray, Organization of Eastern Caribbean States (St. Lucia, West Indies)**
Mr. Murray gave his presentation on the wahoo biology (paper included in proceedings).

Questions and answers.

Mr. Campos questioned how the fish were caught in St. Lucia.

Mr. Murray said in St. Lucia they trolled, primary 3 guys in canoes with 3 different lines over the side of the boat. Although he doesn't know the trolling speed.

Mr. Campos asked if he had found them aggregating around floating objects?

Mr. Murray said there was a study done that suggested that when they targeted dolphin, they catch the wahoo as well. In Grenada they adopted the Cuban longline to use in small vessels, so they have short longlines, 3 to 6 miles long to target the dolphin, wahoo, and other pelagics.

Mr. Campos noted for the record in Puerto Rico and in the U.S. Virgin Islands there is and has been a traditional recreational fishery for wahoo for several years. It has a tremendous economical impact. Tournaments are held that target wahoo and fish range in size from 1 to 100 plus pounds. Most of small wahoo they catch school together with Mahi around floating objects and it is a very important recreational fishery in the Caribbean.

Dr. Oxenford stated she supports the statement of Mr. Campos and Mr. Murray, because the dolphin boats do target floating objects whenever they can. You will find that the dolphin are very tightly schooled or aggregated around floating objects and are the ones that are taken first. The wahoo are aggregated at a further distance away at a larger diameter. So, they take the dolphin first then the wahoo.

Mr. Waugh said if you look at the ratio of "F" (fishing mortality rates and the natural mortality rates), the "F's" are 3 times higher. Given those values would be refined with more data, does this support a general conclusion ,that in those areas, the wahoo are highly exploited?

Mr. Murray said he didn't want to make a general statement like that.

3. **Dr. Brian Luckhurst, Division of Fisheries (Bermuda)**
Dr. Luckhurst gave his presentation on wahoo biology (paper included in proceedings).

Questions and answers.

None.

4. **Dr. Jean Cramer, NMFS Miami Lab**
Dr. Cramer gave her presentation on wahoo (paper included in proceedings).

Questions and answers.

Dr. Nelson asked Mr. Murray and Dr. Oxenford what were the biggest sizes of dolphin caught in St. Lucia and Barbados?

Mr. Murray said as he recalls it was 6 feet but it wasn't documented.

Dr. Oxenford said during the beginning of the season they are getting fish up to 60 and 70 pounds. Those will be the ones from last year which made it through the year and will the 12 plus month olds.

Dr. Nelson asked Dr. Cramer if she had looked at the longline data enough to see if there has been any change in the ratio between dolphin fish kept versus discard over the time period you have the data?

Dr. Cramer said she doesn't see many discarded at all it isn't a common thing, but she hasn't actually queried this information.

Dr. Daniel, of the SAFMC, noted North Carolina has submitted a MARFIN proposal for the next 3 years to look at the most appropriate structures and to collect fish from Georgia, North and South Carolina. He asked if anyone had any inside or background information on looking at other structures, such as, bones, dorsal spines on dolphins, etc. Also, how old have you been able to age these fish with the daily growth increments from the otolith?

Dr. Dean said they did a few 2 plus fish, but at that time they were not able to do daily increments out beyond several months, because it required SEM. Although now they are able to do the daily increments of a micron as they do in the yellow fin for 4 to 5 years. It does look like the work they are doing with Wahoo micro-structure, looks very similar to what we have with yellow fin. However, since there wasn't any interest at the time we did the study on wahoo they didn't pursue it.

Dr. Daniel said in North Carolina they have looked at a lot of dolphin otoliths from incidental catches in trying to get as many fish as they could. They have looked at fish from up to 38 to 40 pounds and have yet to see any type of mark on that structure at all. He questioned if he was using a different otolith?

Dr. Dean said their study was only on 6 to 8 fish when they looked at the yellow fin. He noted it would probably be more productive for he and Louis to get together and discuss this later.

Dr. Nelson added one of the things we have not discussed today in regard to longevity or stock structure is any information which may be available from tagging and capture program. He asked if anyone there was familiar with any information or has anyone looked at any data-bases from NMFS or other tagging programs?

Ms. Wingrove said she believes that the Marine Lab did a tag and recapture study, however, she was unaware of the results.

Dr. Dean added the South Carolina recreational tagging program has been quite vigorous, although he didn't know the results of this.

Mr. Hammond said this is a program that South Carolina has just gotten into on dolphin/wahoo this past year. They are providing an incentive for tagging dolphin during the Governor's Cup Tournament, and the fishermen have bought into this program with about 100 dolphin tagged this past year, with 3 recoveries. This is something their program is really interested in pushing and trying to work in cooperation with some of these other areas. He is planning to do this by talking with representatives to see if we can develop a cooperative tagging program. We desperately need this and could probably generate some funds especially from the private sector to help fund this program.

Mr. Hammond said they were caught over fairly short periods of time, about 10 to 15 pounds and recovered within a short period of time with the exception of one. You have to understand there is no fish worse than a dolphin in the boat. Trying to tag one is hazardous to your health. Therefore, they really are not encouraging the tagging. They haven't really devised a way to get good actual release information on this side.

Dr. Oxenford added the SEFRAMP program in the Caribbean has just started a tag and release on a number of pelagic species including the dolphin. To date they have tagged 3 dolphin. However, she believes it would be a great idea to do a cooperative program,. but it would have to be very intensive because the fish is so short lived.

Mr. Hammond concurred, adding this is something we can work together on because one study documented dolphin can travel 70 to 80 miles within a 24 hour period.

Dr. Luckhurst said when he first suggested to the fishermen to tag wahoo they laughed at him, but they have come around in the last few years and have tagged about one dozen wahoos so far. Because of the highly migratory nature of the wahoo we will definitely need to coordinate this with all the people involved. He added they have developed a tagging tube that would better control the animal and measure it more accurately. He will be glad to share this information with anyone who is interested.

Dr. Dean stated that Dr. Oxenford has done more direct work than anyone else.

Dr. Oxenford added they use daily otolith growth rings (or presumed daily growth rings) on dolphin they counted without any difficulty up to about 300 rings.

Mr. Campos stated that in the Caribbean they are running out of certain groundfish and fishermen who have traditionally lived off the groundfish are now moving towards other horizons, which are the highly migratory species (tuna, billfish, dolphin, and wahoo). The longline issue or the use of longlines in the Caribbean is expanding. Back in the old days it was only one line with one bait, and one fish. With the expansion and this large group of newcomers to the highly migratory pelagic species will mean, perhaps, an over exploitation of these fish. Especially now that we have to supply a market, tourism market, and the European community market. The stakes are growing higher and higher every day, so do you believe that 4 or 5 years from now we will have the same status-quo in the fisheries? Will we still be using our traditional one hand line, one bait, or will we be using 5 - 10 - 15 mile longline?

Mr. Murray said we can't predict this but most of the Caribbean countries have been looking at moving the fisheries offshore and may preclude their fishermen from going to the large 50 mile sort of thing. He does know that Granada is still using the 27 flood pier and setting out 4 or 5 miles, also, St. Lucia is adopting this particular plan. The economics are such that it will not allow them to go into this on a larger scale, you can almost define this fishery because it is a fairly young one from the point of view of longlining for pelagics. Therefore, if management comes in soon enough we probably should be able to limit the extent to which it is exploited. There appears to be the political will, but it is one that has not yet started to take cognizance on the political reality. In other words fishery officers have convinced their ministries that you need to expand offshore, but that they also need to limit participation. However, a lot of the fishermen have not been talking among themselves and haven't seen the need to move from the near shore, so it hasn't yet become a problem for them. It is just a very funny game that has to be played before they realize what you are doing. It is very hard to predict because it could fall any way, you just cannot really tell what is going to happen. All he does know is there appears to be a commitment to management and in regard to what they have been trying to do, at least for those islands, is to take as much of a participating management approach as possible. So, you need to involve them in the management plan and process. Where you go and talk to them, not as scientists talking to fishermen, but more of a stake holder type of approach. Basically, this is the type of approach they are taking, playing the politics before they realize there is politics to play and involve them in the process. Then before they realize they should have been playing politics they are part of the process too, and it is too late for them to turn back.

Dr. Oxenford said if we face reality it is obvious that we are capable of overexploiting the stock whatever it is. We have done it to so many fisheries, globally, that it is only a matter of time. We have a unique opportunity here to step in and put in some sensible precautionary management before we reach the crisis point.

Dr. Luckhurst added history has shown us that whenever technological innovations in a fishery increase fishing power, and if the socioeconomic-political climate is right all types of things can happen. So he would like to echo what Hazel has just stated, that a precautionary approach, given what is known is the course you want to follow. Whether you can make this a reality is another matter. Certainly, there is enough evidence that if you don't act you can expect the worst.

Mr. Mahood said one of the critical issues will be the stocks, how many and their locations. He asked Ms. Wingrove in her sampling protocol did she determine how many samples from each area she would need to get a clear determination of unit stock structure?

Ms. Wingrove said for each sampling area to get at least 50, preferably more, but 50 is her goal to analyze. She is trying to get a good distribution of the geographical range of this species within the western central Atlantic. She just wants as many sampling locations as possible in this area.

Mr. Mahood asked her if she is also involved in Dr. Chapman's proposal on MARFIN.

Ms. Wingrove said yes, he is her advisor at school.

Mr. Mahood said he had hoped that we could have gotten some information on wahoo and hope there was a MARFIN proposal on wahoo.

Dr. Dean said there are fundamentals that are developed now and they have limitations and methodologies which have to be addressed. Certain markers you can get by with fewer samples than others, especially, with the possible mixing zones which is really quite narrow. With Mitochondrial (mtDNA) and the rule of thumb is a 2% exchange, so it would make it impossible to resolve. Therefore, this is just a fundamental problem. This is why we have these other techniques that are now coming on board, and we just need to use all our tools. The important things we need to remember is that these are techniques that have not been available to us. Also, if we don't get going on this we won't get the information, and there is no single piece that will be the answer for it. This will not happen overnight and we have to be prepared to stay with it for several years, it just won't happen in one shoot.

Mr. Mahood said in some of the MARFIN programs when they talk about DNA and dealing with old fishery scientists there is still a lot of skepticism on what can and what can't be done. Therefore, it is critical for some of these new techniques to show definite results in the future.

Mr. Hinman said he was curious in the preliminary agenda it said Mediterranean.

Mr. Jepson said we had hoped they would have attended this meeting.

Mr. Hinman asked if this was because they have done a fair amount of work on dolphin biology and structure over there?

Mr. Jepson said recently there was a workshop which was held in Spain and we had hoped they would report on the type of work done there.

Mr. Hinman said there has always been traditional bycatch in the longline fishery when targeting tuna and swordfish, we saw an increase which was due to fishing patterns and configurations. He asked how do you factor this into the assessments in looking at the quality of effort in the CPUE indices and trends of populations.

Dr. Cramer said she encounters indices referred to the March 1998 paper which shows the percent of targeting indicated as other fish broken down into and only in the southeast coastal areas was there a notable change in reported, "other effort." This was only in 1995, "other effort." "Other," is indicated as an effort and was started in 1992, because before this it wasn't required. The decline was due to the longline fishermen in effort for one year trying to move away from the swordfish and small tuna. It will be interesting to see what happens to the figures in 1997, because going from 2% to 6% to 2% doesn't really give you a trend.

Regarding his second question on how do you produce a CPUE which would realistically take into account the quality of the effort has changed and they were actually targeting the dolphin; you have to work with this data just like the other CPUE as well as the other information they have available to try to identify those sets. She said you have to take into account the indication that other fish were targeted and this would give you some of the other variables (depth of the lines, length of the lines, and length of sets). This information is in the longline data and can be used.

Mr. Hinman said basing his statement, to this council, from Dr. Kemmerer's report on 1997 trends in longline catches in the southeast on dolphin. This report stated the longline catches jumped up sharply in 1994, and then reaching an all time high in 1995. It also stated the fishery has been dominated by swordfish longliners that target dolphin on the side.

Dr. Cramer said it may be that they didn't have the 1996 data available at that time. She agreed that in 1995 it probably did look like a trend but right now there is a big question here, and we don't know if it will continue to happen.

Dr. Oxenford added she recently attended the Mediterranean meeting and there has been a lot of work done there, but up until there was a lack of communication between each of the islands. There were approximately 40 papers and they will all be published within the next year. She summarized the work by saying many of the reports were simple, interesting, descriptions of the fishery, but there have been some excellent work on age and growth and biological characteristics of the fishery.

Dr. Cramer noted she has the abstracts from that workshop with her if someone wants to look at them.

Mr. Charles Moore, SC DNR, said he will be presenting information on commercial harvest of dolphin later in this meeting. He wanted to mention on a state level, particularly in the southeast there does seem to be a clear cut increase in dolphin landings and in the percentages of the harvest of dolphin in the southeast by the pelagic longline fleet.

Mr. Hammond added from the recreational side, beginning in 1993, from the sport fishing tournaments, we first began receiving reports of longlines sitting in the daytime in waters as shallow as 30 fathoms. Off the coast of South Carolina you don't catch swordfish during the day nor in 30 fathoms. This was then their first indication that longliners were in fact targeting the dolphin because it is the dominate fishing for that period. It came to a head in 1995 when they had tremendous landings all the way up and down the southeast coast where longliners were setting up inside the 100 fathom curves and fishing during the day. This is contrary to swordfishing patterns and verifies this was directed towards the dolphin.

SESSION III: CONSENSUS RECOMMENDATIONS ON DATA, INPUT PARAMETERS & STOCK STATUS (Moderator - Gregg Waugh)

Mr. Waugh gave a presentation on the consensus recommendations on data, input, parameters and stock status (copy included in the administrative records).

1. Stock Structure & Migratory Patterns

Mr. Waugh said we are going to use our best assumptions for the stock structure and migratory patterns.

Dr. Nelson said the only hypothesis was presented by Dr. Oxenford and Ms. Wingrove has evidence and he believes it is our best information at this time. He noted that Ms. Wingrove's work is not done yet and there is some uncertainty to it, but is the best working model we have.

Mr. Murray questioned if the information we have reflects wahoo?

Dr. Oxenford said there isn't any corresponding information on the wahoo given they are longer lived and larger fish. We may well be looking at a much simpler stock structure for that species and we really don't have a model.

Mr. Waugh said he would like to focus on dolphin first.

Dr. Luckhurst noted we are still at a preliminary state to do anything on wahoo to make an assessment or talk about any hypothesis.

Dr. Dean said he thinks it is useful to have the hypothesis to test against. It is also important regarding information on stock structure on circular global migratory fish which has not been done to show stock structure. So, at this point in time it is important for us to recommend to the council that they do need a sustained, structured program to develop this information over time with the different tools available today.

Mr. Robert Chapman, SC DNR, said we need to on focus dolphin and ask whether or not we should be framing our studies on dolphin given what information is available in other billfishes and tuna, since dolphin is a little more coastal in their distribution than these other billfish. It is a question which would be more appropriate for this group to look at because of your expertise.

Dr. Dean said he is not trying to spilt off a particular piece. Conceptually where the council has to go and what they have to understand is that Ms. Wingrove's stuff is preliminary. It is important for the council to understand that one piece like this probably will not give the definitive answer.

Mr. Chapman said the problem that we are going to have is should we focus our attention on this particular region. Let's suppose we find some level of difference between these two groups that reinforces Hazel's hypothesis. So, how do we put that into a context of a broader geographical distribution of this species. Basically, you are making a comparison in a vacuum, you have no out group to compare it against. He noted there is data that Carol Reed has that is a more global look at dolphin. It has not been published and has been sitting there for the last year and one-half. We need to push her to get this information out to use, but even so, the sample size is 200 fish, which are scattered all over the Pacific and into the Atlantic. It may not help us too much in evaluating what this is all about, but we can start at this level and build this thing outward. It will be a long process simply because of the distribution of the organism, but he doesn't see any other way to do it.

Dr. Nelson said we tend to focus some things on stock and the lines of genetic analysis with the overlapping of reproduction. This is certainly a very strong tool and very useful, but at the same time it doesn't take a great deal of exchange between 2 groups of fish to get a fairly uniformed genetic structure. In fact, in a management sense the stock doesn't have to be genetically distinct, i.e., blue marlin where they have tagged fish traveling large distances ending up some where else. If you look at the tagging returns, 90 some are taken in the same area they were tagged, 2 or 10 years later.

Mr. Chapman said that is true as far as it goes. However, if you focus your attention on the Mitochondrial (mtDNA) and the frequency differences between populations you are correct. There are other ways to look at nuclear DNA which will give you indications that these populations are not randomly matched. We are seeing evidence of this in a other species even within the Charleston Harbor. We need to use our tools whether they are tagging, genetics, etc., in concert. Let's propose we use genetical tools to get the big pattern and then use the other tools, such as tagging, etc., if you need to make that fine level of discrimination. We just need to find out how fine the resolution needs to be, and this is not a question for him to answer.

Dr. Dean said there is no way we can answer this today, and Bob has put his finger on it, just how much do we need to know, to what level, and with how much accuracy. The tools are out there now. He is just not sure the fishery justifies the investment it would take.

Mr. Waugh questioned if it was safe to assume that this figure of the distribution we have been talking about, is the working hypothesis in terms of stock structure?

Dr. Nelson said this may even be a step beyond that because back in the early 80's it may have been Dr. Oxenford's working hypothesis with the work she was doing supported this. Therefore, this isn't just a best guess, there is some evidence to support it.

Mr. Gay questioned if at some point in this workshop we could make some assumption as to where the fish in the Gulf and the Mid-Atlantic region fit in this loop. Because we have not recognized this in the loop and we need to tie it all together.

Mr. Waugh asked the panel if they would fold Gulf fish into this first?

Dr. Oxenford said we could build on this model now in the same way it was put together in the early 80's because we have data now from the
Gulf which was not available at that time. Therefore, we do have seasonality data, mean size, age data, and the thesis which was done in 1988 which provided information presented yesterday on the mortality and growth rates. If someone wanted to spend the time they could be added in and compared to what we already have already and relatively quickly.

Dr. Nelson asked if the sample from Texas were included in the preliminary analysis.

Ms. Wingrove explained she has information from Texas and the Gulf, so she is including the Gulf in her sampling. She noted she is also trying to collect more samples.

Mr. Waugh asked if she was going to sample further up on the east coast beyond North Carolina?

Ms. Wingrove said that John Graves said he would help collect samples off the east coast of Virginia and they will be added in as well.

Mr. Waugh stated Charlie Bergmann said he could help get samples further north.

Dr. Nelson added that we don't have any definitive data and it shouldn't take a great stretch to include the Mid-Atlantic region within the same model produced here. Maybe someone could come up with a hypothesis for something different otherwise these fish would have to fit into this.

Dr. Oxenford asked if anyone knew what the seasonality and the mean size was in Massachusetts because if we knew that we probably could just stick an arrow in there and move it on up the coast.

Mr. Bergmann said that all of New England area doesn't start seeing the dolphin in the coastal areas until the Gulf Stream starts pushing forward to the west. He can arrange for you to get samples from the boats that are fishing the Grand Banks, and as far as the size they catch they are predominately small fish. They are caught inshore as close as 15 miles off the beach and the ones they catch in the canyon are a little larger the closer they get to the Gulf Stream. Also, the season is usually during the summer months.

Mr. Waugh clarified his role as moderator because what the staff is looking for is the information the panel is comfortable in presenting. As council staff we have certain requirements that have to be met within any FMP, so we base our work on the best available information. It may be that if the panel is not comfortable with including the Gulf that when we put together the plan with the management unit in it we would include the Gulf and use the information available to present the best argument. But, here today, he is trying to work with the panel and get what they are most comfortable in supporting. This still leaves us with this issue of including the Gulf and further up the east coast in this model. He asked the panel if they were comfortable with including this?

Mr. Hammond said that in April fishermen in the Keys note a significant migration of large dolphin moving through the straights of Florida heading from the Bahamas. This is a good reason for a tagging program down in this area so we can delineate some of the movements, and it would tie the Gulf into this particular pattern you have shown here.

Mr. Waugh asked if the panel is willing to include the Gulf and further up the east coast or should we just use this structure which has been indicated?

Dr. Oxenford said we are supposed to be putting down research recommendations, since this is what we have and it has been published and sitting there for years. We can decide what is to be done short term and what needs to be done long term, then we could start to build on that model and include the Gulf and the eastern coast. Then the longer term research, which is Ms. Wingrove's work, could be expanded upon as well as the tagging work.

Mr. Waugh read the recommendation, **"to use Dr. Oxenford's work as the hypothesis and as the structure that is supported by the work now. Then we will indicate in research section, both short and long term, information which is needed."**

Mr. Waugh asked what about wahoo, since the have two different views: one that states it is similar to dolphin and opinion is we just don't have enough information at this time to make any decisions.

Dr. Luckhurst said he doesn't think we have enough information to hypothesis anything about possible migrating routes. We need to get others and do some fundamental work. We could start with some development or enhancement of ongoing tagging activities, but until we have some data we are left to just speculate. Given the differences we have heard in life history parameters, particularly with age and growth. We really can't go out on a limb and make hypothesis about migratory routes of wahoo, because it is just too early.

Dr. Nelson concurred that the stock structure is unknown. He suggested there is other additional information that we can get before we bring this issue to the council, such as the tagging. There may be some additional information out there on tags, returns, and distribution data available from some of those sources.

Mr. Waugh said the panel's recommendation for wahoo would be, **"the stock structure is unknown and under research data needs and recommendations what needs to be done."**

Mr. Hinman said we need to keep in mind for management purposes, if wahoo is in this management unit with dolphin we need to be cautious about the hypothesis until the research and information is available.

Mr. Waugh said we have to propose alternatives for the management unit, not necessarily stock structure, but definitely the management unit. We have to have a definition for the management unit and one option would be similar to dolphin. Although he doesn't know what other options we might propose to take out to public hearings. So, in each of these instances we would have to propose something for the management unit. Lacking anything else this is one option, and the only one he can think of right now.

Mr. Campos said he understands there has been several publications on the wahoo fishery in the Pacific because it is very abundant there.

2. Natural Mortality

Dr. Oxenford presented the overhead she has on the dolphin (included in the administrative records).

Mr. Waugh noted that we have made a decision to look at a stock structure that divides these two species and we are more interested in getting parameter estimates that would apply to the group in the South Atlantic area.

Dr. Oxenford said this is correct and we can essentially ignore other areas at this point if we are going with a working hypothesis of the best effort of the stock. The best we have to work with here is the longevity predictions, so you would be looking at about 88% of the fish will be dead within the first year from the North Carolina and Florida work that was done.

Mr. Chapman asked if that mortality rate was unusually high for an organism that grows that fast with this life span? He questioned if these were in anyway influenced by the fishing pressure that is on them. Also, if those numbers are correct and that is the way the dolphin lives are you going to get a statistical difference, something that can be tested with percentages that are going to be 95 plus percent? So, even if there was a difference in the mortality rate would you still be able to tell it?

Dr. Nelson said one way to look at the internal consistency of the information we have is to look at the growth model information that Hazel displayed yesterday, and see if there is a reasonable relationship between the "Ks" and our estimates of instantaneous mortality. They should be close because you can't have a dramatic difference. If there was a way, it would indicate there probably was some glaring problem with the data.

Dr. Oxenford said she has North Carolina information from 1968 by Rose Hasler who noted there is a maximum life span of 4 years, but noted that 96% died before they are 2 years old. She noted in Florida the maximum life span is 4 years, with 98% dying before they are 2 years old.

Dr. Nelson asked if there were growth rate curves for this stock?

Dr. Oxenford said her information is for the Caribbean and the Gulf of Mexico, and presented Table 10 for the Gulf growth curve parameters on dolphin fish.

Dr. Nelson noted from this chart the "Ks" are sustainablely higher for the Gulf than the "Ks" in the Caribbean.

Dr. Oxenford showed the Von Bertalany curve when you have a very high "K" and certainly higher than in North Carolina.

Mr. Chapman questioned that there is data taken from 2 different places, one in 1968 and one 1988, is this correct? He thinks this is pretty scattered both in time and in space, so is the comparison legitimate?

Dr. Oxenford said she doesn't have anything else.

Mr. Chapman said that's correct and it is pointing out one of the needs in the data is to try to get all of these locations collected in the same time frame. He asked what is the annual variation in that growth rate, because you are getting warm water versus cold water. He doesn't know how to interpret this.

Dr. Oxenford said if we are going to get critical about interpreting it we have to look at the size range of the fish that we use to put the data together and take the ones with the biggest size range.

Dr. Nelson said we should look with the scattered information we have where there is consistency amongst the growth calculations, and the "K" factors, and the observed rates of mortality to see if there is some reason to hit on a particular range morality rates.

Dr. Oxenford displayed an overhead with Puerto Rico dolphin ranges on the size of age data, but she noted that we probably won't need this type of level of precision anyway. Maybe something more like a risk assessment or recruitment approach.

Mr. Murray said if you really feel you need to have a an estimate of "K" there is an empirical formula that calculates the longevity of about 2.997 divided by "K". The point is if you use the 2.19 to 2.55 estimates of "Ks," this seems to be consistent with what you have been finding in terms of the age of the fish.

Dr. Nelson said if people agree what we are looking at here it appears to be fairly constant with the 96 or 98 percent mortalities before age 2 then it is probably our best bet. He didn't think the management of this fishery is going to be dependent on yield or spawning stock for recruit type models, the issues will probably be different.

Mr. Waugh said the panel's recommendation will be to, "use these values between 96 and 98 percent dying before age 2. *(use Dr. Oxenford's work as the table 11. mortality estimates for dolphin fish (Corphaena hippurus) from the western central Atlantic dying before age 2 so it would be age 1 plus - total mortality not for this stock)*

Dr. Oxenford noted what we just agreed upon was for total mortality because we don't have that much information on natural mortality.

Mr. Waugh questioned if there was anything else in terms of mortality for dolphin? It not then we can move on to wahoo.

Dr. Nelson said there is very little to say about wahoo.

Mr. Waugh questioned if this was the conclusion for wahoo we don't have the information?

Dr. Luckhurst said this is a reasonable conclusion.

Mr. Waugh said the panel recommendation will be that, **"there isn't enough information for wahoo to make a decision."**

3. Growth Rate & Longevity

Dr. Oxenford presented Table 9, a summary of first year growth rate estimates for dolphin from the western central Atlantic. The documentation notes the species grows fast and then slow down when they approach maximum size of about one year.

Mr. Waugh asked if the panel was comfortable with presenting any growth rates, or should we just leave it as is?

Dr. Oxenford said we can present a range for the work that is being done and possibly take the estimates, they use a wide size range of fish.

Dr. Nelson concurred.

Mr. Waugh questioned longevity? The information presented shows that 4 years is maximum but what you have said is the bulk of the population lives only 1 year.

Dr. Oxenford said it is less than a 2 year life span.

Dr. Nelson said the field data as opposed to the laboratory data for North Carolina, Florida current and Puerto Rico has a range of about 1-1/2 to almost 4 millimeters per day. This is probably a reasonable way to present this.

Dr. Oxenford said this is one piece of evidence that suggests perhaps the Gulf of Mexico fish are separate from the western Atlantic fish.

Dr. Dean said we do have the culture work which indicates the growth is extremely placid, so that food availability could be different.

Mr. Chapman said we have to be careful in over-interpreting that Gulf of Mexico data because the fish there tend to be larger than the rest of the data sets. You have 19 individuals that range from 850 mm and 1.2 meters which is the upper end of their size range and the growth range slows down at maturity.

Mr. Waugh said the panel's recommendation would be to, **"use the maximum longevity of 4 years with most of them dying in less than 2 years and then we will pull an average value from the range of growth rate estimates available, roughly 1-1/2 to 4 millimeters per day."**

Dr. Nelson suggested they don't pay a lot of attention to an average value, although it probably does apply here. This growth is very plastic in particular in the early part of the first year of life where it changes dramatically in response to prey being available.

Mr. Waugh questioned what about wahoo?

Dr. Luckhurst said these are going to be relatively short comments because we don't have a lot to work with. He wanted to go back to a comment from yesterday regarding the preliminary work that he and John have been doing and to indicate at this stage it appears that wahoo are indeed very fast growing. However, we do have more data to be collected before we can come up with some sort of estimate. They are perhaps growing as much as 1 meter in the first year, but really don't know yet.

Dr. Dean said for the sake of where we are now we need to go with values that are in Bill Hogarth's publication and use that as the measure to work against.

Dr. Nelson reiterated that if they could look at some of these tagging sources there may be information on time at large which could be to some relevant to longevity.

Mr. Waugh said the panel's recommendation would be, **"to use Dr. Hogarth's and Dr. Luckhurst's works."**

4. Age/Size at First Reproduction & Fecundity

Dr. Oxenford referred to Table 5 summary of reproductive characteristics reported for dolphin from the western central Atlantic, noting there is a consensus of anywhere from 350 to 520 millimeters and maturing 550 to 600 millimeters. The age maturity estimates range from 3 to 4 months to 6 to 7 month.

Dr. Nelson said in reference to management how big will they be when they start to reproduce and how soon do they start to reproduce in terms of lengths, because management will probably deal with sizes.

The important stuff is there, with the range of sizes of 350 to 600 millimeters, with 50% to 100% maturity, and it is pretty sound information to present to the council.

Dr. Oxenford said males mature slightly larger than females and it should be noted.

Mr. Waugh said the panel's recommendation is, **"the size at first reproduction is 350 to 520 millimeters for full reproduction it will be 550 to 600 millimeters, noting males mature slightly larger than females."**

Dr. Oxenford added in Florida we essentially have males at 430mm and females at 350mm, and the Gulf of Mexico is 530mm for males and 490mm for females. This 100% maturity data is only for females.

Mr. Waugh said in the report then we will only show those separate ranges for males and females for the first reproduction.

Mr. Waugh said then for fecundity he would use those values that we have in the table for Florida and Puerto Rico as well.

Dr. Nelson said it may be worthwhile to use the equation to generate some estimates of fecundity by link sizes to present, because there appears to be some sort of a flexion point there around 7 to 8 hundred millimeters where fecundity really begins to increase dramatically.

Mr. Waugh questioned if we have anything on wahoo?

Dr. Luckhurst said we have a little bit more information but not a lot. Yesterday he quoted some figures from Bill Hogarth's thesis with respect to size at first reproduction, but he didn't' mention they did fecundity estimates, and as far as he knows they are the only ones out here. Some of these were quite impressive. One of the fish he indicated the fecundity for was 45 million eggs, so this was rather a large fish. Although this was based on a relatively small sample size and we do need to continue on with this to have a more comprehensive sampling.

Mr. Murray added that there is nothing yet from CFRAMP, because they have had problems collecting the information. They think they need at least another year before they can start thinking about using the data.

Mr. Campos said he has caught a lot of large wahoo off Puerto Rico's south coast and he has never caught a running ripe female wahoo with eggs, so he doesn't think they are spawning that early. Although he has caught them with gonads.

Dr. Luckhurst said in the same data set he has preliminary data on the weights of ovaries and testis so he can work up some preliminary GSI numbers. Just guessing in those females he saw the GSI will come in around 2 or 3 percent.

Mr. Campos said he will send any information he has from his area.

Mr. Waugh said the panel's recommendation is that, **"we pull the values out Bill Hogarth's work and then also include Dr. Luckhurst's preliminary results."**

Dr. Daniel asked if Bill Hogarth indicates if the fish were total or batch spawners, or was he just doing a gross total fecundity estimate. If so this may need to be addressed.

Mr. Waugh said this is something that will be addressed in the report.

5. Stock Status

Dr. Oxenford gave a presentation on the stock assessment which is included in the administrative records.

Questions and answers.

Dr. Luckhurst concurs we have been very fortunate to date and if he could give advice to the council it would be that this is just another opportunity to be in front of the crisis and get it right. He teaches this and when someone dings the council there is the wreckfish fishery, which this council took action on and maintained a viable fishery for some time now. He just doesn't want to be one of the people that they talk about, such as the tuna biologists and managers as well. He, therefore, agrees with the precautionary approach.

He asked how do you deal with recruitment in the models where you have fish that can reach sexual maturity within it's first year of spawning?

Dr. Oxenford said it is quite possible that a dolphin fish born at the beginning of the season will contribute to the end of the season. But, because they are so highly migratory and seasonal they will not contribute to the data set you are looking at it. It will contribute to some one else's catch. Therefore, she didn't think we had that problem within the one fishery catch data. You may have this problem if you are modeling combined catch rate data from all your states.

Dr. Nelson said we can do it similarly to what we do in shrimp with the time frames, where we use months instead of years.

Dr. Dean said that with shrimp you use size classes as your unit, whereas in this fishery we can in fact put specific age on individuals, so you can really be specific with size at age, better than with most fisheries.

Dr. Nelson said instead of focusing on size of year 1, 2, 3, 4, we would be focusing on months not years.

Dr. Oxenford said they run their catch data analysis, not by calendar year, but by dolphin season, taking data from September through August, so they can keep track of the same year class.

Dr. Cramer said it just may need structured production models to blend itself well to the analyses. It would have more size information to make up for some of the problems of not having the complete information about the capability, and is well worth a try.

She noted she was also instructed to volunteer no work from NMFS.

Mr. Campos said this is a good point that the fish seem to aggregate. In the Dominican Republic they use fish aggregating devices to catch undersized yellow fin and skip jack. This is something that needs to be taken into consideration when we go into the regulations. So, with the tendency to aggregate we could wipe out huge schools of them.

Dr. Oxenford said although they have a very "R" selected biology which would tend to protect them from overfishing, but because of this habit of schooling we could be capable of driving them to a very low number without noticing it.

Mr. David Whitaker, from South Carolina DNR, noted in the stock assessment curve you identified stock in some manner in order to do the plotting, so you do have some estimate of what the stock is. If your stock is moving and migrating up the coast, growing and spawning further north, then it would seem those fish would be the most critical stock. We do know Virginia stock is smaller and perhaps 2 months old, spawning off North Carolina or Florida. He asked her to comment on the initial spawning stock and are those big fish coming back around?

Dr. Oxenford said we have to make that assumption that the large fish are returning otherwise the geographic location of a population would move at every generation.

Ms. Hass questioned, because of these aggregations would she say longlining as a gear type may cause a problem? It is her experience over the last 4 or 5 years when they come up to a weed line were the dolphin often aggregate, this is exactly where the longline has drifted to. The longline will stay with the weedline for an enormous amount of time and this would hit an aggregate easily.

Dr. Oxenford said certainly the longline represents a fairly heavy fishing effort, where fishing boats with one or two hooks out and a longline vessel would have 2 or 3 hundred hooks out. If they happen to be associated with weedline then it is a very efficient way to take the fish. The more dangerous approach would be to actually set the longline and to set artificial weedlines attached to it. and it would be an extremely efficient way of taking dolphin because it doesn't take more than 12 hours to start aggregating.

Dr. Dean said the Japanese have been using a technology for dolphin where the trawlers will go out and drop plywood sheets and run a small purse around them when they come back. It is a very effective fishery. Incidentally the value of this fish is one of the lowest valued fishes in Japan. They are considered a trash fish and often times they don't fish because the market value doesn't justify bringing the fish in. Also, there is no recreational fishery there.

Mr. Hinman said after hearing an excellent summation of why we need to take a precautionary approach in holding the stock status quo, so we can have a healthy fishery. A lot of them feel without early action an opportunity may be missed. The main reason this opportunity may be slipping past us is that the public doesn't have much confidence in the catch numbers. So, if you are capping a fishery at status quo people will argue those numbers aren't real because they catch more fish, and then this becomes a real issue.

He questioned how strong our information is here in the US is but this one thing we need to look at and be able to sell these numbers as representative of the fishery. If not then we need the absolute numbers that are being caught. Then there is the problem of shares and who is going to be locked into this share of the resource for an indefinite period of time.

Dr. Cramer said we can get a good handle on commercial, in particular longline catches of dolphin, because we do have good records of that. It will be harder to get a handle on the recreational catches. The fear here is that the commercial will expand, however, this is not the same feeling for recreational fish, and we may then be in pretty good shape..

Mr. Waugh said the panel's recommendation is, **"this overview will go into the report as an indication of what we think the current status is, recognizing that we do have the different groups as well as the panel's recommendations."**

Wahoo

Dr. Luckhurst said this will be the same in all the other cases. He asked Peter if there were any plans in the CFRAMP framework to attempt stock assessments for any of the highly migratory pelagics in the region.

Mr. Murray said yes, one. There is an approach they have in mind for this, but the big problem is the information data. When we get to the section on management which is essential to any attempt to sustain the fishery and that is the interaction of the fish and the social consideration that may go outside the scope of biology. From what we have seen there, the biological situation, even if we assume for the sake of argument, that wahoo is on the same lines as dolphin, then the biology may not look as bad even when you have the information. So, you are talking more social and economical factors, than fishery management.

But, to answer your question, yes there are plans to do a stock assessment by the end of the next year and also when the funding starts to wind down he believes they won't have enough to do anything.

Mr. Waugh said then the panel's recommendation is, **"that it is basically unknown at this time and we are just collecting data."**

6. Data Collection & Research Needs

Mr. Waugh said when we talked about stock structure we talked about short and long term data. Short term was looking at some of the data and work that has been done in the Gulf to see if this fits into the model we are using for stock structure now.

Then long term, in terms of stock structure, is the issue of designing genetic work to get at it in the genetic structure? There is some work which is on going now.

Mr. Murray said in looking at how the Gulf data fits into the model we are using, he thinks there is another problem. The fish are being caught north of North Carolina and there is a question of how it will fit into the Gulf model.

Mr. Waugh noted the reason the Gulf was specified was because we do know there is some information available now which could be looked at relatively quick. He didn't know to the extent you have the same information because the seasonality information should exist from north of North Carolina as well. This information can be brought in the short term information as well.

Dr. Dean said this is early in the game and what he would like to see presented here is an opportunity to use the studies which have been done already. If they point us in the right direction and we can build on them.
However, this is a case with the nature of this fishery, that the studies need to be well integrated and coherent. Samples collected over time and space are very important and we can maximize the material in the sampling if we did an appropriate plan. Perhaps we can pull a group together and actually work on a coherent research program for dolphin and wahoo, although this isn't possible today. Therefore, a serious workshop specifically on a coherent integrated research plan is appropriate and everything you say for dolphin, which is the highest priority, you can turn around a duplicate for wahoo. You may even be able to fold these two together.

Ms. Wingrove concurs, that this really needs to be more of a wide scale project, as opposed to her smaller one. She is trying to collect as many samples on her very limited funding, because she only gets graduate student grants. However, the needs of this stock identification are much larger than what her little sampling regime can provide, even though her sampling results can provide some good information, it just can be relied upon.

Dr. Oxenford concurred with John and Robyn. She believes the time has come that we should form a working group of scientist, like ICATT, but let's do it before ICATT does and keep dolphin here. There has been a precedent set already and there has been some very successful work done already with conch, and she would really like to see the same approach with dolphin and wahoo.

Mr. Campos added Brian and Gregg are on the GCFI Board and maybe by November we could have something going. We could get all these island nations around the Caribbean and we could really start to do some fantastic work on Mahi and wahoo.

Mr. Waugh noted that Dr. Oxenford is on the board as well and this is something we started through GCFI for other species, i.e., spiny lobster, so this is certainly a vehicle.

Dr. Oxenford displayed a chart of all the current organizations who are doing cooperative research or management. They are a mess because all these organizations don't include the countries that are relevant to the particular species we are looking at.

Dr. Nelson said it is obvious the type of research we need but there are things we need to try to get that are available out there, i.e., tagging. Most of the tagging that is being done haphazardly and then it only gives us a little idea of what is going on. Additionally we should check the studies from the Gulf longline, on the catch percent, percent dead or alive, size distribution, because there may be some information there that they may want to share with us.

Mr. Jepson pointed out when forming this group, the council does have the capability of setting up a list server for e-mail services. This would make it very easy for a group of people to correspond and the council could offer this for the group to begin. We also have the capability to set up a web site for people to go and get more information. He hopes that some of the work that comes out of this workshop will be put up on the council's web site and will be easily accessible to a lot of people. If you want to take this a step further to put data there it can be done, however, the council staff does not have the time to develop and implement this type of work. If someone has a graduate student who would be willing to work on developing a web site the council would be grateful.

Mr. Waugh concurred and pointed out that there is a list of attendees on the back table and one of the things we have asked for is everyone's e-mail address. He asked everyone to look at that list and check the mailing address.

Dr. Oxenford said she isn't knowledgeable at getting funding but if we form a cohesive recognizable group then our access to funding would be greater.

Dr. Dean said if you could put a group together to seize and control the initiative at this level then it will ultimately be an ICATT agenda item because of straddling stock. This will be the table at which all fisheries in the Atlantic will be discussed, but it would be to our advantage to have control of the issues and the agenda at our level and then we would be the ones to take it to ICATT. So, there is a real tactical strategy in doing this in addition to doing the best kind of biology available.

Dr. Daniel said he wanted this group to be aware of the proposal which was submitted to MARFIN as a cooperative joint effort between Georgia, South Carolina and North Carolina, with South Carolina being the PI to examine otolith scales, etc., for dolphin, to identify the best structure and most practical method for age determination to generate sex and gear specific age link keys, etc. To provide all this data in a timely fashion to NMFS and South Atlantic Fishery Management Council. They would like to look into the assessments and management models for these pelagic fisheries that are dominated by a single year class. He would like to get an idea of what the panel is feeling about this type of research and if it would be of value.

Dr. Nelson said all agreed it would be valuable.

Mr. Waugh asked if there were any other items to be listed under data and research.

Mr. Hinman said one data need which occurred to him which also relates to the other research projects and the issue of funding them, to get funding for the research you do you have to prove: people want it, they care about it, and you may include research in social and economical value in the fishery. He believes it is quite valuable particularly to the recreational fishery and also to the traditional commercial fishery in the southeast. South Carolina probably has some information and maybe can coordinate something on this, but having this information would be valuable in putting together the management plan and in making the case to justify expenditures for dolphin research money.

Mr. Murray said he disagrees. Very often when social and economic are clumped together, as one entity, they can have two very different impacts on a fishery. Therefore, we need to look at social and economic separately.

Dr. Nelson said that is a point well taken but he agrees with Ken. All of us who have been involved in the process realize that increasing need and credence given to that sort of information. He suggested in this report we put some small part to deal with some of the trophic work that has been done in terms of dolphin. At least the food habitats. There is direct relevance with the new emphasis on critical habitat and a lot of this information describes a very clear link between dolphin fish and the floating sargassum and other types of substrates. Also, within the plan we need to start paying more attention to these types of linkages. It is going to be very important to us to start looking at these individual species and their prey as well as what is eating them. It is the beginning and the foundation. It also contains answers to several popular questions that will be interesting to people, i.e., fecundity by dolphin on billfish.

Dr. Oxenford showed an overhead on the frequency of occurrence in the diet, Table (b), which summarized the top 5 ranking fish in the similarly numerical abundance.

Dr. Cramer said we need to go one step back and mention oceanography.

Dr. Oxenford said there was a paper published in 1990 which attempted to explain the annual variation on oceanography.

Dr. Cramer said she would suspect this is very significant with dolphin and wahoo.

Dr. Oxenford said yes, he explained 27% of the variability.

Mr. Waugh said we have a Habitat Plan and a Comprehensive Habitat amendment which will be submitted for informal review and public hearing within a week or two. It will carry an extensive discussion of the interaction of dolphin and their habitat. Along with a designation of essential fish habitat for dolphin.

7. Annotated Bibliography Dolphin

Mr. Waugh add that Dr. Dean has 2 students who are working on this and we have a draft of the papers they have accumulated thus far. He has made copies of this list to be handed out (copy included in administrative records). If you have additional information we will be setting up this list server where it can be added.

Dr. Dean said this was a quick scan and the trick now is to find some of the reports that are not in cited literature to bring to the council for their deliberation. Also, getting copies of the material was also more difficult than getting a citation.

SESSION IV: DESCRIPTION OF CURRENT MANAGEMENT PROGRAMS & MANAGEMENT ISSUES (Moderator - Mike Jepson)

Mr. Jepson gave an overview on the description of current management programs (copy included in the administrative records).

1. **Dr. Russ Nelson, State of Florida** said in 1988 the Marine Commission in Florida began to look at the dolphin in Florida and decide there were some slight problems which could be dealt with through management. They were armed with the work from Dr. Oxenford and others. Their concern was not over recruitment, although there could possibly be some potential for overfishing, this was not their main concern. Primarily their concern was that fish occur throughout the Gulf coast and the east coast with pulses of dolphin moving up the east coast of Florida, passing through the most populated stretch of urban

coast area of the US. They were subject, when these pulses came through to heavy recreational fishing as well as heavy commercial fishing. After looking at the data on landings, anecdotal information from fishermen one problem seemed to be that they were intercepting a lot of these fish and fishing them off as they moved through Florida. This then decreased the opportunity and the availability and access to the fishery from up north to the Palm Beach, Cape, and the Jacksonville area. There was also a conservation issue where many people felt there just wasn't any reason for people going out and catching, literally garbage cans full of young schooling dolphin. Therefore, they proposed a number of options for the Commission to deal with; size limits (24 to 30 inches), potential commercial quotas, and recreational bag limits. Ultimately, in 1989 they put a plan into effect which established a recreational bag limit of 10 dolphin per person, without a size limit; and a commercial minimum size limit of 24 inches, which is at 100% maturity. This is still in place today.

He noted the commercial fishery at the time was dominated by landings from charterboats fishing when they did have passengers with occasional longline landings coming from the longline fleet in Florida. They have revisited this issue once or twice and the recommendation the Commission has followed is to move to do something beyond the State of Florida through the council for a regional plan.

Mr. Bergmann asked regarding the size limit of 24 inches was there a basis for this?

Dr. Nelson said no, in looking at this 24 inches was above the 50% maturity level. They did look at 30 inches but ultimately decided to go with the lower size limit because of concerns that if you reach a certain point dolphin become much harder to handle and release alive.

Mr. Bergmann asked if there were any recreational size limits?

Dr. Nelson said no, what they proposed was trip limits for commercial and recreational, but there was strong arguments on both sides about the limits.

Mr. Wayne Waltz, SC DNR asked if there was any information on hook and release mortality with that 24 inches?

Dr. Nelson said they have good information for things like king and Spanish mackerel, the same size, and the Florida release survival rate is up to 12 hours while they do the sonic tracking in excess of about 85% for those other fishes, which are similar. Although he is not aware of any release information which focuses on the dolphin. From his personal experience and professionally he believes that dolphin are somewhat susceptible to a lot of problems associated with release, as in the Spanish Mackerel. He has tried to keep both fish alive when he has tried to bring them back to the lab, and it is easier to keep the dolphin alive versus the Spanish.

2. Ms. Susan Shipman, State of Georgia

Mr. Jepson said Ms. Shipman was unable to attend this meeting, however, she did pass on Georgia's information for an 18 inch size limit for dolphin (recreational/commercial), also a 15 fish limit per person bag limit for dolphin at this time.

3. Mr. David Cupka, State of South Carolina

Mr. Cupka stated that South Carolina has no state laws currently for dolphin or wahoo, in regard to size or bag limits. There was a bill introduced last year which would have given their department authority to set size and bag limits for about 12 species, and one of those would have been dolphin. This bill would have allowed the department to set size limits at 14 and 24 inches, with bag limits at 5 and 20 dolphin fish. However, this bill did not pass the legislation because they didn't want to give the authority to the departments. Interestingly enough, there is a law on the books called, Federal Consistency Law, which makes it unlawful to possess, or land, or sell fish at less than a minimum size limit. It is set in accordance with tolerance limits established by federal regulations under SCMA. So, on the one hand while they don't want to give us authority to set size and bag limits, then on the other hand the law on the books states that once the council takes action in regard to size limits, those will automatically become state laws. He really doesn't understand the rationale for this, but nevertheless this is law.

They also have the authority from the legislators to propagate legislation or actions taken under SCMA, but in South Carolina it is more difficult to get a regulation through than it is to get a statute through. So, once the council takes action on having a size limit then South Carolina will automatically have a size limit because of this law.

They did consider a bill this session which looked at just dolphin, but before they could move ahead with it they wanted input from the fishermen. Once they got this input they wanted to pursue the development of that legislation through the Marine Advisory Committee, however, they haven't gotten to that point yet. They do have a MAC meeting tomorrow and will be giving them an update. He noted they have done a survey with the Saltwater Fishing Clubs in South Carolina, and a good portion of the charterboat captains who restrict their fishing activities offshore were able to respond to options relative to things like size and bag limits. He said Don Hammond from the SC DNR will be presenting this information at this meeting. Although it is a little late in the session to try to get anything through the legislation right now, and this year has been a little crazy with video poker machines, etc. However, there are a lot of people in South Carolina who want to get something in place right now, they don't want to wait to go through the council process which will take awhile to get in place.

In terms of data available now, we do have a tagging program ongoing for quite awhile but not really focusing on offshore pelagic fish. Just this last year the tournaments have encouraged the sport fishermen to do tagging of pelagic, like dolphin, wahoo, and tuna, so we are just now starting to get into this. Back in the early 70's when we were creating our saltwater sportfishing program he met with Graham Beardsly where they established a program which is still going on to this day where they sample certain tournaments (6). They do this to get catch and effort data on offshore fish, and they are primary billfish. This will be a long term data base they have, which goes back about 25 years. Also, early in the 1990's they put into effect the saltwater fishing stamp and under the provisions of that was to require mandatory logbook reporting by charterboats and headboats. To avoid duplication they just tacked on to the NMFS's survey where they actually collect the information and provide it to NMFS and South Carolina. More importantly they now have a data base they are building where they are looking at charterboat catches and it is a lot better data set than looking at some of the tournament data. They have about 5 to 6 years worth of data, and they had a couple of staff people look at both data sets, tournament and charterboat data, for things like: size of fish taken, the number of fish taken to see if a bag limit would protect or impact those trips, etc. He said this will be covered more in Don's presentation on the results of these 2 data collection programs.

In terms of management issues and in his position he has had the opportunity to talk to both the commercial and recreational fishermen as well as sea food dealers, and they have told him that some of these issues are more perceived than actual issues. As many of us in the management section know perception becomes reality pretty quickly and you just can't afford to avoid some of these issues. But, some of the concerns he has heard from these different constituent groups include targeting of dolphin from longliners and there does seem to be a switch now where we are getting more specific targeting of dolphin by some of the people who traditionally fished for swordfish.

Another issue is the large commercial landings of dolphin both in terms of trips as well as total landings, and his people get very upset when they see a longliner come in with extremely large catches of dolphin on their boats. There seems to be an increasing dependence by longliners on mixed species trips and this has happened because swordfish catches have become more of a problem. Some of the commercial people are willing tell you that it is becoming more of a mixed species trip situation and that they are depending more and more on dolphin to have a viable longline fishery. He stated in the swordfish fishery that efforts are being taken to decrease the number of permits in those fisheries and some of those permit holders are doing nothing more than speculate. However, some of those permit holders in the swordfish fishery have the potential to go out and longline for species like dolphin.

Of course there is displacement from other fisheries such as the snapper grouper fishery after we put the limited access in place. Therefore, those boats will be looking for alternatives and one is pelagic and perhaps longlining. So, there is a lot of concern about increased fishing in these fisheries.

There is also the problem that this fish tends to aggregate and it lends itself to a situation where potentially you could have some localized depletion of fish. A lot of recreational fishermen he has talked to are in favor of bag limits and want to put a limit on their industry if terms of catch. However, they are only interested in doing this it commercial harvest is limited as well with trip limits, or a quota invoked in the commercial sector.

There was also concern about the sale of dolphin fish by recreational fishermen and what this does to the local markets, etc. As well as occasional large catches of small fish by recreational fishermen and this is certainly one of the issues that something such as a bag limit would help address. If you look at the data they have, a reasonable bag limit would not be exceeded on most trips, but there are occasions where boats do get into large numbers of small dolphin and sometimes catch large numbers of them.

Also, there is a concern from the recreational fishermen over the harvest of sargassum and at the last council meeting we spent a lot of time trying to define EFH, and trying to minimize the impacts on EFH. We voted to move ahead by not allowing any harvest of sargassum. Currently there is only one company who is harvesting out of North Carolina, but there is a lot of concern that a fishery or harvest on sargassum could develop. He noted that sargassum is an important habitat for dolphin.

Also, the lack of knowledge on the status of the stock because we really don't know how many fish are out there. He believes the SAFMC has taken a very pro-active stance in regard to dolphin and wahoo. He said he attended council meetings for years before he was appointed to the council and he can remember a time when NMFS wouldn't even address a fishery or develop a fishery management plan until it was actually in trouble. Thank God those days are gone, and we are now trying to be more pro-active and risk adverse. Although dolphin will be harder to overfish than some of the other species it can be done just like in other stocks. So, you have to look at the records in regard to what has been done in other fisheries, and why we are trying to be pro-active in trying to get ahead before we get into a situation where there is a problem.

He wanted to go into the impacts of imports on fish prices. There is a lot of Mahi imported into this country and there was a presentation yesterday which showed how much fish is coming in. Since there are a lot of fish coming into this country it does have a big impact on the prices here. Then the prices go down to the point fishermen refuse to catch fish because the prices are so low, about $1 per pound or less. This is a concern to the sea food dealers, etc.

4. Dr. Louis Daniel, State of North Carolina

Dr. Daniel said the dolphin issue has come up recently in North Carolina and it is a hotly contested and controversial issue. For a number of years they have had a recreational bag limit of 10 fish per person per day and a 60 fish bag limit on charter vessel per person per day. However, they don't have any size limit.

One issue that has come up recently is the concern which was generated by the South Carolina Issue Paper on bycatch, principally billfish in the longline fishery, which was presented at the Charleston public hearings. Also, overfishing, conflict and competition between fishermen. He wrote an issues paper (included in the administrative records) which notes the billfish bycatch doesn't appear to be as critical a problem in the southeast coastal area as we had thought previously. Secondly, the overfishing problem seems to be probably a long shot, so the principle issue appears to be conflict issues between recreational and commercial fishermen.

He referred to his paper noting the effort on all the highly migratory species has gone down fairly dramatically since 1995. The efforts on sharks, snowy groupers and swordfish have basically been cut in half since 1995. The dolphin trips have declined since 1995, from around 230, which was the highest reported by longline to 112. So, we are seeing the catches fluctuate just like the information Hazel showed. He noted that fishing can have an impact on this, but he believes it is impossible to overfish dolphin, or anything else. The principal issue they were dealing with, and the real conflict issue when dealing with the longline information from 1994 to 1997 they definitely saw a dramatic increase in the number of directed dolphin trips that were landing significant and large catches of dolphin. In 1997 there were 1,504 trips that landed dolphin to sell, 7 trips had greater than 2,000 pounds and those 7 trips accounted for 48% of the entire commercial landings for the State of North Carolina. The catch rates were 20 to 25 to 30 thousand pounds per trip. So, it shows the possibility or propensity for a developing directed longline fishery for dolphin is there and it is possible to go out and catch tremendous numbers in a generally short period of time. Based upon this information and discussion on different management options they decided to wait. They are now going to go out to pubic hearings and have published a notice of intent to go to a permanent rule which would require a 2,000 pound trip limit on the commercial dolphin fishery in North Carolina. This would impact less than 1% of the entire commercial harvest of commercial catch of dolphin.

He explained the fishery occurs from April through August with the peak being around May, June and July which is consistent with biological information on migratory behavior. They will be going to public hearings very soon on these issues and it will be interesting to see what his state decides to do. Clearly it does appear there is a very real likelihood that very large numbers of dolphin can be caught with longline gear. A trip limit may be the only way to go to maintain the historical allocation between commercial and recreation fishery.

Dr. Dean questioned the 60 fish on charterboats when those fish come where do they enter the catch column? Are they recorded as recreationally caught fish?

Dr. Daniel said yes. The fish that come in on the charter vessels are basically subject to the MRFSS information. However, his concern is that a lot of those fish are sold because the clients generally don't take 60 dolphin away with them when they leave. Many times those caught fish are used as tips for the mates and then they sell those fish. So, they may be double counted.

Dr. Dean asked if it is possible for the boat and crew to sell those fish?

Dr. Daniel said yes, if they have a commercial fishing license and endorsement to sell. There is a moratorium on those licenses right now.

Dr. Dean asked if the charterboats in North Carolina switch back and forth from recreational to commercial?

Dr. Daniel said yes, some do.

Mr. Chapman questioned when North Carolina puts in their trip limit you said it will effect less than 1% of the commercial harvest, is that true?

Dr. Daniel said that is correct from the trip limit information they have in 1995 where they had 26 trips which landed over 2,000 pounds, 8 in 1996 and 7 in 1997. But, those few trips landed almost half of the entire commercial landings of dolphin in North Carolina during those years. Therefore, it shows that we would be cutting commercial landings in half by having this 2,000 pound trip limit. However, we would still be able to allow the traditional fishery which has been trolling and rod and real gear to continue to land what they have historically caught. Generally speaking you don't see trips much over 2,000 or 2,500 pounds for dolphin with rod and real gear. However, with the longline what we have seen is the maximum trip in 1995 was about 10,000 pounds with surface longline. This stayed about the same for 1996, but jumped up to 28 to 30 thousand pounds in 1997. So, it does appear that we are seeing a directed longline fishery which has the capacity of taking large numbers of fish.

Mr. Chapman said he didn't understand how a trip limit would be able to reduce the commercial harvest.

Dr. Daniel said if the vessels can't go out and bring in 2,000 pounds per trip, this would limit them.

Mr. Hammond asked if there was any way of telling whether the big trips of over 20 to 30 thousand pound trips were made by resident longline vessels or transient vessels?

Dr. Daniel said for 1995/96/97 time period that approximately 50% of those catches were made by outstate vessels and 50% were made by local longliners. A lot of the effort is coming from New Jersey and New York boats, but they didn't' see any Virginia, South Carolina or Georgia boats.

Mr. Mickey Scott, Marine Advisory Committee in South Carolina, questioned the 1,500 trip were not just longline trips they were total trips which were listed as commercial.

Dr. Daniel said that was correct, of those 1,500 trips 1,400 were hook-and-line, and about 100 of those trips were longline trips.

Mr. Scott questioned since North Carolina has the intent to put a trip limit on, what then is the process which will occur now.

Dr. Daniel said he presented this information to his Finfish Committee which is a subset of their Marine Fishery Commission, and they voted 4 to 4 not to do anything, so the tie is a loss. The Commission deemed it prudent to go forward and recommend the 2,000 pound trip limit, so they will be publishing in the state register an intent to go to permanent rule on the 2,000 pound trip limit. Then we will go to public hearings and after receiving public comment will vote on this permanent rule. If this then goes into effect there will be 120 day cooling off period, after that point it will become a rule.

Mr. Scott asked if it then wouldn't have to go through the North Carolina Legislators office?

Dr. Daniel said no, not in the North Carolina system.

Mr. Gay said it is important to have this on the record correctly, some of the information you presented to the committee on some of the bycatch and mortality which had been mis-stated at their meeting.

Dr. Daniel said in this issue paper he handed out he hoped it was clear that there are a lot of unknowns in this fishery which is relatively new and developing longline fishery. He noted they really don't have the observer data to say what is the bycatch in this fishery. The incidental reports from fishermen have said it is primary dolphin that are being caught in this gear. It is shorter gear and fished for a shorter period of time and generally quick sets, usually 4 or 5 sets in one day rather than long standing sets. Some of the information presented in their previous paper had transposed columns in the NMFS logbook and observer data and it indicated that about 70 to 80 percent of the billfish that were discarded were discarded dead, when they were actually discarded alive. So, when breaking this landing information down, there were about 218 blue and white marlin and sail fish which were discarded dead in this southeast region in 1995. Therefore, this discrepancy has been corrected by the primary author and himself.

Mr. Bergmann questioned he had indicated 218 billfish were discarded dead, was this in the dolphin fishery or all the surface longline fisheries?

Dr. Daniel said this information was from Dr. Cramer's report and he assumed this was from all longline fisheries.

Dr. Cramer said this is correct as reported in the longline fisheries.

Mr. Bergmann asked if this was from the Caribbean, Gulf of Mexico, and the Atlantic?

Dr. Cramer said you are probably looking at the southeast coast from Key West to Hatteras.

Dr. Daniel said this information is from 1995 which is the most recent.

Mr. Rhodes asked, in your opinion, are the dolphin that come in on the charterboats a large percent of them being sold?

Dr. Daniel said he couldn't hazard a guess as to what is kept or sold.

Mr. Rhodes said from his observations in South Carolina he would assume it would be a fairly small percentage that gets into the market channels. Especially if the mates will clean it for them and they will give them tips for doing this, because they do like to take the product home. Now it may be different in the Keys, etc.

Dr. Daniel said a lot depends on the magnitude of the catch because if they only bring in a couple of fish then they would take them home, but if a six pack brings in 60, 10 pound fish we have information that say they don't bring the fish home.

Mr. Rhodes noted there may be a lot of variability between the different regions and states on this and he is talking about the full charters where they take 30, 40, 50 fish and those people do want the fish.

Mr. Gay said in Carolina Beach, which is his closest neighbor and the third largest fleet in the state, they are now charging 50¢ to 60¢ per pound, depending on the boat, to dress their fish instead of depending on tips. Therefore, they have already been paid to take the people fishing and they have a lot of fish they are starting to add up a large bill at that point, so there is a lot of encouragement by them to leave that fish as a tip, where they do get sold at that point. However, he really didn't think it was a large percentage of the catch, but it does occur.

Mr. John Tortorici, a local distributor with Lowcountry Lobster, noted that based on his experience since they buy fish from the charter boats as well as the commercial boats, what they see is the charterboats come in on a regular basis and sell fish into the distribution chain to distributors such as himself. There are fishermen who run regular routes from Columbia and other places in the state to come down to meet those charterboats in order to buy that catch. There are also people on those boats that go out on the boats on a regular basis and this is how they make their living. They go out on the charterboats and catch fish then come in and sell them to distributors. He isn't sure of the percentage breakdown but there is no doubt they rely on that part of the industry to supply fish for them to distribute.

He said that North Carolina wanted to put on a trip limit, in order to keep the distribution of commercial and recreational fish percentages in line, and he was wondering what those percentages are that we are shooting for to keep in line?

Dr. Daniel said what they have seen in North Carolina is the commercial catch has been historically about 10% of the North Carolina harvest. He is not pushing any of these things right now, and is glad their Commission acted as they did to first go to public hearing and get comments on these different issues. He was just speculating as to the reason some of the Commissioners took the action they did.

As far as the bycatch and the overfishing condition is concerned, he thinks this issue is one of conflict, and anything can be overfished, so we do need to take the cautionary approach. What a lot of the people are seeing and hearing from public testimony is that this is a conflict, a competition from the charter vessels who are going out to the weedlines where the longlines are set, and they don't want to see them there. This fishery has historically been a recreational fishery and they want it maintained as a recreational fishery. He has heard, correctly or incorrectly, a lot of analogies to amberjack, for example, where this fish was mostly a recreational fish in Florida and has now become more commercial. The recreational fishermen just don't want to see this happen with the dolphin fishery. So, by putting this 2, 3, or 4 thousand pound trip limits on this fishery you may be able to cap effort, or at least those people who want to go out and set specifically for dolphin, catching large qualities.

Mr. Tortorici asked if those trip limits take into consideration the type of local vessels who are in those markets? Or, what the economics are there in terms of what is a break even trip based on average market prices, or is this arbitrary?

Dr. Daniel said he didn't believe this was arbitrary because we are talking about 23 to 38 trips over the last 3 years for longliners, which is about 12 trips per year that landed over 2,000 pounds. His primary concern and his urging to take action was to show that this has solved the problem they foresee and they could somehow help this process along within the SAFMC and some of the proposed options in the option paper for the council. He believes that some of the options in the proposed option paper are too restrictive on the dolphin fishery, such as no sale over the bag limit, but he does see this historical fishery with the historical participation and it is a very lucrative fish for the trollers and the rod and reel. So, what they are trying to do is not to impact any of the historical participation in the fishery, but to simply curtail any development of a new fishery.

Mr. Tortorici said his question was would it be economically feasible for the fishermen with a 2,000 pound trip limit to become non-profitable, then forcing them out? They wouldn't have this livelihood, thus decreasing the commercial catch, and then distributors, such as himself, would lose that source of domestic fish. He doesn't know the answer to that question, he is only asking because he doesn't know what the expenses are above what it would be to become a non profitable fishery. He just doesn't want to drive all these fishermen out of that line of work or lose that commercial fishery as a source of revenue and food in the distribution market for the state. Also, the distributors like himself would lose the local trade.

Dr. Daniel said if you are looking at a historical fishery where there were a lot of people going out and targeting dolphin, catching 10 to 20 thousand pounds per trip for 5 to 10 years, then yes he was correct in his statement. However, this is not what is happening here, it is a new fishery and there isn't anyone out there who is solely dependent on dolphin. Historically, it has been an opportunistic fishery where fishermen were out trolling for king mackerel, for example, and ran across dolphin. The majority of the trips, 95%, in the last 3 years have been less than 500 pounds. So, basically we are talking about an extremely small participation in any kind of directed dolphin fishery. Although this data does show a directed longline fishery could have a significant effect if it were to increase. It will be up to, first the North Carolina Marine Fisheries Commission, and then this council to decide what type of allocation is necessary or wanted by the majority. Also, what will be the best thing for this resource.

Mr. Tortorici said there has to be some type of balance which will work for everyone because of the situation with the swordfish. These fishermen don't make a year round income anymore based on swordfish, plus there are closures and quotas on the swordfish. So, when you say no-one makes a living with dolphin you are probably correct, but it has become part of the mix when they need that revenue or they won't be in business. This is just the state for a lot of those guys out there that he hears and talks to.

Everyone is piecing and pulling the data together to try to come up with a comprehensive plan, but at this point in time the dolphin fishery, for a certain amount of the guys is the difference between making it or breaking their backs.

5. **Mr. Jose Campos, Caribbean Fishery Management Council**

Mr. Campos said in his council's jurisdiction of St. Thomas, Puerto Rico, St. Johns, St. Croix there has been a traditional recreational fishery for Mahi ever since he can remember. They had a longliner problem of invading their waters back in the late 70's and early 80's, catching, without reporting lots of Mahi. After the majority of them left for greener pastures in the Pacific, South America, and fishing beyond our EEZ they are no longer fishing close to the council's jurisdiction. In Puerto Rico it extends 10.35 miles and the US Virgin Islands the usual 3 miles.

In St. Thomas they have management problems which are caused by the charter fleet catching lots of Mahi. The traditional small scale artisanal fishery that can't go out 20 miles on the north slope being limited to what they can catch Mahi wise. But, the charter boats come in with lots of Mahi and sometimes they flood the market and that market is limited, mostly to the tourist trade, hotels, white table cloth restaurants, and wholesale distributors. The main issue here is there is a conflict between two user groups, the small scale fisherman who is limited because of the size of boat they are using and the highly solicited charter fleet.

St. Croix has a small directed small scale artisanal fishery and the conflict there is not as much as the one occurring in St. Thomas, due to the fact that the charter fleet in St. Croix is limited. Their season starts around late November with the peak of the season around late February or March.

Tournaments are held on the north coast of Puerto Rico with 3 being held on the south and southwestern coast of Puerto Rico. Tournament results for the north coast showed somewhat larger fish but fewer fish. However, with the southwestern tournaments the results showed lots of smaller fish but very few large fish. He stated he wasn't aware of any Mahi/wahoo tournaments being held in St. John's, St. Thomas, or St. Croix. The tournament results in 200 to 250 fish caught, mostly on the south-southwest coast of Puerto Rico, the average size is about 12 pounds. However, on the north coast there is only 1 tournament and the tournament results show that size fish are healthier, larger fish of about 22 pounds. The majority of the fish that are caught are females and they all have ripe eggs. The tournament gear is 50 pounds and this will be changed to 20/30 to make it more of a sporting event instead of a killing event as he defines it now.

All of the fish are heading west after coming in from the east and followed by the man-of-war-birds as usual. The smaller fish have a tendency to aggregate in the weed lines and in the black garbage bags, and they have never caught anything around white floating objects. The contents of the stomachs of these fish shows flying fish, file fish, and small squid, about 1 inch in length. Aggregations around these floating objects cause slaughter by the recreational fishermen, because when they find an aggregation they will stop their boats and start chumming. Recreational fishermen preset their fishing equipment with small leaders about 1 to 2 feet in length, rigged with cut bait and will bring in anywhere around 150 small fish.

He is not very well liked at home because he tries to talk sense to these fishermen. Also, these recreational anglers are selling their fish and this is unfair competition.

They have a difficult time with the tagging programs because it is such a lively fish, that when you get it along side to try to stick a fish it is very difficult. Especially the small ones of about 10 to 20 pounds. He has tried to use a dehooker and it works very well, but it doesn't work too well when the majority of the fish are gut hooked. The majority of the fish they catch using ballyhoo are gut hooked, so they are having trouble releasing fish. When they use artificial bait the majority of the fish are caught in the jaw and then they don't have the same problem. They only use one hook which is at the end of the lure. Also, Mahi has a high economic value and this is a fish that will sell with it's head on for $3 per pound. So, when you have that high economic incentive then that tagging program will not be a success.

Puerto Rico has a management plan for swordfish with a provision that only allows a longliner to land 5 fish as a bycatch, 5 Mahi and 5 wahoo, so they shouldn't have a problem with this. Also, they have to have a commercial fishing license from Puerto Rico as well as paying income taxes. So, recreational fishermen in Puerto Rico and the Virgin Islands are selling their catches but this can be taken care of by local laws and regulations. Therefore, this is not a management concern to them.

He noted that incidents of histamine poisoning are frequent because of the poor handling of the fish.

6. Mr. Rick Leard, Gulf of Mexico Fishery Management Council

Mr. Jepson said Mr. Leard is here from the Gulf of Mexico Council but didn't have anything additional to add to what has already been discussed because this is a jointly managed plan.

7. Mr. Charlie Bergmann, Mid-Atlantic Fishery Management Council

Mr. Bergmann noted that the Mid-Atlantic Council has supported the South Atlantic Council's request for developing a management plan for dolphin/wahoo. Currently the Mid-Atlantic Council has no regulations on either of these species, however, they do have concerns predominately dealing with the potential size limits and bag limits that the recreational fishermen are going to have to contend with in the Mid-Atlantic region. These fishermen have expressed these concerns and felt they the one way they could help was to have a fair amount of representation on the South Atlantic Management Council's Dolphin AP.

8. New England Fishery Management Council

Mr. Jepson said there isn't any representative here from the New England Council.

9. Status Report on Designation of SAFMC as Lead Council for FMP Development-Dr. Joe Kimmel, NMFS

Dr. Kimmel said back on March the 9th the NMFS published in the Federal Register a notice announcing the desire of the SAFMC to become lead council on the dolphin/wahoo FMP. This opened a 30 day comment period which ended April 8th. Just before the comment period ended the Gulf Council requested an extension of the comment period for an additional 30 days so they could address this issue at their next meeting to be held next week. Therefore, on May 5th they published a second notice in the Federal Registered opening the comment period once again, which will close on June 19th.

Mr. Jepson questioned if people wanted to send comments where would they send them to?

Dr. Kimmel answered that they should be sent to the regional office of the NMFS, attention Mark Godcharles. He commented the Federal Register notice is not received by everyone so this is something that one has to get on their own. Usually when they publish a Federal Register Notice they publish it in a bulletin called the Southeast Fishery Bulletin. They have not published the Southeast Fishery Bulletin for the second notice as yet, it will be finalized tomorrow and should be out sometime early next week.

Mr. Scott asked if it goes through the normal process how long would it take for a management plan to be in place.

Dr. Kimmel said this is a new process and what we will do is to gather comments and review those comments. Then the Regional Administrator will make a decision that will be passed on up the line to NMFS in Washington DC. He cannot predict how much time it will take but he didn't think such an action should take that long. We aren't talking about several management actions here, this is just something to protect the resource and they should respond to the comments fairly quickly.

Mr. Waugh restated Mr. Scott's question of, how long would it be before you had a management plan in place? We aren't sitting around waiting for the Secretary of Commerce to finalize the comment period, this just represents our first step to gathering information. Then at our June council meeting we will have a committee that will go over the material contained in the final report of this group. They will be looking at some further development of options that were asked to be looked at for management actions. He didn't believe we would be ready to go out to public hearing at this stage, but we have our next meeting in September in Charleston. So, depending on how much detail the committee and council wants to put together, because we have to involve the other councils as well. Therefore, this will take time and a specific timeframe hasn't been laid out yet. Our fastest timeframe for getting a plan in place has been about one year and that was recent times. He noted there is no adherence to legal guideline time periods for review anymore, and it makes it a very difficult question to answer. We can answer in terms of what the legal mandated timeframe is, however, it isn't being followed anymore. We are probably looking at a year to a year and one-half which would probably be the fastest before we could have a plan into the Secretary of Commerce. Then it is anyone's guess as to how long it would take after that.

Mr. Campos said he hopes that we will go by the Southeast Fishery Bulletin date of March 23rd, the 5th paragraph, on the last sentence which states, "the designation of one council to prepare their FMP or amendment does not preclude participation in developing proposed management measures by the other councils concerns." Also, the last sentence which says, "The South Atlantic Council indicates the FMP would provide for consistent measures throughout the full range of dolphin and wahoo, but where possible the management program would be tailored to each council's jurisdiction."

Dr. Nelson noted he is the chair on Dolphin/Wahoo Committee and it is our intent to have active participation by members of all the other councils. To attend meetings and public hearings in the various regions, and to obtain their information on the differences of fishing in these regions. It would be the same model used in the Billfish Plan.

Ms. Buchanan, SAFMC Public Relations staff officer and coordinator for the Dolphin/Wahoo AP Committee said the council will appoint members for the AP at the June meeting. If anyone is interested in serving on this committee she invited them to apply.

Mr. Bergmann asked when you are selecting industry advisors at the June council meeting has any thought been given to selecting or affording the other councils opportunity to put their industry people on this AP?

Ms. Buchanan said yes, they will be discussing this at the June meeting as to how many members our council is going to be putting on the AP and they will also determine how many will be invited to serve from each of the councils. This is all pending the appointment of this council to be lead council for dolphin/wahoo by the Secretary. Of course if it isn't then the other councils wouldn't be involved in the SAFMC process.

Dr. Nelson questioned that currently dolphin is in the Coastal Pelagic Management Plan, which is a joint plan by the Gulf and South Atlantic. It is his impression that if the Secretary decided not to appoint us as lead council for developing a new Dolphin/Wahoo Plan we would then proceed under the joint plan which is in place with the cooperation of the Gulf Council. Under this plan we would have the ability to extend those regulations throughout the range of the species managed. Is this correct?

Mr. Jepson said that is correct, and part of the reason we haven't taken action in regard to a control date, etc., is we just don't know were we stand yet. Once the Secretary has made his decision then we can either proceed with development of a plan, as true lead, or to the Coastal Pelagics Plan as is.

Mr. Waugh added it would cover our area of jurisdiction but he would have to check and see with the management unit for dolphin, definitely the Gulf and South Atlantic. At times we have had to extend the management unit for certain species up through the Mid-Atlantic, however, he isn't sure the dolphin would be included throughout this range. We can check on this and have an answer by tomorrow.

He wanted to mention on the AP it will up to the each of the other councils to appoint and fund their own AP's. We may make some recommendations in terms of numbers to facilitate a meeting, but certainly any council is free to appoint as many members to their own AP as they want. It just may be helpful to have some guidance when we hold joint meetings for the number of members.

Mr. Rick Leard, with the Gulf Council, concurred with Mr. Waugh. He explained in the past, with cobia, we did the same thing because it was also in the joint plan. Some of the measures on cobia have been extended cooperatively between the South Atlantic Council and the Mid-Atlantic Council. He didn't know of any changes to the Magnuson-Stevens Act that have been forthcoming since then which would preclude you going forward with something like this with dolphin.

Mr. Jepson said in Amendment 8 it did extend the range of cobia through the Mid-Atlantic's jurisdiction and he would assume that with dolphin if we go through the Coastal Pelagic Plan we would have to go public hearing to extend that management though the Mid-Atlantic and Caribbean.

Mr. Leard added if the Secretary approves the South Atlantic Council requests then we would simultaneously have to have an amendment done to the Coastal Migratory Pelagic Plan to remove the dolphin from that management unit. It wouldn't change the timeframe that Gregg was talking about but it would have to go to public hearings, etc.

Mr. Bergmann said he is concerned with the selection of AP members at the June meeting, when this selection will take place prior to the end of the comment period for lead management.

Dr. Nelson said regardless of who the South Atlantic Council chooses as their advisors, every council will be able to appoint their own AP to consult with and advise their council on the plan.

10. The Commercial Market for Dolphin/Wahoo, Ray Rhodes, SC DNR

Mr. Rhodes presented his report on vessel price trends for dolphin (Mahi-mahi) (included in the administrative records).

Mr. Campos questioned if the FDA had ever given him any data on the decommissioned shipments of Mahi-mahi from Central and South American Countries, such as fish filets with lots of histamine?

Mr. Rhodes said no, he hasn't seen any of their detention data on this. He noted it is possible to start digging into this information. There is commercial data out there that has invoice data from imported products, it is just that you have to start digging through all of those even with the computer it will be time consuming.

Mr. Dean said he has been thinking about the implication of the market which drives this system to some extent. If you go back to your early data he has been intrigued by looking at the increase in landings and the increase in the sea food consumption from the mid-70's. He noted we have seen an increase in the seafood restaurants over the last 5 to 7 years, total disposable income in the economy going to higher end products. He questioned how he saw all of this fitting into this picture.

He would also like to comment on this drop in landings from 1991 to 1992 and questioned if anyone else agreed with those figures?

Mr. Rhodes said what he thinks he is seeing here, and it is true with seafood in general in the US, just because the prices are going up doesn't mean you are seeing profits, because other prices are going up as well. But, he sees in the deflated price trend, a general upward movement in the price which maybe systematic of the demand for it. Maybe, marketing dolphin as Mahi-Mahi contributed to the price. However, the reality, which the commercial fishermen know, is that this country is more and more dependent on imported products and the dolphin fish are just another symbol of that. This filet segment is being totally serviced, basically, by imported product coming out of Southeast Asia and Latin America.

Mr. LaRoche said last year the headed and gutted price of imports dropped a $1.25 per pound in the summertime and the whole fresh fish price dropped to $1 per pound. With those prices a boat couldn't fish on them even though there were a lot of fish out there. So, there was probably a lot less effort on those fisheries last year just because of the cheap import prices.

Mr. Bergmann asked if he had a graph which indicated the prices of the fresh market as opposed to the import market on the filets?

Mr. Rhodes said yes, and displayed his graph which showed the exvessel versus the filet imports.

Mr. Bergmann said you need to note that the exvessel prices is whole fish as opposed to the individually wrapped frozen filets. He hasn't dealt with any of those imported filets in awhile but the last time he purchased any of them you could buy them from any distributor in the US after it goes to another distributor for about $2 per pound. He just wanted to note the filet price is competing with the whole fish prices and gives the American fisherman a disadvantage.

Mr. Rhodes noted restaurants are buying indiscriminately and not concerned with the quality of that product and maybe we need to educate the American consumer.

Mr. Bergmann said with the new regulations that went into place on December 18th these restaurant chains are going to become very familiar with the difference in the quality.

Mr. Rhodes said for the consumer's sake, hopefully, HAACP will, if there is histamine tainted filets coming into the US, etc., this will have an effect. However, on the other side of this equation is sometimes the import product can have very high quality standards, which is true in the case of shrimp. Sometimes the domestic product is not the same quality and this is the reality, although there are people in the commercial industry who work hard to keep their product fresh.

Mr. Tortorici said he has followed some of these trends from the last 11 years from the wholesale end, there is no way the domestic catch can come close to making any impact in the demand for Mahi at this time, nationally. Mahi is like the chicken of the sea at this time. He believes what is happening is that other species have become more expensive, and Mahi because of it's abundance has stayed relatively inexpensive. So, then you have this fresh fish that has a mild flavor and can be used in a wide variety of different dishes and the price is consistently under $5 per pound. It has become very attractive in the restaurants and supermarkets throughout the county. So, traditionally when we are coming into our season here along the coast, down in South America they are going into their winter and their catches and imports tend to drop, or have in years past but this is changing.

He said they deliver from Wilmington, North Carolina down to Jacksonville, Florida and he believes his customers are very quality oriented as opposed to someone that is sitting in Ohio at a Ryan's Steakhouse and won't know if that Mahi is fresh or frozen, or even an import. Also, a lot of the chefs here are real sensitive and want fresh domestic fish. So, it may make sense that a lot of that frozen fish is going to other parts of the country to fill the demand that is left from the lack of imports and then the fresh fish that is coming in is filling in the demands along the coast markets.

He noted a couple of years ago there was an increase during the winter time, which tended to be stronger. He thinks this is because you have bigger boats with larger fleets who are able to stay on the fish as opposed to a bunch of smaller boats who were unable to make those longer trips when the weather was bad. Therefore you are now starting to see a more global supply of H and G and fresh Mahi in the U.S. Then as a result of this if you get good catch on the domestic fish you have the situation where the price hasn't risen as it has in years past because of the decreasing supply in South America. When this happened a couple of years back, a lot of people got excited on the domestic front because the price of fish fell. This is something we will have to see how it plays out over the next few years.

Mr. Rhodes questioned if he was talking mainly about a H and G.

Mr. Tortorici said yes, this is a frozen filet which is an entirely different market. If the price gets too low in the U.S. then South Americans, Peruvians, etc., say they aren't going to send their fish here. They want more money for their fish, so they take their fish to the freezers and start building their stocks. So, when the supply in the U.S. is shut off and the demand here is still strong because it is a good value fish, then they start shipping it to the U.S. and it will stay close to $2 per pound.

Dr. Oxenford said it is nice to see economic data on the dolphin fishery and it is very useful for the council in pushing for their trip limit management options, if there is data that states the price crashes when you get these very large landings. So, if you are worried about driving the longline boats out of business you won't be driving them as far out of business as you might imagine if in fact the prices drop considerably when they are landing large amounts of fish. This is, therefore, a very useful piece of information.

She asked, given the data he has, did he come up with any economic values for the fishery, which would also help the council in showing it's importance and need for management? Also, what do you mean by deflated value?

Mr. Rhodes explained what he meant by deflated value was to take the inflation that may be in the economy in general which is tagging along with the price and try to index this out so you can then hopefully see what is really going on in terms demand for that particular item. Some economists call this the "real price," which to him is more confusing and this is why he uses the term "deflated price." If you see this price going up and the price is deflated already, then there is something going on in there relative to demand which the price is reflecting.

He wanted to note in regards to the imported filets which is an undesirable effect for the U.S. producers in that those filets may have eroded a market segment that may have been an outlet for their product. But, in terms of trying to look at these time series it is very difficult. Just to give you an idea, on the filets in 1997, when all the data started to be collected on the imports, if you take a 40% yield or about 16 million pounds, and back it around into whole fish you are then talking about 40 million pounds coming into the U.S. in 1997. Then the landings in his region (Gulf and Atlantic States), would only make up about 5% of that figure.

He has come up with a guesstimate what the H and G that is moving in the coastal states along the Gulf and Atlantic, on the low side it is at least 1 million pounds coming into the southeast which goes to seafood distributors. This may well be a low estimate, but it would be about 50% of the 2 million pounds that are reported landed in South Atlantic and Gulf states. Therefore, our overall domestic landings may be a very small percentage of the market place.

In regard to trip limits, in fairness to the longliners, even if you had a desirable increase in the prices the dynamics of it may be such the price will never go up high enough to offset the volume that they would catch if there were not trip or bag limits on it. This could have negative effects on their overall profitability in a given season.

11. The Recreational Fishery for Dolphin/Wahoo, Don Hammond, SC DNR

Mr. Hammond gave his report on recreational fishery for dolphin/wahoo 1994 to 1996 monthly contribution by charterboats.

Dr. Daniel questioned in the size distribution and catch rates for the tournament fishing area what makes you think this information is bias based on the size of the baits they are using? Also, are they not targeting marlin in those tournaments?

Mr. Hammond said blue marlin is the primary target species, however, historically they had to go out with a shot gun approach to where they are going have one or more baits out there of what we refer to as 12 pack ballyhoo. So, yes, it is going to select larger fish, but we have consistently seen 3 to 5 pound dolphin taken on those lines.

Dr. Daniel said regarding the CPUE information you submitted as well as the response, it seems interesting that the complaint is of the declining dolphin stocks and the CPUE is raising. Perhaps if the fishermen had been more aware of the data their responses may have been much different. It seems to be based more on perception than reality based on the data.

Mr. Hammond said you have to understand the nature of this fishery; the offshore big game fishery is an intense fishery, not a leisure fishery, with a rapid turnover in participants. Most participants are in there for 3 to 10 years at the most. They fish hard and burnout and then get out. There just aren't that many fishermen who were fishing back in the 1970s and 80s to know what the catch rates were like then as opposed to what they are seeing today. So, their information is very short term and it is biased.

Ms. Hass said when they are tournament fishing if she sees schools and little ones she won't stop, but if she wasn't in a tournament and had a charter on board she would stop. Therefore, in tournament data you will always have bigger fish reported, because they aren't stopping for the little ones.

Also, with the CPU where she can get the Gulf Stream and Roffler information you are going to see them catching more fish but it is very expensive for them to get some of this information. They just don't spend as much time looking for boards, etc., they just go straight to where they think the temperature break or weed line is going to be. Those with the money can afford this but the little guy can't. There is just too much that has been going on over the last few years and it makes this data very shaky.

Mr. Hammond said this is what he was getting at because you are looking at two ends of the spectrum, from charterboats who will stop and fish on a school of dolphin hard, versus a tournament boat who tend to shake them off. It is still amazing to see how close they both come out, but you are correct that there is no way he can factor in the new electronics and Roffler to be able to provide data ahead of time to direct the fishery to go places. So, what you may be seeing is in fact a reflection of better information to direct fishing effort to the more highly productive areas.

Mr. Tortorici questioned what percentage of recreational fishermen do these clubs represent?

Mr. Wayne Waltz, South Carolina DNR, stated they sell right under 90 thousand salt water fishing stamps per year and this is a good idea of how many private boat anglers they have they. When they mailed out to the clubs one of the questions asked was how many club members participated in answering these questions and how many people are in your club in general. The clubs that responded represented about 300 people.

Mr. Tortorici questioned that there are 90 thousand recreational fishermen and this data you presented represents about 300 people, and out of those clubs of 300 people we got responses back from less than 10% of the clubs, correct.

Mr. Waltz said yes, that is why he is saying this is a very small data base. He asked if Mr. Tortorici was talking about all saltwater fishermen from the trout fishermen in the creeks or do you want to just focus on offshore bluewater fishermen? This question was directed towards the bluewater fishermen and those that had an interest in dolphin/wahoo.

Mr. Tortorici said that is still less than one-tenth of 1% if you took the 90 thousand and cut it in half and said 45 thousand.

Mr. Waltz said it is probably less than that offshore.

Mr. Jepson pointed out on the recent 1997 MRSS data there was an economic add on which included some question about dolphin management in the South Atlantic and this information will be available to the council soon.

Mr. Tortorici said he is just trying to get an accurate picture of what is going on because of what had gone on with the Marine Center which was a real hot emotionally charged issue for a very small percentage of people. This seems to represent the same thing with a small percentage of motivated people based on having some awareness, so you have a survey based on emotions rather than the facts of what is actually going on out there.

Mr. Waltz noted the comment was made that respondents may not have had all the information, but in addition to sending them the questionnaire they also sent them the two reports that Don has been referring to. So, they did have all the information to read before they responded to the survey. Whether they did or not he couldn't say. The survey was designed to be directed to the more avid angler and it doesn't represent the whole population, but they are the people who tend to be the leaders of the recreational fishing community.

Mr. Campos requested to use this survey in Puerto Rico.

Mr. Hammond said yes.

12. The Commercial Fishery for Dolphin/Wahoo, Charlie Moore, SC DNR

Mr. Moore gave his report on Atlantic and Gulf dolphin/wahoo commercial landings (included in the administrative records).

Dr. Cramer said the comparison you are making there in the first case you have .39 billfish taken per 1000 sets and in the other one you have 3.10; if you look at it you have reduced your effort to about 10% by choosing sets that did catch billfish. Therefore, she didn't think it was really CPUE because you biased the effort and they are not collecting on positive sets with dolphin, they are selecting on positive sets with billfish. So, it doesn't say anything about the fact the dolphin are there.

Mr. Moore concurred, he is not a statistician and is only trying to understand this as well. He has shown this to about six people and they have all come up with different ways of looking at the information. If your look at the positive sets this is the rate of billfish catch in those sets per 1000 hooks.

Dr. Cramer said but you have picked only the sets where you caught billfish so you are not really looking at total effort and have biased you sample. When she looks at it you are catching a few dolphin fish on CPUE based on billfish and it isn't going up a lot.

Mr. Moore said this may be the solution to his problem because if you go to the observer data and you don't see that in this data. All the sets in the observer data, billfish per 1,000 hooks are the positive sets and the numbers per 1,000 hooks. What he did was graph those to see what it would look like (he displayed another graph on the overhead) noting the billfish were all positive sets and in every case, whether you are talking about dolphin or billfish you get more in terms of a rate. He said the observer data is definitely higher numbers of billfish per 1,000 hooks in the longline fishery. This is the discrepancy between the logbook data and the observer data.

Dr. Cramer said the fact that the second subset in each case the billfish are higher means nothing because you selected the sets where they caught billfish. There seems to be a somewhat consistently higher percentage of dolphin fish per 1,000 hooks in the lower charts and maybe this says you are likely to catch dolphin hooks on a set where you have caught billfish, but not the other way around. This is because you didn't select on dolphin fish, but whether or not this is statistically significant she isn't sure. She noted there seems to be underreporting in the reported logbook as opposed to the data base for billfish.

Mr. Moore noted basically this is what the paper said that it found no correlation between the number of dolphin and the number of billfish bycatch.

Dr. Cramer said the proper question here is to compare sets that were obviously set up as a dolphin target. Then compare the billfish bycatch in those sets with the billfish bycatch in sets where targeting tuna, shark, other species. If she were doing this she would build up swordfish separately, etc., and then try to weed out the dolphin sets. The problem you will run into here is you wouldn't have any observer sets for dolphin and you would have a very low number of even reported longline sets. So, it would probably get to the point were you wouldn't have any sets for good statistical work.

Mr. Moore said he has very little information on wahoo and his report basically covers the Gulf and Atlantic landings from 1974 to 1996. He displayed an overhead which reflected his findings.

Mr. Cupka said it was interesting on the data you presented the dolphin per 1,000 hooks by area for the South Atlantic Bight it really jumps out at you with a very high dolphin catch. That information was from both the observer data and the logbook data. He asked if he had any thoughts as to what was going on in this area, i.e., more targeting in this area, etc.

Mr. Moore thanked David for pointing this out. He believes this is basically because of the targeting by the initial vessels back in the mid to late 80's that were primary off the southeast coast of South Carolina. In the council's option paper they had information that there may be 25 boats now targeting dolphin.

Mr. David Whitaker, SC DNR said yesterday there was data presented on the average size on dolphin was 3 to 5 kilos and you had no data on the size. He questioned if there is any data that exists and if so is it broken down by area or season the council could look at?

Dr. Cramer said one of the data bases where those lengths were drawn from would have been from the landings data which is reported by dealers and the tally sheets. This data base is maintained at the Southeast Fisheries Center. There is also a database for the headboats and the MRFSS database, where the recreational sizes must have come from, one or all of those. However, she is not that familiar with those databases.

One of the problems with the commercial database is that the dolphin are not always individually weighed and you will get a total weight and number. Then those are put in as the same individual weight. With the commercial landings they will look more consistent than they actually are, you'll get a good average size but not the type of resolution you think you are getting.

<u>Session V: Consensus Recommendations on Alternatives for Council's Management Programs</u> **(Moderator - Mr. Waugh)**

Mr. Waugh gave a presentation on consensus recommendations on alternatives for council's management programs to be developed by the panel. These recommendations will be presented to the council for their consideration at the June meeting. (copy included in the administrative record).

1. Management Unit

DOLPHIN

Dr. Oxenford said with the lack of any other information it would suggest that we should use the Gulf of Mexico and South Atlantic dolphin fish as a unit until we have more information. Also, ignore the southeastern Caribbean fish for right now.

Mr. Waugh questioned the catches north of North Carolina, should they also be included?

Dr. Oxenford said yes.

Mr. Waugh said the panel's recommendation for dolphin will be to, **"using the Gulf, the South Atlantic, and north of North Carolina where they occur. Basically, include the area that was discussed in the diagram and it would include portions of the Caribbean Council's area (Puerto Rico, Virgin Islands, and Bahamas).**

Dr. Oxenford noted if we get better information in the future, such as Robyn's work showing differences in the Gulf fish then they can be managed separately thereafter. But, for a precautionary approach it is better to go larger than smaller for a management measure.

WAHOO

Dr. Luckhurst said the panel's recommendation was to use the whole western Atlantic (Caribbean up the eastern seaboard to Bermuda) at this point until more information is gained.

Mr. Waugh said this is referring to the figure we looked at for dolphin which would include a northern and southern, so what you are saying is to consider both of those together along with catches in the Gulf and however far up they occur on the east coast.

Dr. Luckhurst said in the absence of anything else we don't have any other basis to reduce this area.

Dr. Oxenford questioned what is the feasibility of managing a larger unit? If it isn't feasible then it is not sensible.

Mr. Waugh said this is one option for a management unit. When this moves to the council arena an option would be to take a portion of that area which occurs within the council's jurisdiction.

Mr. Waugh said the panel's recommendation for wahoo will be to, **"if the council's were to go forward with management then there should be coordinated management between the council's approach and what approach would be done further down in the Caribbean."**

Mr. Murray said this is something which will have to considered carefully. If you take that whole region as your management unit for wahoo, it would mean that your linkages for collaboration with other management or authority units would have to be at the highest urgency. Otherwise, you are likely to end up being very uncoordinated.

2. Size Limits - Recreational & Commercial

DOLPHIN

Mr. Waugh asked on size limits is this a feasible approach for both the recreational and commercial fishermen?

Dr. Luckhurst said when you are talking about size limits you can apply in an active fishery you can take action on whatever the regulation is at the time of the catch. But, in a passive fishery, such as longlining, it isn't really going to work, because by the time you haul the fish back on the line they will be dead.

Dr. Daniel added a lot of the longline fisheries operate that way, but we understand from the longline dolphin fishery that it is a rapid set and retrievable method where 4 or 5 sets are made in one day. Those fish are then brought back to the boat in much better condition than overnight sets and long term longlines which are fished much longer.

Dr. Luckhurst questioned if there was any observer data on the percentage or number of fish coming on board the longline vessel alive so we can take action on a minimum size?

Dr. Daniel said no, this is such a new fishery and we really don't have any really directed dolphin longlining observer data. By just knowing the rest of it and the way it operates and generally a day trip with many sets the gear just isn't in the water very long at all. There is some incidental observer information that indicates they are coming aboard alive but we don't have any NMFS observer data to that fact.

Dr. Cramer said unlike the swordfish at this point and with this species the protection of smaller fish may not warrant putting a size limit for gear such as longline where they may tend to, as a bycatch, catch undersize fish. It would then be lost and it becomes waste and we don't need more discarded bycatch, certainly, not in the longline fishery. With the recreational, where they are even seeing the fish before they target them it makes more sense. She would really discourage using this to limit bycatch going on to trip limits is a much better way to prevent targeting or to reduce targeting.

Mr. Campos explained he has spent a lot of time fishing for Mahi and wanted to give the panel an example of the mortality; on a 50 pound test he has taken fish 35 to 40 pounds and left them on the line along side the boat and within 15 to 20 minutes they are dead. So, if we are talking about size limits and having a longline fishery he didn't see any reason we should even look at it for size limits. It is a very fragile fish and it won't survive more than one-half an hour on the line.

Mr. Waugh asked about the recreational side what is your feel for the survival of released dolphin in the recreational fishery.

Mr. Campos said it is going to be difficult to release this very lively fish. When they get close to the boat they jump all over the place, the majority of the people don't use nets they graph them, and when they haul that fish on board they are bleeding and banging all over the boat or against you. So, it is impossible to release them alive.

He wanted to mention the tagging program because he believes this is going to be difficult as well, unless you are going to be dealing with the large fish. But, the smaller fish no way.

Mr. Hinman said this is a very critical issue we are getting at with size limits, no matter which fishery we are talking about. The important thing is these fish can be released alive.

He noted there are 2 different longline fisheries with dolphin; one is with the shorter sets and soak time, with multiple set targeting dolphin. This may have a higher survival rate of a fish retrieved and in this case maybe a minimum size is an option to be looked at and discussed. He didn't believe this is one that should be looked at in the swordfish longline fishery, multi-mile sets (20 plus miles long), and thousands of dolphin are caught as bycatch with a very high mortality rate of those released. Other options should be put in for consideration and how you can control that catch. Options such as, limiting the soak time, or closing certain areas were the dolphin aggregate.

Mr. Waugh noted those options will be addressed later we are just focusing on size limit right now.

Dr. Oxenford noted that what seems to be coming out of this is we are using fairly non selective gear, therefore, it is not a sensible measure because the fish take any hook size and you cannot legislate hook size. She had thought that some states are using minimum size limits now, so let's see how they are working there.

Mr. Waugh said that is correct, Georgia, and Florida have minimum sizes in place now.

Mr. Bergmann said the swordfish longline gear will catch fish at an early time. When the fish bite in the longline gear it is either sinking or being retrieved as the bait is moving through the water. If you change the amount of time as in the directed fishery then they are virtually short sets. Also, you can put a minimum size limit, but from experience in the swordfish longlining you don't catch school fish, they are generally large fish that you catch.

Dr. Luckhurst questioned if there was any information available about the effectiveness of these minimum sizes in other states?

Mr. Waugh said these have been put in place fairly recently and he didn't think there has been an evaluation yet. One part of a minimum size on the recreational fishery is that it could induce people to move off of smaller fish if they start catching them, and it would be benefit.

Mr. Waugh said the panel's recommendation would be to, **"use of the minimum size would have problems, in the general longline fishery directed on dolphin to the extent there is one, it may have some feasibility."**

Dr. Oxenford said she is reluctant to say it is a foolish idea when it is already being implemented in several states, and until we have data we can't say it is inappropriate, but clearly it will have problems.

Mr. Bergmann stated the reason Florida has a minimum size is because there have been many times when the longline fleets will get ready to set their gear at night in school fish, getting their little hooks and gigs out and they caught garbage cans full of them. Fish that usually bit the hooks on the longline gear tend to be larger fish, and a minimum size is not going to effect those fish. What it will stop is the people fishing on the school fish which is what you want to happen.

Mr. Waugh said then an additional panel's recommendation would be to, **"also, we need to monitor the effectiveness of the size limits which are in place and determine to what extent they are effective. Then indicate the potential problems with minimum size."**

Dr. Luckhurst said this is the sensible thing to do. He would like to have clarification; presumably as recreational catches have dominated the southeast coast for some time now that those minimum sizes were put into place specifically directed at managing the recreational fishery, which is an active trolling fishery. Now we have the advent of the longliner activity, which is somewhat different, and what is coming out of this may be a horse of a different color. You have to look very carefully on whether this is applicable in this situation. He believes, as do some of the fishermen here, that dolphin fish are, in general, fairly delicate. Even if you do have a minimum size, what is the probability of them surviving the capture and release? If the survival is very low then what is the point.

Dr. Oxenford asked if we could have a minimum size for recreational fishery and minimum size for commercial sale from the commercial fishery, so that you are not telling your longline guys to waste those fish by putting them back. What you are telling them is, to take those fish home and eat them, but they can't sell them. This would stop them from moving into the sport fishing area because if they can't sell their 20 thousand pounds dolphin when they got home then they wouldn't catch them.

Mr. Waugh asked for a recommendation of minimum size?

Dr. Oxenford said we have the biological information to set it to about the early maturity or somewhere above this, which seems like a reasonable starting point. She believes somewhere between 400mm and 500 millimeters, because 100% maturity is about 550 millimeters and we should start at something like this.

Mr. Waugh said Florida minimum size is 24 inches fork length.

Dr. Luckhurst said to add to the panel's recommendation, **"24 inch is 60 centimeters exactly and 100% maturity according to the data which has been presented."**

Dr. Oxenford said this would be well within the safety margin. But, we do need to look at the landings to see how badly this is going to affect the fishery, because we don't want to close the fisheries down.

WAHOO

Dr. Luckhurst said he has to go back to what was said before that there is very little data and the 2 pieces of information which were mentioned during the course of this workshop come from Dr. Hogarth's work, published 1976, and this first preliminary work he has been doing in Bermuda. This is not a particularly solid basis for going forward with a recommendation at this time.

Mr. Murray said there is another complication, if you have decided you are going to use the whole western central Atlantic for wahoo, the nature of the fishery in the Caribbean Islands are such that you may very well exclude a lot of fish landed. If you were to have a coordinated approach using a size limit at this time you would probably wipe out about 50% of the fisheries for some of those countries in the Caribbean. If we are going to take this whole area as a management unit then he would urge some caution because you don't have the information right now to set size limits.

Dr. Luckhurst said we are working towards developing a plan within the South Atlantic Council's jurisdiction. He does take Peter's point but what we are talking about is what is going on from Florida up to here and this is what we have to focus on.

Mr. Waugh said in Dr. Hogarth's material the chart he showed a big change in growth rate, what would the panel's view point be about using this as a minimum size?

Dr. Luckhurst said from his work the mean size at age 1 was about 112 centimeters and after that growth slowed down dramatically through to age 4 which is the oldest fish we have. In the same context size at the first reproduction was somewhat under this at age 1, around 95 centimeters to 1 meter.

Dr. Oxenford said we need to be careful of setting what appears to be biologically sensible size limits as managers without having any idea of the impacts of those measures on the fishery. So, until we have data on what the size ranges are that are being landed at this time. We just need to hold things at status quo for the fishery because we are not trying to reduce effort or close this fishery down. so let's not try to be bold and go ahead and do things we can't predict what we may do to the landings.

Mr. Waugh said the panel's recommendation for wahoo is, **"we have too little information to consider a size limit at this time."**

Mr. Campos noted a removal of a hook from a Mahi is completely different from removing a hook from somebody that can cut your fingers off. So, let's take it easy.

Dr. Oxenford said we should soften the recommendation a little, not to discount it, but to consider it a possibility which needs further research to consider the impact.

3. Bag Limits - Recreational & 4. Trip Limits - Commercial

DOLPHIN

Mr. Waugh said we are looking for bag limits for the recreational fishermen and trip limits for the commercial fishermen.

Dr. Oxenford wanted clarification on setting trip limits, are you going to be setting a limit for the length of that trip as well? Because that guy can come in unload and go back out again, so how effective is this going to be.

Mr. Waugh said this is certainly a concern and we are dealing with this issue in other fisheries right now.

Dr. Luckhurst asked how are you dealing with this?

Mr. Waugh said now notvery well. It is difficult because we have talked before about some bag limits which are set, recognizing certain sectors make multiple day trips, some headboats off of Florida. We do have bag limits that are set based on multi-days. This subject is a bone of contention in our mackerel fishery where we have trip limits in place. When the distance to the fishing grounds is very short there is the concern that you could have multiple trips versus areas where it is farther to get to the grounds and then you have less trips. So, it is difficult to deal with. Also, the issue of enforcement for determining a poundage based on a number of days out is hard to keep track of and it is difficult to monitor. So, we have been encouraged not to look at this . Right now we have been setting trip limits, and looking at differential trips limits. Perhaps lower in an area where they can make multiple trips and higher in an area where the likelihood of making multiple trips is not as high. Also, there are limits which are set for daily limits versus a trip, but again it is difficult to track how long a vessel has been out fishing.

Dr. Luckhurst said presumably it would require mandatory port reporting by the vessels, so is there a mechanism in place for this to happen?

Mr. Waugh noted in some fisheries this occurs now, the scallop fishery in the northeast is managed with a day at sea program and they notify NMFS on their way out and when they are coming back in. But, this is costly and difficult to manage.

Dr. Oxenford asked if ITQs have been considered for the commercial sector for longline fishery?

Mr. Waugh said no, it is something we could look at, but Congress took ITQs or transferable quota away for the council for a period of time.

Dr. Oxenford stated it would be the easiest way of holding the status quo if you know what the catches are now.

Dr. Daniel said the ASMFC's Weakfish Amendment 3 looked at bycatch limits and allowances in their plan and a certain poundage was stated for day or trip, whichever was longer, to prevent the in and out type of trips. This seems to be working.

Dr. Oxenford asked what would stop her, as a fisherman, reporting she was going out today, but doesn't go out until next week, just to give her extra days at sea to land more fish?

Mr. Waugh said in the scallop fishery they are looking at the vessel monitoring system which will deal with this. Again these are problems with these types of systems you have to address on the enforcement side.

Dr. Cramer noted one possibility with longlining, to limit the amount of targeting on dolphin, would to put an upper limit percentage on the proportion of the catch. In looking at the options this might be one of the easier things to monitor.

Dr. Oxenford said then you would be encouraging your highgrading or discarding with this approach.

Dr. Luckhurst said in the commercial context some sort of limitation on a trip basis probably makes good sense. Unless there is some mechanism to define the trip or another way to deal with this, you have an open ended problem. However, by putting some sort of a limit on one or the other it wouldn't be open ended.

Mr. Waugh said the panel's recommendation was to have, **"bag limits on dolphin on the recreational side."**

Dr. Oxenford said yes, it is clearly working and seems to be favored by fishermen.

Mr. Campos said bag limits are the way to go because if you take 5 guys out on a fishing trip and give them 6 fish each, that is 30 recreationally caught fish that don't go into the market. Let's say they weighed 10 pounds, now we are talking about a lot of meat. What are they going to do with anything else over this? Let's think about my grandchildren and your grandchildren down the line and other people.

Mr. Hammond said this was one of the points he wanted to make in his presentation. When you have a fish that is averaging 16 pounds each, and you are talking about a recreational bag limit, that is not up for sale, what is a reasonable amount? Ten fish is about 160 pounds of fish per person, which is 60 fish on the average offshore tournament boat or 50 fish on a charterboat and who wants to clean them. In his years of working with the sport fishery he has yet to encounter an individual that thinks cleaning fish is a sport unto itself.

Mr. Murray asked what about the scenario for the charterboats which have a relatively low acceptable bag limit involved; they go out and catch 5 fish per person, quit and come back to the docks, then go back out with another charter, will this help or hamper the situation?

Mr. Campos said with Mahi you just don't go out and catch them with a surf rod 100 mile from shore, this is an offshore species. You have to make plans to go out all day because otherwise you will be using a lot of money on gas, bait, and wear and tear on your body. It's just not that easy.

Dr. Luckhurst said the idea of recreational bag limits are sensible for the reasons and rationale that have already been mentioned, which is the same rationale in general that is used everywhere. If you are doing this for sport or for the love of it you don't need to catch so many fish you can't carry them. It just doesn't make sense. On the other hand for the commercial fishermen who is trying to make a living at this it is another set of circumstances. However, if you are talking about limitations they have to be shared equally by both the commercial and recreational sector. There needs to be some kind of cap on both the sectors, but a cap which is sensible in relation to the needs of the nature of the fishery. The nature of the fishery is prosecuted on two different levels; one, recreational where you are out there to have a good time, spending money which is spinning off into the economy. On the other hand you are going out there to make a day's pay and put the fish into the market. Therefore, he believes if there are limitations they should be on both sectors, but should be appropriate to the fishery.

Mr. Waugh asked if the comments so far on bag limits just apply to dolphin or are you going to be apply this to wahoo as well?

Dr. Luckhurst said he hasn't seen anything that indicates that wahoo is in trouble. The reality is we don't have any data and without the data it is unwise to think about imposing some limitation before we have evidence of a problem.

Mr. Campos said this is more of an incidental bycatch than anything else, and without the data he can't say if there is an abundance out there or not. He said we should leave it alone.

Mr. Murray said he wanted to play the devil's advocate; and asked, what about a precautionary approach?

Mr. Campos said we need more information before we do this because landings are so few and far between. He has not heard of anyone in Puerto Rico catching more than 10 or 12 wahoo in one day.

Mr. Hinman disagrees that to not do anything with wahoo just because we don't' have a problem. The reason we are here today is because we want to be cautious on our approach and what we have done with dolphin is hold the line to keep things where they are and don't get worse. We seem to have good data on catches to try to figure out what kind of management measures we can have to do this. However, the question here is do we have this information for wahoo on what the catches are and what suite of measures would be appropriate to take. But, if we don't have the data then we can't do anything.

Dr. Luckhurst noted we have very little information on wahoo to base this on and he is very much for the precautionary approach for a general principal. However, he thinks we need to be careful in implementing management measures where those measures are taken based on certain assumptions which you will have to wait to try to verify in the course of conducting more research. However, if those measures are reducing catches when there is sufficient production from the stock, so then what you are doing is not optimizing the benefit from the stock, you are putting a limitation on it. Whether or not it is necessary is one of the questions you have to ask. So, basically it is a guessing game.

Mr. Hammond said he wanted to profile a reference point on general abundance and occurrence; wahoo are probably 1/10 of the dolphin. In South Carolina a typical day would result in maybe 1 wahoo and a good day would be 3 wahoo. Although they have had some catches as high as 19 and one very reliable report of 32 being caught in one day. But, typically it is considered more of an incidental catch. Even if you wanted to catch one it isn't something you can do that easily. This is just something else to keep in mind when setting these limits is that we can go out there and target dolphin by backing up to the schools, but you are going to be catching yellowfin tuna, and wahoo as well, so it's not a case of someone going out to catch only the limit of dolphin, they are going to be catching other fish as well. This will add up very quickly when you look at the average yellowfin here which weighs 35 to 40 pounds, and the wahoo is about 25 to 35 pounds, this is just a lot of meat they will catch in one day of fishing here. There are still some reasonable limits which can be considered for wahoo, not biological management, but reasonable for the recreational side.

Dr. Nelson asked if based on what we know, would they recommend that we encourage new means and methods of fishing to be able to increase our ability to harvest wahoo and increase our catch of wahoo?

Dr. Oxenford said no, if we take the precautionary principal we are trying to hold it at where it is right now, which seems to be OK. This discussion about bag limits in one area is OK and another area would not be OK if they were consistent, because our fishery is different. You are saying wahoo catches are insignificant up here; is less than 10%. In Bermuda it is about 50% of the fishery. So, if we are looking at this as management unit and looking at measures then it is going to have to be area specific bag limits based on what the present status is. Therefore, yes, we should be precautionary, but not foolish and close fisheries down. At least until we have this information.

Mr. Scott commented on the dolphin bag limits with the commercial fishermen having to make a living at this, but their historical proportion has been 10%. Therefore, bag limits need to be kept in this line so we don't lose sight of these historical proportions.

Mr. Waugh said the panel's recommendation would be, **"for the dolphin, bag limits are working; for dolphin trip limits, it is a way to influence the targeting of dolphin by the commercial longliners.**

Then for wahoo the panel recommended holding the status quo and not encouraging increased exploitation. Then look at the available information to evaluate area specific bag limits or other regulations that might be necessary."

Dr. Oxenford said the wahoo was summarized OK but she was sure they came to a consensus on how to deal with the commercial sector on dolphin.

Dr. Cramer said it may be rational to start by defining the goal of what we want to accomplish. She had the impression throughout the meeting that the feeling about longline fishing on dolphin and there does seem to be a great deal of apprehension about the blatant power of longline gear on the resource. However, there has been no discussion about the majority of the gears for catching dolphin by commercial fishing. Therefore, she thinks that we need to define what we want these limits to accomplish, such as, to hold steady or limit the amount of actual sets that are targeting dolphin.

Mr. Al Segars, is a commercial fisherman from South Carolina, he stated the last thing we need to do is to create another class of regulatory discards. This is one of the most discussed portions of the management scheme, which is a lose-lose situation for everyone. It is scoffed at by the longliners, managers, and everyone, because the fish is dead whether it counts or not. From a commercial standpoint the dolphin is dead if he is on a longline and should be put in the dead tally and applied toward the TAC. Let that fish's death account for something at least as opposed to being thrown over the side.

Dr. Cramer said historically, a longline that is targeting swordfish, tuna, sharks, etc., catches are relatively small proportion of dolphin. We can look at the data to find out what a generous portion of dolphin is. She has the perception that large numbers of dolphin fish can be caught on dolphin targeted longlines, and hopefully there are people with more knowledge of dolphin targeting than she has. She would like to go with her former proposal that you look at the proportion of catch if someone is bringing in 80% or 100% dolphin then this may be something we want to control. Whereas someone bringing in 10% dolphin is fishing with the methods that have been traditional and not targeting dolphin, and not expressing that blatant power on dolphin. There probably are some percentages that would not require fishermen targeting swordfish or other pelagics, to discard anything. There probably is some percentage there that allows those fish to be sold and would discourage the direct targeting on dolphin.

Mr. Waugh questioned if you couldn't do the same thing by using a trip limit, looking at the bycatch information in the directed swordfish and tuna longline fisheries. There you can set a trip limit that would allow them to keep the dolphin they catch incidentally but have it be sufficiently low that it would prevent them from targeting dolphin.

Dr. Cramer said possibly, but she is concerned that offshore fishermen may have 30 day trips and dolphin is fairly acceptable in a one day trip. So, you may get into this bad balance where your highliner offshore is getting too many dolphin on board, going out a short way and targeting dolphin.

Mr. Hinman said there is just a problem with managing mortality in the longline fishery that you can't get away from and this is any measure that just regulates the disposition of what is caught is the measure that is likely to turn landings in to discards and to waste. The problem is, if you just say let's not waste them if we kill them and bring them in, this is not a limit and does not limit fishing mortality. It is not a disincentive to target those fish if that is what you are trying to do. In looking at this problem in a lot of other fisheries, longline fisheries, there is really only two ways to deal with this and that is avoid the encounters with the fish or enhancing the survival of those that are going to become regulatory discards. As far as the latter is concerned it means limiting the length of time those lines are in the water. This is a benefit that will go across all the pelagic fisheries because you have this same problem in the other fisheries, tuna, shark, swordfish, bluefish fishery, etc. Regulations are now in place which are just resulting in a lot of fish being killed and thrown overboard, and the mortality is higher than what it should be. So, we have to avoid encounters with those fish or you have to have some way of ensuring those fish will be released alive.

Dr. Oxenford said after listening to these discussions she believes that trip limits would work for commercial fishery sector that uses trolling lines, that works on a daily basis, and set the trip limit on what they normally bring in. The longline fishery seems to be the problem, so she suggested setting a trip limit for commercial sales. This would eliminate the longline boats from moving into a situation where they are targeting dolphin. If they had a reasonably low limit which coincided with what they normally bring in when they are fishing for their targeted species, and this would stop them from moving into the dolphin fishery.

Mr. Leard suggested that you are focusing too much on what trip limits might be, bag limits, etc., because you have a lot of options of what management alternative could be. Some of these may be applicable in some fisheries and areas, some may not be applicable with certain factions within the individual fisheries. He thought that the process you were going through was to try to get things out and discuss with the users at public hearings and to develop some type of scoping document. In that sense, almost all of these things might be applicable including soak time for certain gears.

5. Control Date

Mr. Waugh moved on the control date and this is a measure they use by indicating a date and time after which fishermen who enter the fishery are not guaranteed continued participation in a fishery should the council limit entry. He questioned if there needs to be any comments or recommendations on the use of a control date.

Dr. Oxenford said this would be a good idea and it would meet our objective for holding this fishery where it is right now.

Mr. Waugh asked if this would be for dolphin and wahoo.

Dr. Oxenford asked Gregg to clarify what a control date is.

Mr. Waugh said it has to be published in the Federal Register and it is a data when that notice is published which is then the control date. Anyone entering after that date would not be guaranteed continued participation should you go to a limited entry program. This is a way of setting a date and time that you can use in the future to limit entrance to those that could demonstrate landings prior to that date. Also, this is only applied to the commercial fishery.

Dr. Luckhurst asked how do you reach a control date.

Mr. Waugh said we send a letter to NMFS, and whenever it is published in the Federal Register this is the control date. We have argued that this is not how it should work, when a council decides on a control data this is the date which should be used. Usually this is done in fisheries where there is a need to limit participants. To then put an announcement to put everyone on advise there is a control date coming, which usually takes 30 to 60 days to get into place. So, basically we are describing a situation where you need to limit effort and then give fishermen a head start of 30 to 60 days to go out an qualify for this pending permit. It really doesn't make sense if you are trying to limit the participants.

Ms. Hass said she didn't believe the question is control and they really don't need to answer this question, because the question at this time is do we need to limit entry into this fishery.

Dr. Oxenford said yes, if we are trying to hold the status quo, but by setting a controlled date you are not doing this you are just giving yourself the ability to do this if you feel the need.

Mr. Waugh said the panel's recommendation would be to, **"hold the participation on the commercial side to the level participants we have now for dolphin and not wahoo."**

6. Closed Seasons and/or Areas

Mr. Waugh said this is very involved and perhaps we should break here to allow more time for discussion.

Session VI: Completion of Workshop Report (Moderators - Gregg Waugh /Mike Jepson)

Mr. Waugh noted that everything has been incorporated in the draft except the diet which can be projected on the overheads at the appropriate time.

He stated aside for the Continental drift problem with Argentina and Brazil was there anything else on page one which needs to be addressed?

He moved on to page two where we need additional information to fill in the blanks for the seasonal variation in the Gulf.

He also stated that wherever we mention Puerto Rico it will include the USVI. Also, the figure on page 2 will be larger he just needs to fit it into the space he had this morning.

Mr. Hinman said on the first sentence of the second paragraph, I was a little confused about the part where there are at least two separate unit stocks in the eastern part of the Caribbean, the northeast and the southeast. Does that mean there are just those two?

Dr. Oxenford said we need to put in, "this region."

Mr. Waugh read the new paragraph, "which suggests that there are at least 2 separate unit stocks in this region, located in the northeast and southeast."

Dr. Oxenford said "in this region," because the western Atlantic is in the same sentence.

Mr. Chapman said is there any information on the occurrence of dolphin in the Caribbean, particularly around Belize and Honduras, because there is a big hole in this figure here and not discussed in the text.

Dr. Dean said this was discussed in the Gulf of Mexico and it could be added.

Mr. Waugh said we cannot, because that is not what the work looked at. This is where we had information and why it is focused the way it is..

Dr. Oxenford said if the geographic terms that you use here that have caused us to miss part of this. When we get down to agreeing that the working hypothesis should be a two stock model, in the western Atlantic and the northern stock should include dolphin from the Gulf of Mexico, what do you call Puerto Rico and USVI? Should we put the U.S. Caribbean in there?

Mr. Waugh said we could put the Puerto Rico and the USVI.

Mr. Waugh asked if there was anything else on that second page? He said we will be getting that FAO Species Guide for the distribution information. Also, we have to track down some of the distribution information and the seasonality where the blanks are.

Dr. Dean asked what was the intent of that sentence to support economically important fisheries for Bermuda through the Caribbean to Tobago and not address the coastal waters.

Mr. Murray said that it was assumed that "Bermuda through" would include that, because southward, all of that area the band of Bermuda waters are important.

Dr. Luckhurst said north and downward.

Dr. Nelson said it probably needs some clarification because some people will stumble on this.

Dr. Oxenford said some people will because she understood this to mean that these weren't economically important.

Dr. Luckhurst said that the term economically important is irrelevant here.

Mr. Waugh said so are we including the southeast US?

Dr. Nelson said you may want to use, "support economically important fisheries in the US, Bermuda, and through the Caribbean to Tobago." He will e-mail the Florida landings next week.

Mr. Waugh said under dolphin mortality rates those total values will be converted into annual and then we will show those in detail.

Dr. Oxenford asked if you were going to put in actual annual, because that's what it means.

Dr. Nelson added we need to rewrite the last sentence to make it clear those percentages are the percentages that die before age 2.

Mr. Waugh said on page 4, the wahoo actual annual mortality values will be filled in.

Dr. Oxenford said this table is supposed to be equivalent to the other ones, so that it read mortality model used, length based catch curve and the years would not be included.

Mr. Waugh questioned if he should not show the years?

Dr. Oxenford said correct.

Dr. Nelson stated on the last sentence where you talk about the batch fecundity/length relationship, 85,000 to 1.5 million, you just need to make it consistent with what you do in the next page for wahoo.

Dr. Nelson said if this does exist then we need to put that in Also, on Diet, 2.5 we need to change that title to Trophic Relationships, and in addition to the summary data on prey items, we should add a sentence or two on the anecdotal or subject stuff we discussed on the potential predators. So, we would include both their prey items and potential predators, which would be our best guess all the other big fish that swim around the same areas with them: tunas, sharks, marlin, etc.

Mr. Waugh clarified then it would be trophic relationships and add the predators/prey relationship.

Dr. Nelson said yes, there really wasn't a lot of quantitative information on predation.

Dr. Luckhurst said these figures add up to 101%, so you would have to knock down the invertebrates 2% and then use 98%.

Mr. Waugh said this is the problem with rounding.

Dr. Nelson questioned when you talk about juveniles of large oceanic pelagic species, tuna, billfish, jacks, and dolphin (2.5.1) where did it come from?

Dr. Oxenford said it was lifted from a review paper she did on the feeding habits of dolphin.

Dr. Nelson said although there are traces in some of those studies weren't there occasional billfish and juveniles dolphin and they weren't really significant portions of their diet.

Dr. Oxenford said this is not to mean it is significant, it is just showing the range. They eat different types of things, large and small pelagics.

Dr. Nelson added here or at some point it would be important to give the relative importance of those things. There will be arguments made that if we kill off all the dolphin then we will have more billfish and tuna. He has heard this argument before, because dolphin are such various predators of billfish that we should go out of our way to destroy as many of them as we can. The studies in fact show that billfish are a very minute portion of their diets.

Dr. Oxenford said we could have a second paragraph there that says what are the top ranking species and then just state these studies from the northern area.

Mr. Waugh asked 3 lines from the bottom?

Dr. Oxenford said add another paragraph in there and lift it from the feeding habits paper.

Mr. Waugh said he has a note to add that.

2.5.2 Wahoo

Dr. Nelson said to put an, "and," in after pompanos and that should be, "invertebrates."

2.6 Stock Status and Management Implications

2.6.1 Dolphin

Dr. Oxenford noted under, "C" there is a sentence missing which is our fault, it should read, "That a yield-per-recruit approach to selecting a management target is probably inappropriate since even the more conservative F 0.1 values are likely to lead to significant reduction in spawning stock biomass."

Mr. Waugh said we added a sentence to "D." Status quo reflects trends in the fishery over the last five years through 1997. This would give an indication as to what status quo means.

Mr. Chapman said in this section, as a separate item E, we may want to include something to the effect that given the growth rate and the longevity of these species, even if they are over harvested they can recover fairly quickly.

Dr. Nelson said if you wanted to add this it should go back in the discussion of the Barbados assessment. where you have the paragraph that talks about the steep initial slope in the stock recruitment relationship. In the fact that you get close to the edge and go down. You might at that point want to add some discussion of the potential resiliency.

He noted that we are talking about a precautionary approach and his preference would be the second sentence should read, "This will require that the current catch levels not be exceeded," as opposed to reading, "current catch levels be maintained."

Mr. Hinman said he is not sure it is appropriate to address this under this section, as far as management implications are concerned, that they can be rebuilt rapidly. Because under the Magnuson-Stevens Act it is prohibited to over harvest. So this is not really a management issue, so much as a biological fact. We are not permitted by the law to overfish and then rebuild, we are required to prevent overfishing.

Also, the status quo reflects the trends in the fishery for the last 5 years through 1997. This is something he knows will be discussed during public hearings, what year will we choose within this for the highest levels or average the catches. Some people will argue for this, but others will argue to average catches over that period.

Dr. Oxenford said we have to use averages.

Mr. Hinman said this should be stated in here because trends in that period might be interpreted as meaning increasing to their highest point during that period.

Mr. Murray and Dr. Oxenford both concurred they have to use average values.

Mr. Murray said we can just remove trends and add average values.

Mr. Waugh asked if they were getting to average catch levels and effort levels?

Dr. Oxenford said yes, and behavior, etc.

Mr. Murray said we might want to say "reflect" as in "might reflect," which leaves it open for discussion.

Dr. Nelson said this would be a good change because this will be interpreted as making a direct recommendation of how allocations should be determined.

Dr. Oxenford said what we are trying to say is that at the moment everything is okay, just freeze it.

Mr. Waugh said he would like everyone to speak into the microphones to have this on the record, because he believes this is going to be bone of contention. His understanding is that this clarification was to indicate what you meant by status quo and not a recommendation as to what should be used for allocations.

Dr. Nelson said he believes this is clear up there now.

2.6 Data Collection and Research Methods

Mr. Waugh said on page 6, data collection and research has been reworked as well. He didn't believe we needed to go through this in detail.

Dr. Nelson asked if it changed, any specific recommendations or did he just amplify on what was there.

Mr. Waugh said he added a paragraph after outlined and effort should be directed, item 10.

Dr. Oxenford said it should read, "effort should be directed in the short term after examining all existing main size and life history data for dolphin."

Dr. Dean said move that section calling for a regional working group to the lead in and it should be very generic, because at this point we don't know everything, so we don't want to exclude anything. This would include, but not be limited to the following, the genetics work and all of that would fall under that.

Mr. Murray noted it should say, "include, but are not limited to the following." Also, "in the short term examine all existing data."

Dr. Nelson asked if you shouldn't add landings data in there?

Mr. Murray said this means the same thing.

Dr. Oxenford said you can add effort and landings

Mr. Campos noted we say critical habitat, is there any way we could imply essential fish habitat, under number 9, page 6. That is the terminology that we are using.

Mr. Waugh said that was a comment made yesterday

Dr. Oxenford said since we are trying to stop trips directed on dolphin, there isn't any need for that is there? So, let's just take it "that are directed on dolphin."

Mr. Waugh noted the only problem with doing that is we want to get information on those directed trips, and the way those trips are selected now is they just sample it across all longliners. Therefore, we are not picking up those trips.

Dr. Oxenford said the observer program should include all trips non-directed and directed on dolphin. If you have a program which is already in place.

Mr. Waugh explained they would say they are already including them.

Dr. Nelson added they will say that if they include them to the extent their 5% subsample of all the total trips will ultimately pick up some trips.

Mr. Waugh said maybe.

Dr. Nelson said the observer program should read, "place observers on longline trips."

Dr. Oxenford said then it wouldn't be bycatch, it is a directed dolphin catch. She questioned why you would look at bycatch if you are interested in directed dolphin catch.

Mr. Waugh said in the Magnuson-Stevens Act they have placed increased requirements to look at bycatch and we just need to make sure we get the bycatch information from these trips.

Dr. Oxenford questioned that the bycatch from the directed longline trip would be something else.

Mr. Waugh said that is correct, but the way they are selecting the program they are already selecting enough of those swordfish trips. What this would do is to target those trips that are focusing on dolphin. We want the same bycatch information and not just the dolphin information.

Dr. Nelson said just put catch and bycatch characterization.

Dr. Cramer said the potential problem is if there are regulations to discourage this kind of trip, there may not be any to observe.

Dr. Nelson said on the other hand we probably won't get these regulations into effect for 2 years .

Mr. Murray added in the short term.

Dr. Nelson said you are making recommendations but ultimately the council will decide what they want to do, but this does cover it.

Mr. Waugh said this is something for us to debate at the council level but it would seem to him for the NMFS to meet the requirements of the Magnuson-Stevens Act with the additional bycatch requirement, they should now, on their own, make an effort to target these vessels so they can characterize the bycatch on these directed dolphin trips.

Dr. Cramer pointed out that it could be quite problematic.

2.7 Annotated Bibliography

Mr. Waugh said we do have a list which was proven by Dr. Dean and copies are available.

3.0 Alternatives for Council Management Program

3.1 Management Unit

Dr. Nelson said he wanted to make the second paragraph dealing with wahoo consistent with the first paragraph dealing with dolphin. The first one describes the stock and the management unit for wahoo is the U.S. EEZ

Mr. Waugh noted that this group is making recommendation for.....

Dr. Nelson said we are going to be putting the most likely assumption on stock structure for dolphin and we are including the northern carousel. Some of that is not in the US EEZ and the paragraph recognizes it by stating that this is the stock. But what the management unit would be and describes the Atlantic, Gulf, and Caribbean US EEZ, excluding Bermuda. Similarly we talking about the assumption for the wahoo which would be the western Atlantic.

Dr. Oxenford said no it should include Bermuda and this was a mistake on their part. You have to recognize this as a management unit.

Dr. Nelson said then this is just a management terminology, the management unit is term of ours within Magnuson-Stevens Act and the US fishery system. It means exactly what you extending your management to and at times it does not extend across the entire US EEZ stock.

Dr. Oxenford noted the dolphin paragraph should have Bermuda in it and the list of areas we are including.

Dr. Nelson said he preferred if you do this that you don't use the term management unit. You need to come up with another term because management unit means something specific in the US which you are not trying to say.

Mr. Chapman asked if we could call it a stock?

Dr. Nelson said this would be one way to do to just leave out management unit and describe where that stock is included.

Dr. Oxenford said if you are using management unit, whether or not you have regulations within the states, the Law of the Sea says that you have to collaborate with other countries according to who shares your stock. If you recognize that your stock is shared by these other countries then international law says that has to be your management unit.

Mr. Murray said maybe something along the order of saying, "as indicated in the working stock hypothesis for two stocks in the western Atlantic and for the purpose of, or within the context of the US jurisdiction, this would include all dolphin, etc."

Dr. Nelson said we could just say, "for the western Atlantic," and just strike it up to "occurring", then say "occurring within the northern areas of Puerto Rico, Bermuda, Bahamas, and Virgin Islands." Then you are describing the unit stock we are working on.

Mr. Murray said you have a two stock hypothesis and you are only describing one stock.

Dr. Oxenford said the management unit should be the northern stock.

Dr. Nelson reiterated by using the term management unit here, it has a legal implication. Therefore, when stating it that way you are going to open up the argument, if this is the case there should be no effort taken to do any domestic regulation for dolphin fish until there is an international accord to do management through the unit stock. If that is what you want to suggest, then go ahead. I'm just trying to give you the implications.

Mr. Murray said typically you want a phase that brings out the fact that what you want to look at is all the dolphin in this area for the northern stock.

Dr. Cramer said this stock is considered to be all wahoo occurring within.

Dr. Nelson said "there is a two stock model for the western Atlantic and the northern stock is considered to be", which includes Bermuda, Bahamas, etc.

Dr. Oxenford said we have to forget management unit.

Mr. Leard said you can use management structure and not management unit.

Mr. Waugh noted that what we are doing here is laying out options for management, and Dr. Nelson is entirely correct. The way this is worded it is not an option the councils can use. It may be the structure that you feel should be managed as one unit. What about inserting another alternative that would have the management unit be the area under the jurisdiction of the council.

Dr. Oxenford said the northern stock for dolphin is such and the management unit could be the US EEZ.

Dr. Nelson said then you will be using the management unit consistent with the way the council does. The council's regulations would not effect Bermuda, but they could write suggestions to look into the fishery and tell them how they would benefit by our efforts.

Mr. Waugh said the new 3.1.1 Dolphin, is the northern stock includes all dolphin, and the southeastern US, the waters offshore the state of Virginia through Maine and Bermuda. The management unit could be those dolphin occurring in the US EEZ Caribbean FMC gulf, Mid-Atlantic, and New England.

Mr. Murray said we should do the same thing for wahoo.

Dr. Nelson asked the reason you have decided this should be the hypothesis is because in the absence of any other information it is the simplest hypothesis?

The panel said yes.

3.2 Size Limits

Dolphin

Mr. Hinman said perhaps a clearer differentiation between the pelagic longline fishery where dolphin are a bycatch and a target among some boats versus the directed longline fishery that is primarily targeting dolphin. When you say passive fisheries, for an example, pelagic longlining, because this describes a fishery where the majority of the dolphin are dead when retrieved. Also, in the next sentence there may be some benefit from size limits in the longline fishery which primarily targets dolphin. This may make it more clear that you are talking about two different type of longline fisheries. Then in the rest of that sentence it would make it clear why you are saying this if you add, given that the short length of gear and short soak time characteristic of this effort enhances, or may enhance, the survival of the fish that must be released by regulation. As it is written it really doesn't say why that shorter soak time would make this an appropriate measure.

Dr. Cramer questioned if we actually know that?

Mr. Hinman said we could just say, may enhance survivability. That whole statement which says there may be some benefit is predicated on that possibility.

Dr. Nelson said, so what you are saying is those characteristics might increase the utility of using a size limit?

Mr. Hinman said because more of those fish might be released alive, although you don't say that or explain why the utility. Therefore, you have to elude to this and maybe it is something that should be looked at.

Dr. Nelson asked how long is this gear and why is it called short gear?

Dr. Oxenford said short compared to the offshore sets.

Dr. Nelson said then we should just say reduced because we already know it is smaller, may be reduced length and reduced soak time in comparison.

Mr. Hinman said he also thought there needs to be some further discussion as to how the minimum size limit for commercial sale might work. He asked if the panel was proposing that size limit would just apply to the commercial sale from fish caught from vessels using passive gear? So, this is not a market prohibition on the sale of fish under that size limit. Those fish can still be sold by other troll vessels, but not by certain vessels using certain gear.

Dr. Nelson noted that it is adequately expressed the way it is written in there.

Mr. Hinman said his next question is this workable?

Dr. Oxenford said in the biologically set to a minimum size or even in full maturity it should have the same range of 550 to 600 or what we have in there, you just need to put in a 550 in there. There was some research in Florida which said full maturity was reached at 550.

Mr. Murray said where you have hence, delete after that and insert "should be monitored."

Dr. Nelson questioned the example of 6 fish, was this based on some analysis bag limits, why should we put a specific number in there?

Dr. Oxenford said that was a number that was being thrown around the floor yesterday.

Ms. Hass noted a range from 5 to 10 would be better.

Dr. Oxenford concurred.

Dr. Nelson said he just wants to know why they put that in there.

Dr. Oxenford said this is not their document, it is only their recommendations.

Dr. Luckhurst questioned if we should use a range?

Dr. Nelson said if the 5 to 10 range is justifiable then it is a good range. He said the section on wahoo there is insufficient information to justify bag limits. He asked if there was just not enough information to justify the use of bag limits, or not enough data to address whether or not bag limits were useful.

Dr. Oxenford indicated address was the right word.

Ms. Hass said she doesn't want, after further, in there.

Dr. Nelson said you could just say expansion.

Dr. Oxenford said then take out the word further.

Dr. Nelson said let's just strike the word, "further," and start the sentence with the word, "expansion." Also, in the discussion of wahoo trip limits, would it be better to change justify to address.

Dr. Oxenford said yes.

Dr. Oxenford asked Ken Hinman if he wished to have the word pelagic longline used to describe what we were calling offshore longlines? We are talking about the ones that are not targeting dolphin.

Mr. Hinman said yes.

Dr. Oxenford questioned whether they use both hook and line and troll fishery?

Dr. Nelson indicated that both terms are used.

3.5 Control Date

Mr. Waugh said they are now on the control date.

Ms. Hass questioned in 2 years, is this going to limit the swordfish fishermen from coming in.to target the dolphin?

Dr. Oxenford said yes, if this is in place. This will stop them from doing that.

Mr. Hinman said he wanted to add a new alternative to be added to the options. It was mentioned that since we do want to be cautious and freeze things then we should say something about allowable gear in the fishery. There may be some potential changes and people could bring in things like netting, trawling gear, etc., to target dolphin.

Mr. Murray said this should be added under 3.8, Other Potential Alternatives.

Mr. Hinman said for participation in a directed fishery there are certain allowable gear to be used.

Dr. Nelson said this would go hand in hand with the recommendation that effort not be expanded. So, they couldn't use a new gear with increased catchability, etc.

Dr. Oxenford said it is that certain trend we want to have maintained.

Mr. Waugh asked if we should put something in or is this covered by the recommendation?

Dr. Oxenford said yes, we are putting something in under 3.8.

Mr. Waugh said this then raises the question of what we want to do 3.6 through 3.8, because we have had no discussion on those topics.

Dr. Nelson asked if this was the closed area and time areas?

Mr. Waugh said yes.

Dr. Nelson said then why not a simple statement that some time and/or areas closures may have some utility in managing the fishery.

Dr. Oxenford said especially when critical habitat has been identified. Then add the word, "qualified."

Dr. Nelson stated the wording as, "the use of primary closures may have some utility in managing the fishery especially when critical habitat is identified."

Dr. Oxenford said you have to use the same format in 3.6.1 and 3.6.2 for dolphin and wahoo. Asked if he could change, "especially with," to "especially when?" Then insert, "further qualified, and/or nursery grounds." We could expand on this issue and maybe a more appropriate method of preventing the exportation of small fish is to use time/area closures rather than using minimum size limits.

Mr. Waugh asked if he should use the same for wahoo?

Dr. Oxenford said yes.

3.7 Allocations Between Recreational and Commercial Harvesters

Dr. Oxenford noted the current conflict situation calls for allocation and not necessarily quota, but methods of allocating.

Dr. Nelson said he would think that given the indication that conflict between gear types and user groups is the main problem in the fishery that some type of explicit allocation should be used. He didn't think that any of the group has visited the issue in depth enough to try to discuss what appropriate allocations should be, but certainly, setting the different gear types and trying to establish.

Dr. Nelson said ultimately this would come to the allocation of catch probably.

Mr. Hinman said to use fair and equitable

Ms. Hass said if you use fair and equitable, you will start with the percentages at 90/10 or 95/5 which are now 50/50 and this is not at all fair or equitable based on historic fishing.

Dr. Nelson said those distinctions are for the council to make. The important point here is there is a conflict between users, and we are trying not to expand the fishery. So, if we are going to resolve the conflict between the users, without expanding the fishery, we are going to have to set allocations to let those sectors know what they are going to be able to catch.

Ms. Hass said based on historic catches.

Mr. Murray said we have done some form of this earlier by size limits, etc.

Dr. Nelson said you are saying no expansion of the fishery and there is this conflict. So you could have no expansion of the fishery or the same level of harvest by switching the allocation to let the commercial sector to take 90% and the recreational sector 10%. This would then satisfy the requirement for not expanding the fishery. However, it would not address the conflict in the fishery, so you will need some type of allocation.

Dr. Oxenford said the wording could be, "given the current conflict situation and the desire to not allow further expansion of the fishery."

Mr. Hinman said it may be worthwhile to put in preserving historic participation. This does go hand in hand with this.

Dr. Nelson said there are different ways to look at allocations, one is historical participation, but if you have a very detailed cost benefit study you might set your allocations based on the best overall economic benefits. The way it is worded is fine.

Dr. Dean said this allows us to go to public comment.

Dr. Oxenford said this could be based on recent participation.

Mr. Waugh asked what is considered recent?

Dr. Nelson said he likes this and believes it is adequate without the addition. The reason for allocation is to solve the two problems which have been identified, eliminate conflicts and to prevent further expansion. Those are the scientific sound management reasons for allocation. Who gets the fish is beyond the scope of this and we will all have our arguments for this.

Mr. Murray asked if this goes for both dolphin and wahoo? There is no conflict with wahoo.

Dr. Nelson said both of those fisheries have the same dynamics, except the wahoo catches is so much less.

Mr. Waugh said wahoo should be the same as dolphin.

Dr. Oxenford noted there isn't a conflict situation at the monument for wahoo she is aware of. She said given the goal, "preventing further expansion and future conflicts," is how it should be worded.

Mr. Hinman said we just have to tie the management plan to further expansion and user groups. The management plan should establish allowable gear.

3.8 Other Potential Alternatives

Ms. Hass noted that gear restrictions may be necessary.

Dr. Nelson said this is not a matter of restriction so much as it is using the philosophy of saying, this gear is allowed in the fishery. Which means if someone comes up with a new and better mouse trap, before they can start using it they have to come and persuade us they can use it. As opposed to saying you can't use this type of gear, that is if someone finds a way out of those definitions then the gear is being used in the fishery and you can't do anything about it until you catch up to it. Which is sort of a philosophical tact we have been taking, and what the Magnuson-Stevens Act has adopted as well.

Dr. Luckhurst indicated that maybe it should be designation of allowable gear?

Dr. Nelson noted designation of allowable gear is a good description.

Mr. Murray asked when does it become allowable gear?

Ms. Wingrove added for future expansion and conflicts.

3.8.1 Co-Management

Dr. Oxenford said forget it.

Dr. Nelson said you can add another sentence saying, "managers might consider alternative measures of management including Co-management in the future." Just leave alternative management and don't have other categories.

Dr. Oxenford said to leave it and say, "management approaches."

Dr. Nelson suggested given disparate geography and cultural context in which this fishery is operated throughout the management range, and the previous recognition of the need for regionalization, the idea of experimental management might be considered. Given that we don't know a great deal about this creature and we may want to try to use different management regimes in different areas just to see how things work. So, maybe you can use co-management or experimental management in there.

Mr. Hinman questioned if allowable gear shouldn't stand alone there because it there seemed to be strong consensus about it?

Dr. Nelson said structurally that would make sense because they have a category of potential alternatives and we only list on, so 3.8 should become allowable gear. Then we have alternatives below this.

Dr. Oxenford added then 3.9 will be alternative approaches.

Dr. Nelson noted this has been very constructive and thanked the panel for attending this meeting to help the SAFMC to get started. He said we would like to return the favor at which time the other countries would like to supply the labor.

Dr. Luckhurst said this has been a learning experience.

Number of tapes used (11)

Transcribed by:
Deb Buscher
June 1, 1998

SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

DOLPHIN/WAHOO WORKSHOP

TOWN & COUNTRY
CHARLESTON, SC
MAY 6-8 1998

SUMMARY of Recommendations

Stock Structure & Migratory Patterns

1. Dolphin: **"to use Dr. Oxenford's work as the hypothesis and as the structure that is supported by the work now. Then we will indicate in research section, both short and long term, information which is needed."**

2. Wahoo: **"the stock structure is unknown and under research data needs and recommendations what needs to be done."**

Natural Mortality

3. Dolphin: **"use these values between 96 and 98 percent dying before age 2.** *(use Dr. Oxenford's work as the table 11. mortality estimates for dolphin fish (Corphaena hippurus) from the western central Atlantic dying before age 2 so it would be age 1 plus - total mortality not for this stock)*

4. Wahoo: **"there isn't enough information for wahoo to make a decision."**

Growth Rate & Longevity

5. Dolphin: **"use the maximum longevity of 4 years with most of them dying in less than 2 years and then we will pull an average value from the range of growth rate estimates available, roughly 1-1/2 to 4 millimeters per day."**

6. Wahoo: **"to use Dr. Hogarth's and Dr. Luckhurst's works."**

Age/Size at First Reproduction & Fecundity

7. Dolphin: **"the size at first reproduction is 350 to 520 millimeters for full reproduction it will be 550 to 600 millimeters, noting males mature slightly larger than females."**

8. Wahoo: **"we pull the values out Bill Hogarth's work and then also include Dr. Luckhurst's preliminary results."**

Stock Status

9. Dolphin: "this overview will go into the report as an indication of what we think the current status is, recognizing that we do have the different groups as well as the panel's recommendations."

10. Wahoo: "that it is basically unknown at this time and we are just collecting data."

Alternatives for Council's Management Programs

Management Unit

11. Dolphin: "using the Gulf, the South Atlantic, and north of North Carolina where they occur. Basically, include the area that was discussed in the diagram and it would include portions of the Caribbean Council's area (Puerto Rico, Virgin Islands, and Bahamas).

12. Wahoo: "if the council's were to go forward with management then there should be coordinated management between the council's approach and what approach would be done further down in the Caribbean."

Size Limits-Recreational & Commercial

13. Dolphin "use of the minimum size would have problems, in the general longline fishery directed on dolphin to the extent there is one, it may have some feasibility."

"Also, we need to monitor the effectiveness of the size limits which are in place and determine to what extent they are effective. Then indicate the potential problems with minimum size." "24 inch is 60 centimeters exactly and 100% maturity according to the data which has been presented."

14. Wahoo: "we have too little information to consider a size limit at this time."

Bag Limits - Recreational & Trip Limits - Commercial

15. Dolphin: "bag limits on dolphin on the recreational side." "For the dolphin, bag limits are working; for dolphin trip limits, it is a way to influence the targeting of dolphin by the commercial longliners."

16. Wahoo: "then for wahoo the panel recommended holding the status quo and not encouraging increased exploitation. Then look at the available information to evaluate area specific bag limits or other regulations that might be necessary."

Control Date

17. Dolphin/Wahoo: "hold the participation on the commercial side to the level participants we have now for dolphin and not wahoo."

Appendix D. List of Papers Presented and/or Discussed at the Workshop.

Papers Presented at the Workshop & Included in the Proceedings

1a. Biological characteristics of the dolphinfish (*Coryphaena hippurus*) in the western central Atlantic: a review. Prepared by Dr. Hazel A. Oxenford, MAREMP, University of the West Indies, Barbados.

1b. Dolphinfish fisheries in the Caribbean region. Presented by Dr. Hazel Oxenford and prepared by Dr. Robin Mahon.

2. A review of research results on the biology of dolphinfish (*Coryphaena hippurus*) and wahoo (*Acanthocybium solandri*) landed by St. Lucian fishermen. Prepared by Mr. Peter A. Murray, OECS, St. Lucia, West Indies.

3. Bermuda's commercial line fishery for wahoo and dolphinfish: landings, seasonality and catch per unit effort trends. Prepared by Dr. Brian Luckhurst and Tammy Trott, Division of Fisheries, Bermuda.

4. Characterization of the Dolphin Fish (Coryphaenidae, Pices) Fishery of the United States Western North Atlantic Ocean. Prepared by Dr. Nancy Thompson, National Marine Fisheries Service, Miami, Florida and Presented by Dr. Jean Cramer. Figure showing dolphin reported kept by longline gear prepared by Dr. Jean Cramer.

5. Stock Structure of dolphin, *Coryphaena hippurus*, in the western central Atlantic, Caribbean Sea, and Gulf of Mexico as determined by molecular genetics techniques. Prepared by Ms. Robyn Wingrove, College of Charleston, Charleston, South Carolina.

6. MFC finfish committee information paper - longline fishery. Prepared by Dr. Louis Daniel, Division of Marine Fisheries, State of North Carolina.

7. Overview of South Atlantic exvessel price trends for the common dolphinfish (*Coryphaena hippurus*). Prepared by Mr. Ray Rhodes, South Carolina Department of Natural Resources, State of South Carolina.

8. The South Carolina recreational fishery for dolphin. Prepared by Mr. Don Hammond, South Carolina Department of Natural Resources, State of South Carolina.

9. The South Carolina commercial fishery for dolphin/wahoo. Prepared by Mr. Charlie

Moore, South Carolina Department of Natural Resources, State of South Carolina.

Papers Discussed at the Workshop & Included in the Proceedings

10. Assessment and management of dolphinfish in the Caribbean. Robin Mahon and Hazel A. Oxenford. Working Paper prepared for: Workshop on the Biology and Fishery of Dolphin-fish and Related Species, 20-23 October, 1997, Palma de Mallorea, Spain. Currently under review: Scientia Marina.

11. Preliminary dolphin/wahoo bibliography. Prepared by Dr. John Dean and USC students.

Biological characteristics of the dolphinfish (*Coryphaena hippurus*) in the western central Atlantic: a review

By

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ABSTRACT

The dolphinfish, *Coryphaena hippurus*, is a circum-tropical oceanic epipelagic species which is of significant importance to both commercial and sport fisheries in the western central Atlantic. Despite this, little attention has been paid to conducting biological stock assessments and developing management strategies for this species, and it remains unmanaged across most of the region. This paper summarizes aspects of the biology of dolphinfish, relevant to assessment and management, from studies of this species in the southeastern United States, Gulf of Mexico and the Caribbean. Throughout their range in the western central Atlantic, dolphinfish are seasonally abundant and presumed to be highly migratory. They exhibit high growth rates, early maturity, batch spawning over an extended season, a short life span and a varied diet. Marked differences in some biological characteristics and in the frequency of IDH-2 alleles between dolphinfish from the southeastern USA and the Caribbean suggest a relatively complex stock structure for this species, which needs further investigation before management strategies are developed for dolphinfish across this region.

WORKING PAPER PREPARED FOR: Workshop on the Biology and Fishery of Dolphin-fish and Related Species. 20-23 October 1997, Palma de Mallorca, Spain. 52pp.

PRESENT STATUS:

UNDER REVIEW: by Scientia Marina

PRESENTED AT: SAFMC Workshop on Dolphin/Wahoo, 6-8 May 1998, Charleston, South Carolina, USA.

INTRODUCTION

The dolphinfish (*Coryphaena hippurus*) is one of relatively few circum-tropical oceanic pelagic species. Dolphinfish are found in tropical and subtropical surface ocean water apparently restricted to waters warmer than 20 °C (Gibbs and Collette 1959). They are of significant economic importance throughout their global distribution. In the western central Atlantic they have had a long tradition of seasonal importance to the sports and commercial fisheries of many countries (e.g. Collette 1978, Palko *et al.* 1982, FAO 1994, NMFS 1996; see also Table 1). Despite their wide distribution and economic importance, they have been the subject of relatively few biological studies in the western central Atlantic (Mahon 1996) and species-specific management is virtually non-existant through most of the region. Management is currently restricted to minimum size and bag limits in the state waters of Florida and North Carolina, and is now being considered for federal waters (R. Nelson pers. comm.[1], see also SAFMC 1997).

A comprehensive review of biological data available on dolphinfishes (Coryphaenidae) was undertaken by Palko *et al.* (1982). Here, that review is partially updated by examining the biological data currently available for *Corypheana hippurus* (subsequently referred to simply as dolphinfish) in the western central Atlantic, which is considered to be of direct relevance to fisheries management.

DISTRIBUTION AND ABUNDANCE

Adults: In the western central Atlantic, dolphinfish have been recorded as far north as George's Bank, Nova Scotia (Vladykov and McKenzie 1935, Tibbo 1962) and as far south as Rio de Janeiro, Brazil (Ribeiro 1918, Shcherbachev 1973). However, it is generally considered to be common only from North Carolina, throughout the Gulf of Mexico and Caribbean to the northeast coast of Brazil, and is only seasonally abundant at these locations (see Table 1).

Even though landings of dolphinfish reported to the Food and Agricultural Organisation (FAO) within the western central Atlantic significantly under-represent actual landings of this species (Oxenford in press, Mahon this workshop) they still indicate that dolphinfish are among the top seven oceanic pelagic species landed in this region, giving an indication that they are indeed abundant. There have been no attempts to estimate actual abundance, but time-series of catch per unit effort data for dolphinfish are available for several locations in the Caribbean (see Oxenford 1985, Hunte 1987, Oxenford and Hunte 1987, Mahon *et al.* 1990, Mahon and Oxenford this workshop) and these generally show no indication of stock declines.

Young: There have been few systematic surveys for young dolphinfish over the western central Atlantic. In the Gulf Stream, juvenile dolphinfish (100-400 mmSL) have been reported during spring, summer and fall (Gibbs and Collette 1959). Off North Carolina, young dolphinfish have

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[1]R. Nelson, Director, Florida Marine Fisheries Commission, Talahassee, FL

been reported in March and May (Anderson *et al.* 1956a,b), in late summer (La Monte 1952, Beardsley 1967) and in October (Anderson and Gehringer 1957).

Juvenile dolphinfish (100-400 mmSL) have been reported in the Florida Current in all seasons, but appear particularly abundant in early summer (e.g. Gibbs and Collette 1959, Beardsley 1967).

In the Gulf of Mexico, distribution of larval dolphinfish has been described by several authors (e.g. Powles 1981, Richards *et al.* 1984, Kelley *et al.* 1986, Ditty *et al.* 1994) (Figure 1). They are apparently present in the Gulf from at least April through to November, and are found in shelf and oceanic waters, although more commonly in the latter (Ditty *et al.* 1994). Most occurred in water temperatures at or greater than 24°C (range: 21.4 - 32°C) and in salinities at or greater than 33 ppt (range: 18.7 - 37.8 ppt). Furthermore, particularly high abundance was reported near the Mississippi River delta (Ditty *et al.* 1994). Off Texas, young dolphinfish have been reported in the summer (Pew 1957, Springer and Pirson 1958), and Gibbs and Collette (1959) report juveniles in the Gulf of Mexico in spring and summer.

Larval dolphinfish have been reported off Barbados year-round (Lao 1989), and both larval and juvenile dolphinfish have been sampled in the southeastern Caribbean waters during April/May (Oxenford *et al.* 1995, Hunte *et al.* 1995)

REPRODUCTIVE CHARACTERISTICS

Population sex ratio: There are several references to sex ratio of dolphinfish catches from different locations in the western central Atlantic, and these are summarised in Table 2. Generally females outnumber males in the catch, but sex ratios do appear to differ with size of fish (Rose and Hassler 1974, Oxenford 1985) and with season (Oxenford 1985) (Table 3).

The tendency for female biased sex ratios is believed to result from inadvertent selection for females by fishers as a result of intersexual differences in behaviour of dolphinfish, rather than a real difference in sex ratio at conception or in larval and juvenile mortality rates of males and females (Nakamura 1971, Rose and Hassler 1974, Oxenford 1985). Oxenford (1985) suggested that small-sized males and all sizes of females spend more time associated with floating objects than large-sized males which tend to spend more time in open water, possibly travelling between female dominated schools below rafts. Hence catches of small-sized fish are likely to have a sex ratio approximating 1:1, whilst catches of large-sized fish will be female biased if taken in association with floating objects or male biased if taken in open water. Observations reported by Perez *et al.* (1992) support this suggestion.

Description of maturity stages: Maturity stages of male and female dolphinfish in the western central Atlantic have been described by several authors (e.g. Beardsley 1967, Oxenford 1985, Perez *et al.* 1992; Table 4). It is clear from the similarity of these descriptions that dolphinfish are relatively easy to classify into well defined maturity stages based on a combination of visual observation of the gonads and egg size distributions in females.

For dolphinfish from the Florida Current, Beardsley (1967) described 5 maturity stages (I-immature, II-early maturing, III-late maturing, IV-ripe, V-spent) for females; and 2 stages (I-immature or resting, II-mature) for males, based on visual appearance, and also provided examples of egg size distributions (Table 4a). It was noted that no running-ripe fish were observed.

For dolphinfish from Puerto Rico, Perez *et al.* (1992) described 4 maturity stages (I-immature, II-mature (inactive), III-mature (active), IV-post spawned) for females and 3 stages (I-mature (inactive), I-mature(ripe), III-spent) for males and provided both a visual and a microscopic description for each (Table 4b).

For dolphinfish from the Gulf of Mexico, Bentivoglio (1988) used the 5 maturity stages for females and two maturity stages for males as described by Beardsley (1967) (Table 4a).

For dolphinfish from Barbados, Oxenford (1985) also described 4 maturity stages (I-immature, II-maturing, III-mature, IV-spent) for females, and 2 stages (I-immature, II-mature) for males, noting that fish in running ripe condition were not observed, presumably because this state occurs rapidly and only during the pairing and spawning process. It was also noted that spent males could not be differentiated from mature males. A description of each maturity stage based on visual appearance and an example of the typical egg size distribution for each stage is given in Table 4c.

Age and size at maturity: Several authors have provided size and/or age at maturity data for dolphinfish from the western central Atlantic (Beardsley 1967, Schekter 1982, Oxenford 1985, Bentivoglio 1988, Perez *et al.* 1992; Table 5). Whilst there are differences in both the age and size of dolphinfish at first maturity from different locations, there is general agreement that: all dolphinfish in the western central Atlantic reach sexual maturity in the first year of life, and that females reach maturity at smaller size but similar age to males (Table 5).

In the Florida Current, Beardsley (1967) reported that female dolphinfish begin to mature (reach stage II) at about 350 mmFL (about 6 - 7 months old), at 450 mmFL 50% are mature, and at 550 mmFL 100% are mature, whilst males mature at a slightly larger size (427 mmFL) than females. Schekter (1982) reported first spawning in laboratory reared dolphinfish from the Florida Current at 6 1/2 months old and at an average weight of 2.5 kg (~ 565 mmFL).

In Puerto Rico, Perez and Sadovy (1991) and Perez *et al.* (1992) reported that the smallest mature female observed was 400 mmFL (384 mmSL), but cautioned that more smaller fish need to be examined to more accurately determine the minimum size at maturity. All fish larger than 600 mmFL were found to be mature (i.e. at stage II or more)(Figure 2a).

In the Gulf of Mexico, Bentivoglio (1988) reported early maturing (Stage II) females as small as 275 mmFL (2 months old). However, not until Stage III (late maturing) were at least two distinct size classes of eggs apparent. He therefore concluded that females reach first maturity between 490 and 520 mmFL (3-4 months old).The smallest mature (Stage II) male was 528 mmFL (4 months old).

In Barbados, Oxenford (1985) provided length frequency distributions for male and female dolphinfish at each maturity stage (Figure 3). Females where considered to have reached first maturity when a group of large translucent eggs could be clearly distinguished with the naked eye from the mass of smaller pale orange undeveloped eggs in the ovaries (i.e. Stage II gonads), and males were also considered to have reached first maturity when the testes appeared swollen and soft (Stage II gonads). Females were reported to mature at a smaller minimum size (610 mmSL or 667 mmFL) than males (735 mmSL or 805 mmFL), but at approximately the same age (112 days for females, 108 days for males). By 5 1/2 months (850 mmSL or 931 mmFL for females and 1074 mmSL or 1178 mmFL for males) 99% of fish were reported to be fully mature (Figure 2b).

Gonasomatic indices: Limited gonasomatic index (GSI) data are available for dolphinfish from the western central Atlantic. GSI values for mature individuals have only been reported from Barbados, and range from 1.02 to 7.90% for mature (Stage II and III) females. For mature (Stage II) males they are considerably lower, ranging from 0.19 to 0.48% (Oxenford 1985). Mean GSI values at each maturity stage for both sexes are also given by Oxenford (1985) for dolphinfish from Barbados (Table 6, Figure 4).

Population monthly mean GSI values for both sexes are available for dolphinfish from Puerto Rico (Perez *et al.* 1992) and from Barbados (Oxenford 1985) (Figure 5). Puerto Rico dolphinfish appear to have higher GSI values than Barbados dolphinfish, and show a different seasonal pattern.

Fecundity and egg size: Dolphinfish from the western central Atlantic typically have two or three size classes (batches) of eggs in the ovaries; one heterogeneous size class of small eggs, and one or two more homogeneous size classes of larger maturing or mature eggs (Beardsley 1967, Oxenford 1985, Perez *et al.* 1992; Figure 6). Mean mature egg size appears to vary slightly with location and/or with author, ranging from 0.97 to 1.10 mm diameter (Table 5). Hassler and Rainville (1975) estimated dolphinfish eggs from North Carolina to be approximately 1.3 mm diameter, and Ditty *et al.* (1994) reported a mean size of 1.4 mm diameter from the Gulf of Mexico. However, it should be noted that these apparently larger eggs were collected from the plankton rather than from the ovaries of ripe fish.

Batch fecundity estimates for dolphinfish in the western central Atlantic range from 58,000 to 1.5 million (Table 5) and are strongly influenced by fish size. Batch fecundity - length relationships are available for dolphinfish from Florida, Puerto Rico and Barbados and all show an exponential increase in egg number with fish size; the exponent being between 3 and 4 (Table 5, Figure 7). Dolphinfish from the Florida Current and Puerto Rico appear to have very similar fecundity-size relationships, whilst Barbados dolphinfish appear to be less fecund at size.

Spawning season and location: There are numerous references to time of spawning for dolphinfish in the western central Atlantic (e.g. see Palko *et al.* 1982) which clearly show protracted multiple spawning behaviour. The presence of several size classes of eggs in the ovaries indicates that they are batch spawners and probably spawn at least two or three times in each spawning period (Beardsley 1967, Oxenford 1985, Perez and Sadovy 1991). Schekter (1982) reported almost continous spawning from dolphinfish brood stock captured from the Florida Current and held in captivity for several months.

Off North Carolina, spawning dolphinfish have been reported in May and June (Schuck 1951), dolphinfish eggs have been collected in July and August (Hassler and Rainville 1975), and peak spawning is reported to occur during June and July (Rose 1966).

In the Florida Current, the presence of very young dolphinfish throughout most of the year suggests that dolphinfish spawn there almost year-round (Gibbs and Collette 1959, Beardsley 1967, Shcherbachev 1973, Fahay 1975, Powles and Stender 1976). Beardsley (1967) reports a spawning season from November to July with a peak in spawning activity from January to March.

In Puerto Rico, ripe females occur throughout much of the year (September-June; Perez and Sadovy 1991, Perez *et al.* 1992; Figure 8), although peak spawning events appear, from mean GSI data, to occur in March and in June (Figure 5a).

In the Gulf of Mexico, the presence of small dolphinfish larvae year-round suggests that dolphinfish are spawning all year in the south and at least from April to December in the northern Gulf with possible peaks in the spring and early fall (Ditty *et al.* 1994).

In Barbados ripe and spent fish are reported to occur in all months that the dolphinfish fishery is active (November-June) and peak spawning appears, from mean GSI data, to be from May through June or possibly longer (Oxenford 1995) (Table 7, Figure 5b). Larval dolphinfish occur off Barbados in all months and are most common from February to May (Lao 1989).

Location of dolphinfish spawning in the western central Atlantic is poorly documented, but presumably widely spread, based on reports of the location of ripe fish and small larvae from the southeastern USA, Gulf of Mexico, Puerto Rico and Barbados (see above). Ditty *et al.* (1994) infer from the distribution of very small (less than 7 mm) larvae in the Gulf of Mexico that spawning occurs in the oceanic waters of the Gulf rather than on the shelf there. Oxenford and Hunte (1986) contend that maximum spawning by the proposed northeastern and southeastern Caribbean dolphinfish populations will occur when the dolphinfish are large. For the northeastern stock this will be in the vicinity of Puerto Rico at the most up-current limit of their proposed range. For the southeastern stock maximum spawning is also proposed to occur at the most up-current limit of the migration circuit, off the north coast of Brazil (Oxenford and Hunte 1986).

LENGTH-WEIGHT RELATIONSHIPS, GROWTH RATES AND LONGEVITY

Length-weight relationships, estimated size-at-age, growth rate and longevity data are available for dolphinfish from several locations in the western central Atlantic, and there is general agreement that dolphinfish is a short-lived (most live < 2 yr), fast-growing species (e.g. Rose and Hassler 1968, Beardsley 1967, Schekter 1982, Oxenford 1985, Oxenford and Hunte 1983, 1986, Bentivoglio 1988, Rivera Betancourt 1994).

Length-weight relationship: Length-weight relationships have been reported for dolphinfish from North Carolina (Schuck 1951, Gibbs and Collette 1959, Rose and Hassler 1968), from the Florida Current (Beardsley 1967), from Puerto Rico (Perez and Sadovy 1991, Perez *et al.* 1992, Rivera Bertancourt 1994), from Cuba (Garcia-Arteaga *et al.* 1997), and from Barbados (Oxenford 1985), and are summarised in Figure 9 and/or Table 8). Most report larger mean size and greater weight-at-size for males than females, there appears to be little difference in the length-weight relationships between locations (Oxenford and Hunte 1983) (Figure 10).

Size-at-age and growth rates: Age and growth rates have been reported for dolphinfish from a number of locations in the western central Atlantic using scale annuli (Beardsley 1967, Rose and

Hassler 1968), daily growth checks in otoliths (Oxenford and Hunte 1983, Bentivoglio 1988, Rivera Bertancourt 1994), monthly progression of length frequency data (Oxenford and Hunte 1983, Murray 1985), and length measurements of captive or known-age laboratory reared fish (Herald 1961, Beardsley 1967, Hassler and Rainville 1975, Hagood *et al.* 1981, Schekter 1982). Although marked differences in first year growth rates occur among locations (Table 9), there is general agreement that dolphinfish in the western central Atlantic grow extremely fast (first year growth estimates for wild fish range from 1.43 to 4.71 mm d^{-1}) and have an average longevity of less than 2 years.

In North Carolina, Rose and Hassler (1968) examined scales for annuli in 738 dolphinfish. They found 593 0-group fish (size range: 400-725 mmFL, mean: 572 mmFL), 117 I-group fish (size range: 650-1100 mmFL, mean: 868 mmFL), 20 II-group fish (size range: 900-1300 mmFL, mean: 1108 mmFL), and 8 III-group fish (size range: 1100-1430 mmFL, mean 1269 mmFL). A mean first year growth rate of 1.56 mmFL d^{-1} is inferred from these data. Rose and Hassler (1968) suggested a maximum life span of 4 yr for North Carolina dolphinfish, but noted that 96% die before they are 2 years old. There are also growth rate data for dolphinfish reared in captivity from North Carolina brood stock indicating early juvenile growth of 1.07 mmTL d^{-1} (Hassler and Rainville 1975) and approximately 5.88 mmSL d^{-1} (Hassler and Hogarth 1977). Von Bertalanffy growth curve parameters were estimated by Rivera Betancourt (1994) for North Carolina dolphinfish using data from Rose and Hassler (1968) and are given in Table 10.

In Florida, Beardsley (1967) examined scales for annuli in 511 dolphinfish. He found 121 I-group fish (size range: 400-1175 mmFL, mean: 725 mmFL), 9 II-group fish (size range: 1025-1325 mmFL, mean: 1175 mmFL), 1 III-group fish (1425), and 1 IV-group fish (1525 mmFL). A mean first year growth rate of 1.99 mmFL d^{-1} is inferred from these data (Table 9). Beardsley (1967) noted that males grow faster and appear to reach larger maximum size than females. He suggested that the maximum life span for Florida dolphinfish was 4 yr, although most (98%) die before they are 2 years old. There are also growth rate data for small numbers of dolphinfish held or reared in captivity from wild caught Florida fish or Florida brood stock indicating daily growth rates of approximately 2.65 mmFL for a single fish held in the Miami Seaquarium (Beardsley 1967), 2.73 mmSL for F_1 generation fish (Schekter 1982), 3.91 mmFL for 2 fish held at the Florida Marineland Marine Studios (Herald 1961, cited by Beardsley 1967), and 9.66 mmSL for 4 wild females held as brood stock (Schekter 1982) (Table 9). Von Bertalanffy growth curve parameters were estimated by Pauly (1978) for Florida fish using data provided in Beardsley (1967) and are given in Table 10.

In Puerto Rico, Rivera Betancourt (1994) used daily growth checks in the sagittal otoliths of dolphinfish from 550 - 1325 mmFL, and reported an average first year growth rate of 2.52 mmFL d^{-1} (Figure 11, Table 9). Differential growth rates between the sexes was also reported by Rivera Betancourt (1994) for Puerto Rico dolphinfish, with males growing faster (2.54 mmFL d^{-1}) than females (2.46 mmFL d^{-1}) during their first year (Figure 11). Von Bertalanffy growth curve parameters were also provided by Rivera Betancourt (1994) for all Puerto Rico dolphinfish and for males and females separately (Table 11).

In the Gulf of Mexico, Bentivoglio (1988) used presumed daily growth checks in sagittal otoliths of dolphinfish and reported an average first year growth rate of 3.88 mmSL d^{-1} (4.15 mmFL d^{-1}) for fish of size range 250-1200 mmSL (Figure 12), and 0.49mmSL d^{-1} (0.61 mmFL

d^{-1}) for large-sized fish (850-1200 mmSL). Bentivoglio (1988) reported a longevity of less than 1 yr. Von Bertalanffy growth curve parameters were also provided for dolphinfish from the Gulf of Mexico by Bentivoglio (1988) and by Rivera Betancourt (1994) using Bentivoglio's data (Table 10).

In the eastern Caribbean, Oxenford and Hunte (1983) did not detect any scale annuli in 558 dolphinfish from Barbados, but were able to read presumed daily growth checks in the sagittal otoliths of dolphinfish from 174-1100 mmSL, inferring an overall average first year growth rate of 4.71 mmSL d^{-1}, and an average growth rate in large fish (600-1200 mmSL) of 1.43 mmSL d^{-1} (Table 9, Figure 13a). Monthly progression of the mean size of dolphinfish landed by the commercial fishery in Barbados indicated a similar growth rate (1.53 mmSL d^{-1}) for large fish (600-1200 mmSL) (Figure 14). Differential growth rates between the sexes was also reported by Oxenford (1985) for Barbados dolphinfish, with males growing faster (5.77 mmSL d^{-1}) than females (4.23 mmSL d^{-1}) during their first year (Figure 13b). Oxenford (1985) found no fish older than one year and concluded that Barbados dolphinfish are essentially annual, living to a maximum of around 14 months. Von Bertalanffy growth curve parameters and growth performance factor (P; from Pauly 1979) were also provided by Oxenford (1985) for all Barbados dolphinfish and for males and females separately (Table 10, Figure 15). Murray (1985) used the probability paper method of Cassie (1954) to examine monthly progression of size frequency data for dolphinfish landed by the commercial fishery in St. Lucia, and concluded that it was possible to follow five growth trajectories showing growth rates of between 32 and 81 mm per month. These data infer a mean growth rate for adult dolphinfish (693-1674 mmFL) from St. Lucia of 1.78 mmFL d^{-1} (Table 9). Murray (1985) also provided von Bertalanffy growth curve parameters from these data (Table 10).

Mortality rates and longevity: Athough longevity estimates have been made by several authors (see above) there are only three, studies which report mortality estimates for dolphinfish from the western central Atlantic (Oxenford 1985, Murray 1985, Bentivoglio 1988; Table 11).

For Gulf of Mexico dolphinfish, Bentivoglio (1988) used the Robson and Chapman (1961) least squares method to estimate mortality rates from otolith-aged specimens using various time intervals to obtain a range of total instantaneous mortality values (Z) between 8.18 and 8.67 which suggest actual annual mortality rates of between 99.97 and 99.98% (Table 11).

For eastern Caribbean dolphinfish, Oxenford (1985) used the size structure of dolphinfish taken by the commercial pelagic fishery in Barbados (Figure 16a) and size-at-age data (Figure 15a) to determine the size/age at which dolphinfish become fully vulnerable to the fishery (775 mmSL, 4 mo), and to construct a catch curve (Figure 16b) and estimate an annual instantaneous total mortality ($Z = 3.9$). Oxenford (1985) also provided alternative estimates of Z using: the relationship of Beverton and Holt (1956) and an average size of 937 mmSL for fully vulnerable fish; and the relationship of Hoenig (1983) and an estimated t_{max} of one year (Table 11). All estimates predict an actual total annual mortality (A) of between 98.0 and 99.7% (Table 11). Oxenford (1985) also provided estimates of natural mortality for dolphinfish from Barbados, using the empirical for.nula of Pauly (1980), a mean water temperature of 28°C and von Bertalanffy parameters for all fish ($L_\infty = 155.9$ cmTL, annual $k = 3.49$) (Table 11).

Murray (1985) used the catch curve method of Ziegler (1979) to estimate an annual instantaneous total mortality (Z = 3.53) for dolphinfish from St. Lucia, predicting an actual total annual mortality (A) of 97.1% (Table 11). Murray (1985) also provided an estimate of natural mortality for dolphinfish from St. Lucia, using the empirical formula of Pauly (1983), a mean water temperature of 27.5°C and von Bertalanffy parameters for all fish (L_∞ = 236.1 mmTL, annual k = 0.532) (Table 11).

The estimates of total mortality for eastern Caribbean dolphinfish are very similar. However, the natural mortality estimates differ markedly, as a result of using an empirical formula dependent on very different estimates of growth curve parameters for Barbados and St. Lucia dolphinfish. Given that the growth curve for Barbados dolphinfish was estimated from size-at-age using otolith increments over a wide size range of fish (174-1100 mmSL), and the St. Lucia growth curve was estimated from monthly progression of size frequencies of adult fish only (693-1674 mmFL), the former is likely to be more representative.

PREY AND PREDATORS

Diet: Several authors have commented on the diet of dolphinfish from the western central Atlantic (e.g. from the Atlantic: Shcherbachev 1973; southeast and Gulf coast of the USA: Manooch *et al.* 1984; North Carolina: Schuck 1951, Gibbs and Collette 1959, Rose and Hassler 1974; Barbados: Lewis and Axelsen 1967, Oxenford 1985, Oxenford and Hunte this workshop). The relative importance of prey items to dolphinfish reported by these studies is summarised by ranking the top 5 prey items according to frequency of occurrence; numerical abundance; and bulk in Table 12. All studies agree that dolphinfish feed on a wide variety fish and invertebrates, including: juveniles of large oceanic epipelagic species; juveniles and adults of small oceanic epipelagic species; juveniles and adults of mesopelagic species that demonstrate diurnal migrations to the surface; and pelagic larvae and juveniles of neritic benthic species. This suggests that dolphinfish probably forage opportunistically rather than selectively, a feeding strategy that appears to be common among tropical pelagic species.

A comparison of diets by frequency of occurrence of prey items in dolphinfish stomachs is also given in Figure 17 for dolphinfish from the southeastern and Gulf states, North Carolina and Barbados. This indicates a fairly strong similarity in the diets of dolphinfish reported by different studies at the same locations, despite an almost 20 yr gap between them in both cases. It is also apparent that there are geographical differences in the diet, which probably reflect differences in availability of prey items, rather than differential selection by dolphinfish from different locations.

Two studies (Manooch *et al.* 1984, Oxenford & Hunte this workshop) calculated indices of relative importance (IRI) for prey items of dolphinfish, to give a less biased assessment of the diet, and these are given in Table 13 for dolphinfish from the southeastern and Gulf coasts of the USA, and for Barbados.

Variations in the diet of dolphinfish have been associated with predator size (Shcherbachev 1973, Rose and Hassler 1974, Manooch *et al.* 1984, Oxenford and Hunte this workshop), with predator sex (Oxenford and Hunte this workshop), and with season (Manooch *et al.* 1984, Oxenford and Hunte this workshop).

Predators: The diets of other oceanic pelagic species indicate that dolphinfish, particularly juveniles, serve as prey for many oceanic fish. Their predators include large tuna (Parin 1968; *Thunnus alalunga*: Murphy 1914; *T. albacares*: Penrith 1963, Dragovich and Potthoff 1972, Takahashi and Mori 1973, Matthews *et al.* 1977), sharks (Parin 1968; *Hexanchus griseus*: Bigelow and Schroeder 1948), marlin (Sund and Girigorie 1966, Parin 1968: *Makaira nigircans*: Farrington 1949, Takahashi and Mori 1942; *Tetrapturus albidus*: Wallace and Wallace 1942, Nakamura 1971, Nakamura and Rivas 1972; *T. audax*: Abitia-Cardenas *et al.* 1997), sailfish (*Istiophorus platypturus*: Beardsley *et al.* 1972, Takahashi and Mori 1973) and swordfish (*Xiphias gladius*: Gorbunova 1969).

MOVEMENTS, MIGRATION AND STOCK STRUCTURE

Dolphinfish are considered to be highly migratory, being only seasonally abundant over most of their range in the western central Atlantic (Table 1). However, for an oceanic pelagic species, it is relatively small (maximum size 200 cmTL and 25 kg), short-lived (essentially an annual species) and tends to approach coastal waters. It is therefore likely to have a more complex stock structure (i.e. a larger number of smaller stocks with more localised migration circuits) than has been proposed for many of the larger highly migratory truely oceanic species such as the marlins, swordfish and large tunas (e.g. yellowfin, bigeye, albacore) which grow to sizes in excess of 100 kg, are long-lived (> 6 yr) and are considered to have between one and three Atlantic-wide stocks (Oxenford in press).

Movements and migration patterns: Palko *et al.* (1982) report that migrations and movements of dolphinfish are likely to be affected by the movement of drifting objects on the high seas, with which they are often closely associated. Direct evidence of dolphinfish movements within the western central Atlantic are very limited. Although tagging programmes have included dolphinfish in the western central Atlantic (e.g. Rose and Hassler 1968, NMFS 1996, CFRAMP pers. comm.[2]), sample sizes have either been very small or results of dolphinfish tag recaptures have not been published in the primary literature. However, several authors have proposed migration hypotheses for dolphinfish. Oxenford and Hunte (1986) proposed two migration circuits in the northeast and southeast Caribbean, based largely on seasonality of the dolphinfish fisheries by location and mean size at capture. They suggest a northeastern migration circuit incorporating the northern Caribbean islands, the southeastern United States and Bermuda, and a southeastern circuit incorporating the southeastern Caribbean islands and the north coast of Brazil (Figure 18). Dolphinfish following the northeastern circuit are believed to travel northwestwards from around Puerto Rico in February through the Bahamas in April/May, to Florida and Georgia by May/June, South and North Carolina by June/July, and then onwards in a southeasterly direction into the Atlantic, passing Bermuda in July/August and reaching the Virgin Islands and Puerto Rico again by November/December. Dolphinfish following the

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southeastern circuit are believed to travel northwards, passing Grenada in February/March, St. Vincent, Barbados, St. Lucia and Martinique in March/April, Dominica and the Virgin Islands in April/May and then onwards in a southeasterly direction into the Atlantic and back down to the northeast coast of South America.

Part of the proposed northeastern circuit is supported by Mather (pers. comm., cited by Rose and Hassler 1968) who reported 2 tag recaptures showing displacement from the Florida coast 97 km and 260 km northwards. Additional support for this hypothesis is also found in Beardsley (1967) who reported that dolphinfish probably move northward from Florida during spring and summer, and in Gibbs and Collette (1959) who suggested that the spring abundance of dolphinfish in northern Caribbean islands (Virgin Islands and Puerto Rico) may be a prespawning migration, mainly by females. The proposed south to north migration of dolphinfish along the Atlantic coast of the USA is strongly supported in some years by observed patterns of peak occurrence in the sport fisheries (Palko *et al.* 1989). However, in other years their CPUE data for the sport fishery support a synchronised offshore to onshore movement of dolphinfish, possibly reflecting the differences in the distance of blue water from the shore (Palko *et al.* 1989). Perez *et al.* (1992) suggest an alternative westerly migration route for the southeastern dolphinfish population, based on the observation of a second peak in abundance of dolphinfish in Puerto Rico. They suggest that the southeastern population would pass the Virgin Islands and southern Puerto Rico during April/May and migrate either southwest into the Caribbean Sea or westward into the Gulf of Mexico.

In the Gulf of Mexico, CPUE data from the sport fishery indicates an offshore-onshore movement of dolphinfish (Palko *et al.* 1989).

Stock structure: There has been one preliminary investigation of dolphinfish stock structure within the western central Atlantic, which suggests that there are at least two separate unit stocks in the Caribbean Sea, located in the northeast and southeast (Oxenford and Hunte 1986). The hypothesis was based on: observed seasonality (months of peak abundance) and mean size of dolphinfish from commercial and sport fisheries (which suggested two different migration circuits; Figure 18); a comparison of life history characteristics of dolphinfish from North Carolina, Florida and Barbados (which showed marked differences in average first year growth rates, fecundity-length relationships, size and age at first maturity, and mean mature egg size); and on observed differences in allelic frequencies at the IDH-2 locus determined through electrophoresis.

Possible alternative hyptheses of (1) a generalised north-south movement of a broadly distributed population, and (2) a seasonal onshore-offshore movement, have been suggested by Mahon and Mahon (1987). However, no alternative stock structure hypothesis has yet been tested. The proposed location of the boundary between the putative contiguous stocks remains unclear. For example, Perez and Sadovy (1991) noted two abundance peaks and differences in the mean size of dolphinfish landed on the north and south coasts of Puerto Rico and suggested that two populations may be present seasonally in Puerto Rico. However, a comparison of reproductive traits between dolphinfish landed on the north and south coasts of Puerto Rico failed to detect differences between them (Perez *et al.* 1992). Furthermore, a comparison of growth rates of dolphin occurring on the north and south coasts of Puerto Rico failed to find expected differences, and were similar to growth rates of the southeastern stock (Rivera-Betancourt 1994). Three explanations were proposed by Rivera Bertancourt (1994): (i) that Puerto Rico dolphinfish represent the northern extreme of the southeastern stock, (ii) that Puerto Rico dolphinfish belong to a smaller intermediate stock, or (iii) that age and growth studies for the northern study were flawed and that there is only a single stock.

The existence of additional stocks particularly within the Gulf of Mexico and central/western Caribbean is very likely, but has not been investigated. This remains a high priority issue for resolution, if appropriate stock assessments are to be conducted, and management strategies developed for dolphinfish in the western central Atlantic.

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Table 1 Summary of locations and approximate seasonality of commercial and/or sport fisheries for dolphinfish (*Coryphaena hippurus*) within the western central Atlantic.

Area	Location	Approximate seasonality	Selected References
Southeastern USA	North Carolina South Carolina Georgia East Florida	April-Sept	Ellis (1957) Iversen (1962) Beardsley (1967) Rose & Hassler (1969) Hassler & Hogarth (1977) Gentle (1977) Brusher & Palko (1985) Oxenford & Hunte (1986) Palko *et al.* (1989)
Southern USA (Gulf of Mexico)	West Florida Alabama Mississippi Louisana Texas	May-Oct	Baughman (1941) Springer & Pirson (1958) Fable (1981) Bentivoglio (1988) Palko *et al.* (1989)
Central America (Caribbean coast)	Mexico	?	FAO (1996)
Northern Caribbean	Bahamas Hispaniola Puerto Rico US Virgin Islands	Jan-June	Erdman (1956) Olsen & Wood (1982) Appeldoorn & Meyers (1993) Perez & Sadovy (1991) Perez *et al.* (1992) Rivera Betancourt (1994)
Eastern Caribbean	Guadeloupe Martinique Dominica St. Lucia Barbados St. Vincent Grenada Tobago	Dec-June	Mahon *et al.* (1981) Sacchi *et al.* (1981) Murray (1985) Oxenford & Hunte (1986) Hunte (1987) Mahon *et al.* (1990) Mahon (1993) FAO (1996) Mohammed (1996)
Southern Caribbean	Curacao	Dec-July	Zaneveld (1961)
South America	Northeast Brazil	?	Monteiro *et al.* (1996)
Atlantic	Bermuda	March-Dec	Oxenford & Hunte (1986)

Table 2. Overall sex ratios reported for dolphinfish (*Coryphaena hippurus*) landings in the western central Atlantic.

Location	Frequency		Size range (mm)	Sex ratio (m:f)	Reference
	males	females			
North Carolina	428	821	450-1275 FL	1:1.9	Rose & Hassler (1974)
Gulf Stream	30	27	313-1165 SL	1:0.9	Gibbs & Collette (1959)
Florida Current	222	392	-	1:1.8	Oxenford (1985)
Puerto Rico	150	450	-	1:3	Erdman (1976)
	266	622	358-1479 FL	1:2.3	Perez *et al.* (1992)
	55	115	430-1480 FL	1:2.1	Rivera-Betancourt (1994)
Virgin Islands	25	47	-	1:1.9	Mather (1954)
Gulf of Mexico	36	43	250-1210 SL	1:1.2	Bentivoglio (1988)
Barbados	773	2353	400-1200 SL	1:3	Oxenford (1985)

Table 3. Sex ratios by size and season for dolphinfish (*Coryphaena hippurus*) landings in the western central Atlantic

Location	Month	Fish size (mm)*	Frequency		Sex ratio (m:f)	Reference
			males	females		
North Carolina	-	450-600	281	685	1:2.4	Rose & Hassler (1974)
	-	601-800	85	97	1:1.1	
	-	801-1275	62	39	1:0.6	
Barbados	Nov	844	29	17		Oxenford (1985)
	Dec	794	56	23		
	Jan	821	256	94		
	Feb	812	240	59		
	Mar	846	600	150	1:3	
	Apr	925	750	256		
	May	921	330	126		
	Jun	778	56	28		
	Jul	433	24	9		
	Aug	656	2	2	1:2	
	Sept	587	5	1		
	Oct	446	5	5		

* sizes are given as range in mmFL for North Carolina and as means in mmSL for Barbados

Table 4. Description of the gonads at each maturity stage for male and female dolphinfish (*Coryphaena hippurus*) from (a) Florida Current (after Beardsley 1967), (b) Puerto Rico (after Perez *et al.* 1992), and (c) Barbados (after Oxenford 1985)

(a) Florida Current Dolphinfish

SEX	MATURITY STAGE		DESCRIPTION	APPROXIMATE EGG SIZE DISTRIBUTION
Females	I	Immature	Ovaries long, thin, hollow tubes, diameter 3-4 mm; eggs microscopic; ovary wine-red to pink.	
	II	Early maturing	Ovary slightly enlarged; diameter, 10-15 mm; eggs visible to the naked eye through the ovary wall, but no distinct size groups distinguishable; pale yellow.	
	III	Late maturing	Ovary much enlarged; at least two distinct size groups of eggs easily visible to the naked eye; bright yellow to orange.	
	IV	Ripe	Ovary distended, half filling the body cavity; lumen full of large, clear eggs which give the ovary a speckled appearance.	
	V	Spent	Ovaries flaccid, hollow tubes; a few remnants of ripe ova may remain in the lumen or folds of the ovary, usually visible by microscopic examination; dull red and discoloured, particularly at the posterior end; numerous blood clots.	
Males	I	Immature or resting	Testes small, firm to the touch; no milt extruded after cutting and squeezing.	
	II	Mature	Testes enlarged; milt extruded after cutting and squeezing	

(b) Puerto Rico Dolphinfish

SEX	MATURITY STAGE		DESCRIPTION
Females	I	Immature	Small diameter gonad lobules are bright orange, neither eggs nor blood vessels visible macroscopically. <u>*Microscopic description:*</u> *Oocytes stages 1 and 2 (previtellogenic) and perhaps, a few oocytes early stage 3. Lamellae looks compact within a thin muscular tunica (i.e. ovary wall). Small blood vessels surround ovary walls and there is no evidence of prior spawning (i.e. disorganized and loose appearance of ovary, muscle bundles, oocytes stage 4 or atretic bodies).*
	II	Mature (inactive)	Turgid gonad lobules are round and orange colour, eggs and small veins visible macroscopically. <u>*Microscopic description:*</u> *First time spawners have compact ovaries with oocytes in stages 2,3 maybe a few early stage 4 and a thin muscular tunica. Oocyte stage 3 (i.e. early vitellogenic) being to predominate the field of view (i.e. 400x). If previous spawning occurred, ovary shows a slightly disorganized appearance, oocytes stage 3 predominate and few atretic oocytes may be present. Also muscular tunica seems slightly thicker than in immature gonads.*
	III	Mature (active)	Gonad lobules could be completely turgid or slightly flaccid with pale orage or yellow colour. Large translucent eggs visible through ovary wall with large blood vessels surrounding the ovaries. <u>*Microscopic description:*</u> *Oocytes stages 1,2,3 and 4 present. Ripe gonads are completely turgid and mid to late stage 4 dominates the field of view by more that 50% (i.e. 400x). Some hydrated oocytes and postovulatory follicles may be observed. Oocytes stage 4 have distinctive thick zona radiata. Muscular tunica is thin. When female is between spawns, gonad lobules are slightly flaccid and healthy oocytes in late stages 4 and mid 4 may be equally abundant. The muscular tunica gets thick and scattered degenerated oocytes could be observed in a disorganized ovary.*
	IV	Post-spawned	Gonad lobules completely flaccid and reduced in diameter. Blood vessels present. <u>*Microscopic description:*</u> *In early postspawners, many healthy oocytes stage 3 with atretic oocytes stage 4 are observed. In late postspawners, oocytes stage 3 adn 4 may be present. Many atretic oocytes are present in several degeneration stages. Stretched muscular tunica, looks slightly thin like immature ovary but, large compressed blood vessels surround the ovary walls. Disorganized and muscle bundles across ovary are present.*
Males	I	Mature (inactive)	Testes lobules are laterally compressed (narrow), firm and shows some convolutions. Colour may vary with freshness of sample. Most samples collected to date have a dark pink/brown appearance. No milt extrudes when cut or squeezed. <u>*Microscopic description:*</u> *Crypts of spermatogonia and early spermatogenesis develops together around each seminiferous tubule. Gonad small and compact. Few or no sperms are present.*
	II	Mature (or ripe)	Testes lobules are narrow. They could be small and compact like immature testes or have convolutions. Tissue feels soft. Milt may extrude when cut or slightly squeezed. Colour varies from pale pink to white. <u>*Microscopic description:*</u> *The seminiferous tubules are cysts in several stages of spermatogenesis. Throughout the testes, the cysts have the sinuses partially or totally full of spermatides and/or sperm. Seminiferous tubules closer to the central or efferent ducts are connected and elongated, partially or totally full of spermatozoa.*

III	Spent	Testes are flaccid with dark pink/brown colour. They may be confused with immature testes. *Microscopic description: Disorganized appearance and elongated cysts. Crypts of spermatocytes and spermatides are present, but most seminiferous tubules and sinuses are empty and some have remnants of sperms. Some spermatogonia may be observed.*

(c) Barbados Dolphinfish

SEX	MATURITY STAGE		DESCRIPTION	APPROXIMATE EGG SIZE DISTRIBUTION
Females	I	Immature	Bright/dark organge, firm, narrow ovaries. No eggs visible through ovary wall.	
	II	Maturing	Medium orange, firm, enlarged ovaries. Eggs visible through ovary wall and small blood vessels over surface of ovary.	
	III	Mature	Pale orange/yellow, soft swollen ovaries. Eggs and large blood vessels visible.	
	IV	Spent	Pale orange, large flacid ovaries. Few eggs visible and large blood vessels.	
Males	I	Immature	Narrow, slightly lobed, firm testes. Colour varies from pale flesh to dark brown/pink. No milt exudes when cut.	
	II	Mature	Large, highly lobed, soft, fragile testes. Colour varies from pale flesh to dark brown/pink. Milt exudes when cut and squeezed.	

Table 5. Summary of reproductive characteristics reported for dolphinfish (*Coryphaena hippurus*) from the western c

Reproductive parameter	Sex	Florida Current			US Virgin Islands	Puerto Rico	Gulf of Mexico	Br
		Beardsley (1967)	Schekter (1982)*[1]	Perez *et al.* (1992)	Perez *et al.* (1992)	Perez & Sadovy (1991), Perez *et al.* (1992)	Bentivoglio (1988)	Oxenford (1985
Size at first maturity (mmFL)	M	427	565	-	-	-	528	805
	F	350		-	-	400	490-520	667
Size class at 100% maturity (mmFL)	M	-	-	-	-	-	-	1178
	F	550	-	-	-	600	-	931
Approx. age at first maturity (mo.)	M	6-7	6.5	-	-	-	4	4
	F	6-7		-	-	-	3-4	4
Mature egg size range (mm diam.)	F	1-1.7	-	-	-	0.85-1.56	-	0.86-1.25
Mean mature egg size (mm diam.) & sample size (n=no.fish)	F	-	-	1.03 n=3	1.08 n=2	1.10 n=25	-	0.97 n=69
Batch fecundity range & sample size (n=no.fish)	F	85,000-938,000 n=19	-	-	-	219,670-1,548,457 n=25	-	58,000-1,243,7 n=69
Batch fecundity-fork length relationship ($Y=aX^b$) Y is no. mature eggs X is mmFL	F	$Y=2.52\times10^{-4}X^{3.12}$*[2]	-	-	-	$Y=6.03\times10^{-7}X^{3.91}$	-	$Y=2.7\times10^{-6}X^{3}$

*[1] Data are for laboratory reared F_1 generation of Florida broodstock

*[2] Relationship calculated by extrapolation of data from fecundity at size graph

Table 6. Mean gonasomatic index (GSI) at each maturity stage for male and female dolphinfish (*Corypheana hippurus*) from Barbados (after Oxenford 1985)

Females (n)	22	37	28	20
Maturity stage	I - Immature	II - Maturing	III - Mature	IV - Spent
Mean GSI (%)	0.74	1.88	2.87	0.86
Males (n)	44	48		
Maturity stage	I - Immature	II - Mature		
Mean GSI	0.19	0.31		

Table 7. Percentage of mature male (Stage II) and female (Stage II, III & III) dolphinfish (*Coryphaena hippurus*) and mean sizes of both sexes observed in the pelagic fishery catch each month in Barbados (after Oxenford 1985).

Months	Nov.	Dec.	Jan.	Feb.	March	April	May	June
Females (n)	5	3	6	22	40	11	15	4
% Mature	40.0	66.7	83.3	50.0	95.0	81.8	100	100
Mean size (mmSL)	683	867	848	802	897	886	937	835
Males (n)	-	-	-	20	14	7	21	12
% mature	-	-	-	10.0	28.6	57.1	76.2	75.0
Mean size (mmSL)	-	-	-	775	896	934	996	987

Table 8. Summary of length-weight relationships for dolphinfish (*Coryphaena hippurus*) from the western central Atlantic.

Location	Sex	Range in length (mmFL)	Sample size (no.fish)	a	b	kg at 1000 mmFL	Data source
North Carolina	All	672-966	18	2.00×10^{-9}	3.22	9.21	Schuck (1951)*[1]
North Carolina	Males	275-1350	176	0.50×10^{-7}	2.75	8.89	Rose & Hassler (1968)
	Females	310-1275	325	1.27×10^{-7}	2.59	7.76	
Florida	Males	550-1300	19	1.45×10^{-7}	2.58	7.97	Beardsley (1967)*[2]
	Females	500-1225	40	5.75×10^{-8}	2.71	7.60	
Puerto Rico	All	381-1479	852	3.80×10^{-8}	3.49	891?	Perez *et al.*(1992)*[3]
	Males	490-1479	261	1.78×10^{-8}	3.62	1289?	
	Females	445-1310	591	5.75×10^{-8}	3.36	691?	
	All	358-1323	332	1.41×10^{-8}	2.92	8.11	Perez & Sadovy (1991)
	All	381-1479	170	3.80×10^{-8}	2.78	8.31	Rivera Betancourt (1994)
Cuba	All	500-1200	56	3.21×10^{-5}	2.67	7.02	Garcia-Arteaga *et al.* (1997)*[4]
Barbados	All	160-1365	365	1.45×10^{-8}	2.91	7.85	Oxenford (1985)
	Males	239-1365	123	1.24×10^{-8}	2.94	8.31	
	Females	160-1240	207	2.22×10^{-8}	2.84	7.58	

*[1] Relationship given in original text appears to be in error. Relationship given here was recalculated with data extrapolated from length-weight graph

*[2] Relationships given in original text were wrong (confirmed by pers. comm. with author on 11.5.84.). Relationships given here are recalculated from extrapolation of data shown in the length-weight graph

*[3] Relationships given in original text appear to be in error. Authors have been contacted on 9.10.97

*[4] Relationship is for length in cm

Table 9. Summary of first year growth rate estimates for dolphinfish *Coryphaena hippurus* from the western central Atlantic. For captive or laboratory reared fish the source of the fish is given in parentheses.

Location	No. of fish	Aging method	1st year growth rate (mm d^{-1})	Size range examined	Data source
Gulf of Mexico	19	daily otolith checks	0.49 SL	850-1210mmSL	Bentivoglio (1988)
Laboratory reared (North Carolina)	28	days known	1.07 TL	15-101 mmTL	Hassler & Rainville (1975)
Barbados	25	daily otolith checks	1.43 SL	700-1100 mmSL	Oxenford & Hunte (1983)
Barbados	1084	progression of size frequency	1.53 SL	600-1200 mmSL	Oxenford & Hunte (1983)
North Carolina	593	scale annuli	1.56 FL	300-653 mmFL	Rose & Hassler (1968)
St. Lucia	2953	progression of size frequency	1.78 FL	693-1674 mmFL	Murray (1985)
Florida Current	121	scale annuli	1.99 FL	475-1175 mmFL	Beardsley (1967)
Puerto Rico	121	daily otolith checks	2.52 FL	550-1325 mmFL	Rivera Betancourt (1994)
Captive (Florida)	1	days known	~2.65 FL	400-1060 mmFL	Beardsley (1967)
Laboratory reared (Florida)	?	days known	~2.73 SL	0-2.5 kg	Schekter (1982)
Gulf of Mexico	81	daily otolith checks	3.88 SL	250-1210mmSL	Bentivoglio (1988)
Captive (Florida)	2	days known	~3.91 FL	0.7-16.8 kg	Herald (1961, cited by Bearsley 1967)
Barbados	50	daily otolith checks	4.71 SL	174-1100 mmSL	Oxenford & Hunte (1985)
Laboratory reared (North Carolina)	30	days known	~5.88 SL	0.5-5.6 kg	Hassler & Hogarth (1977)
Captive (Florida)	4	days known	~9.66 SL	0.7-5kg	Schekter (1982)

Table 10. Von Bertalanffy growth curve parameters for dolphinfish (*Coryphaena hippurus*) from the western central Atlantic.

Location	Group	Growth parameters					Reference
		L_∞ (mm)	W_∞ (kg)	k (annual)	t_0 (years)	P	
North Carolina	All	1733 FL	-	0.31	-	-	Rivera Betancourt (1994; data from Rose & Hassler 1968)
Florida	All	1650 FL	-	0.68	-	-	Rivera Betancourt (1994; data from Beardsley 1967)
	Males	1670 FL	-	0.53	-	-	Pauly (1978; data from Beardsley 1967)
	Females	1350 FL	-	0.62	-	-	
Puerto Rico	All	1457 FL	-	2.19	-0.046	-	Rivera Betancourt (1994)
	Males	1381 FL	-	2.55	0.023	-	
	Females	1506 FL	-	1.82	-0.087	-	
Gulf of Mexico	All	1940 FL	-	1.12	0.033	-	Bentivoglio (1988)
	All	1427 FL	-	3.13	-	-	Rivera Bertancourt (1994) using reworked data from Bentivoglio (1988)
Barbados	All	1208 SL	16.2	3.49	0.055	4.75	Oxenford (1985)
	Males	1260 SL	21.8	5.24	0.089	5.06	
	Females	1221 SL	16.2	3.43	0.063	4.74	
St. Lucia	All	2361 FL	-	0.53	-0.173	-	Murray (1985)

Table 11. Mortality estimates for dolphinfish (*Coryphaena hippurus*) from the western central Atlantic.

Location	Mortality parameter	Mortality model	Fish group	Instantaneous mortality (annual)	Percentage actual mortality (annual)	Reference
Gulf of Mexico	Total (Z)	Robson and Chapman (1961)	All	8.18	99.97	Bentivoglio (1
				8.23	99.97	
				8.67	99.98	
Barbados	Total (Z)	Ricker (1975)	All	3.93	98.03	Oxenford (198
		Beverton & Holt (1956)		5.84	99.71	
		Hoenig (1983)		4.22	98.53	
	Natural (M)	Pauly (1980a)	All	2.56	92.23	Oxenford (198
			Males	3.30	96.29	
			Females	2.52	91.94	
St. Lucia	Total (Z)	Ziegler (1979)	All	3.53	97.07	Murray (1985)
	Natural (M)	Pauly (1983)	All	0.66	48.28	Murray (1985)

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Table 12. Dietary importance (by rank) of the five main prey categories of dolphinfish (*Coryphaena hippurus*) from the western central Atlantic, assessed by (a) numerical abundance, (b) frequency of occurrence in the stomachs, and (c) total bulk (weights, volumes or lengths).

(a). Numerical abundance

Location		Southeastern & Gulf states of USA	North Carolina		Barbados	
Data source		Manooch *et al.* (1984)	Gibbs & Collette (1959)	Rose & Hassler (1974)	Lewis & Axelsen (1967)	Oxenford & Hunte (this workshop)
No. dolphinfish		2219	46	396	70	397
Fish	Ammodytidae	.	3	.	.	.
	Balistidae	1	5	3	4	4
	Carangidae	5	.	2	.	.
	Coryphaenidae	.	.	4	.	.
	Dactylopteridae	.	.	.	1	1
	Exocoetidae	.	.	.	3	3
	Gempylidae	.	1	.	.	.
	Monacanthidae	.	.	.	2	.
	Nomeidae	.	.	.	5	.
	Ostraciidae	.	.	5	.	.
	Scombridae	.	2	.	.	.
	Syngnathidae	3	.	.	.	.
	Tetraodontidae	.	4	.	.	.
Invertebrates	Cephalopoda	.	.	.	.	5
	Decapoda	4	.	1	.	.
	Mysidacea	.	.	.	.	2
	Stomatopoda	2	.	.	.	.

(b). Frequency of occurrence

Location		Southeastern and Gulf states of USA	North Carolina		Barbados	
Data source		Manooch *et al.* (1984)	Gibbs & Collette (1959)	Rose & Hassler (1974)	Lewis & Axelsen (1967)	Oxenford & Hunte (this workshop)
No. dolphinfish		2219	46	396	70	397
Fish	Balistidae	1	3	2	4	3
	Carangidae	4	5	1	.	.
	Dactylopterida e	.	.	.	2	1
	Exocoetidae	5	.	4	1	2
	Monacanthidae	.	4	.	3	.
	Tetraodontidae	.	.	.	.	5
Invertebrates	Cephalopoda	3	1	5	5	4
	Decapoda	2	2	3	.	.

(c). Total bulk (weights, volumes or lengths)

Location		Southeastern & Gulf states of USA	North Carolina	Barbados
Data source		Manooch *et al.* (1984)	Rose & Hassler (1974)	Oxenford & Hunte (this workshop)
No. dolphinfish		2219	396	397
Fish	Balistidae	3	4	4
	Carangidae	4	3	.
	Coryphaenidae	1	5	.
	Dactylopteridae	.	.	1
	Diodontidae	5	.	.
	Exocoetidae	2	1	2
	Scombridae	.	2	.
	Trichiuridae	.	.	5
Invertebrates	Mysidacea	.	.	3

Table 13. Relative dietary importance of the main prey categories of the dolphinfish (*Coryphaena hippurus*) from the southeastern and Gulf states of the USA (after Manooch *et al.* 1984), and Barbados (after Oxenford and Hunte this workshop). IRI - index of relative importance.

Prey category	IRI rank	
	Southeastern & Gulf States	Barbados
Dactylopteridae	.	1
Exocoetidae	4	2
Mysidacea	.	3
Balistidae	1	4
Cephalopoda	5	5
Tetraodontidae	11.5	6
Trichiuridae	.	7
Coryphaenidae	7	8
Carangidae	2	9
Monacanthidae	.	10
Diodontidae	9	11
Scombridae	10	12
Decapoda	3	.
Stomatopoda	8	.
Syngnathidae	6	.
Stomateidae	11.5	.

FIGURE LEGENDS

Figure 1. Distribution of dolphinfish (*Coryphaena hippurus*) larvae in the northern Gulf of Mexico by season, as determined by catches in bongo and neuston net tows. Seasons (spring:March-May; Summer: June-August; fall: September-November) are combined across years (1982-1984). Adapted from Ditty *et al.* (1994).

Figure 2. Frequency of mature females by size group for dolphinfish (*Coryphaena hippurus*) from (a) Puerto Rico (after Perez and Sadovy 1991), and (b) Barbados (after Oxenford 1985).

Figure 3. Size frequency distributions at each maturity stage for male and female dolphinfish (*Coryphaena hippurus*) from Barbados (after Oxenford 1985).

Figure 4. Mean gonasomatic index (GSI) at each maturity stage for male and female dolphinfish (*Coryphaena hippurus*) from Barbados (after Oxenford 1985).

Figure 5. Monthly mean gonasomatic indices (GSI) for male and female dolphinfish (*Coryphaena hippurus*) from (a) Puerto Rico (after Perez *et al.* 1992), and (b) Barbados (after Oxenford 1985).

Figure 6. Egg size distributions in the ovaries of female dolphinfish (*Coryphaena hippurus*) from (a) Florida Current (after Beardsley 1967), (b) Puerto Rico (after Perez *et al.* 1992), and (c) Barbados (after Oxenford 1985).

Figure 7. Comparison of fecundity-length relationships reported for dolphinfish (*Coryphaena hippurus*) in the western central Atlantic. Relationship for Florida Current was obtained by extrapolation of graphical data given by Beardsley (1967). Relationships for Puerto Rico and Barbados dolphinfish were given by Perez *et al.* (1992) and Oxenford (1985) repectively.

Figure 8. Relative frequency of each maturity stage for female dolphinfish (*Coryphaena hippurus*) landings in Puerto Rico (after Perez *et al.* 1992).

Figure 9. Length-weight relationships for male and female dolphinfish (*Coryphaena hippurus*) from (a) North Carolina (after Gibbs and Collette 1959), (b) North Carolina (after Rose and Hassler 1968), (c) Florida Current (after Beardsley 1967), (d) Barbados (after Oxenford 1985).

Figure 10. Comparison of length-weight relationships reported for dolphinfish (*Coryphaena hippurus*) in the western central Atlantic. (a) shown separately by sex (after Oxenford and Hunte 1985), and (b) overall (calculated from data presented by

Schuck 1951 for North Carolina, after Perez *et al.* 1992 for Puerto Rico; and Oxenford 1985 for Barbados).

Figure 11. Relationship between daily growth increments in sagittal otoliths and fork length for dolphinfish (*Coryphaena hippurus*) from Puerto Rico. Slope of regression line indicates mean first year growth rate and curve indicates the von Bertalanffy growth curve for (a) all fish, (b) males, and (c) females (after Perez *et al.* 1992).

Figure 12. Relationship between daily growth increments in sagittal otoliths and standard length for dolphinfish (*Coryphaena hippurus*) from Gulf of Mexico. Slope of regression line indicates mean first year growth rate for both sexes (after Bentivoglio 1988).

Figure 13. Relationship between daily growth increments in sagittal otoliths and standard length for dolphinfish (*Coryphaena hippurus*) from Barbados. Slope of regression lines indicates mean first year growth rates for (a) all fish and separately for adults; and (b) for males and females separately (after Oxenford 1985).

Figure 14. Monthly progression of length frequency distributions for adult cohort of dolphinfish (*Coryphaena hippurus*) landed by the pelagic fishery in Barbados. Arrows indicate monthly mean size (after Oxenford 1985).

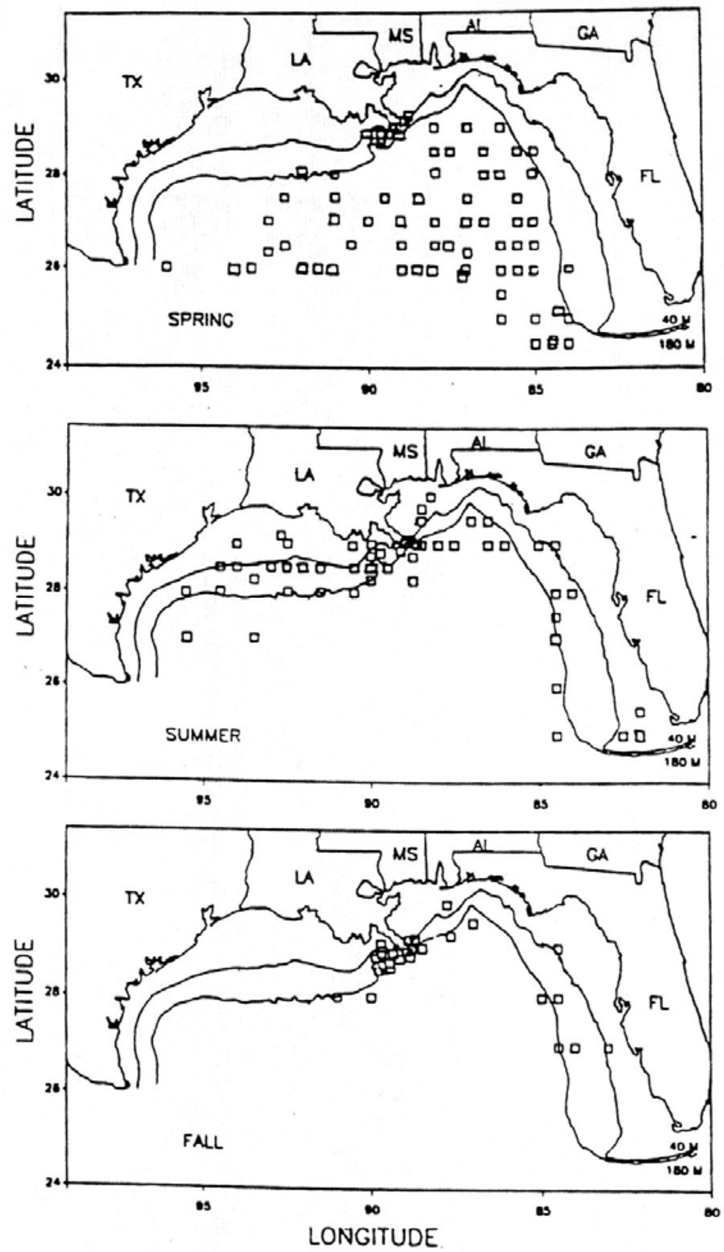
Figure 15. Von Bertalanffy growth curves for dolphinfish (*Coryphaena hippurus*) from Barbados showing (a) all fish; and (b) males and females separately (after Oxenford 1985).

Figure 16. Catch data used in estimation of total mortality of dolphinfish (*Coryphaena hippurus*) from Barbados, showing (a) length frequency distribution of the dolphinfish catch taken by the pelagic fishery, and (b) catch curve derived from age-converted size frequency of fully vulnerable individuals.

Figure 17. Comparisons of dolphinfish (*Coryphaena hippurus*) diets from the western central Atlantic based on percent frequency of occurrence of the major prey items in stomachs. Data sources are shown in parentheses.

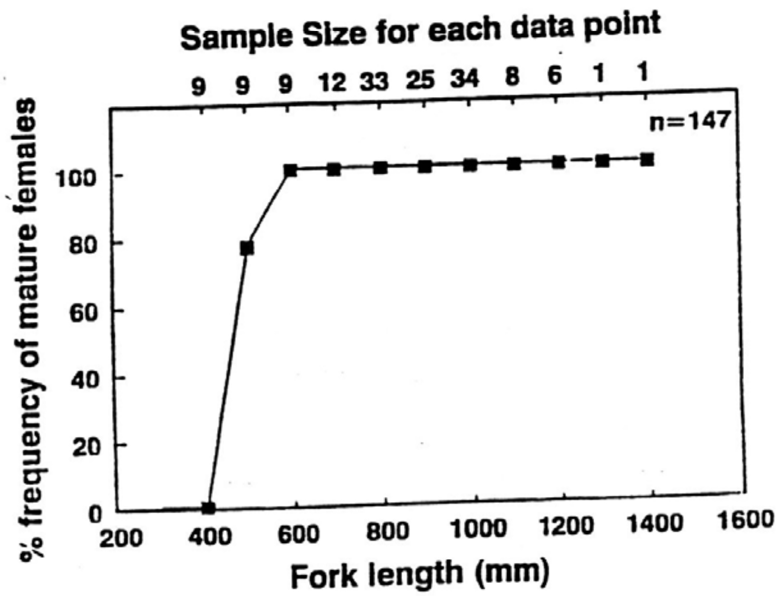
Figure 18. Proposed migration circuits and locations of putative northeastern and southeastern Caribbean dolphinfish (*Coryphaena hippurus*) stocks in the western central Atlantic (after Oxenford and Hunte 1986). Dark arrows indicate segments of the circuits for which seasonality and size data are available; clear arrows indicate areas where no data are available.

Distribution of larvae in the Gulf of Mexico



Percent mature fish at size

a



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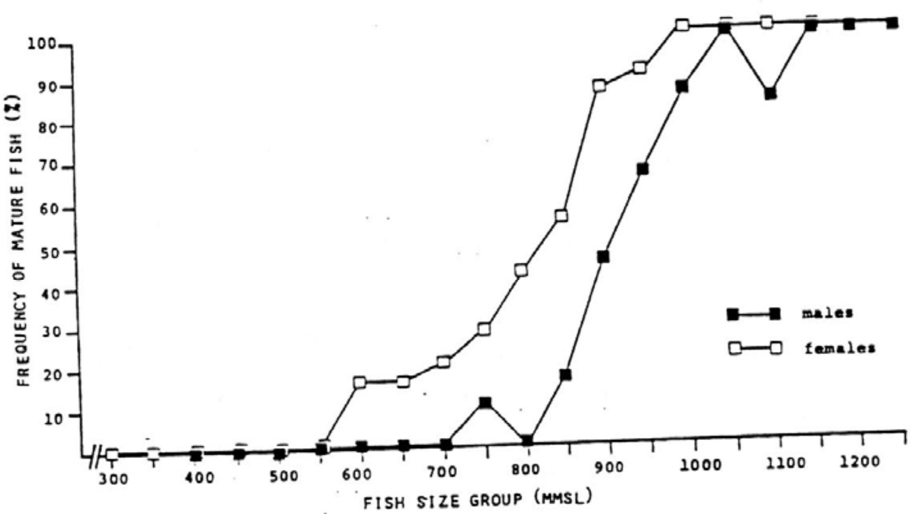
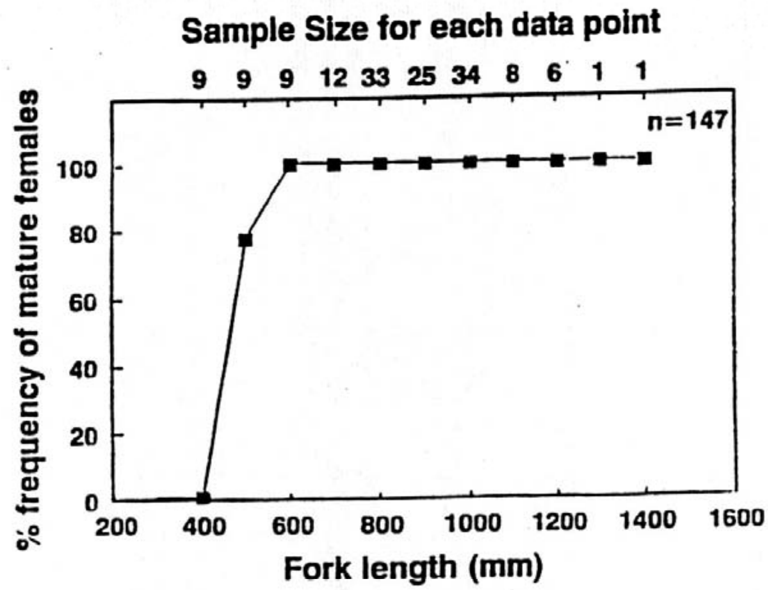


Percent mature fish at size

a



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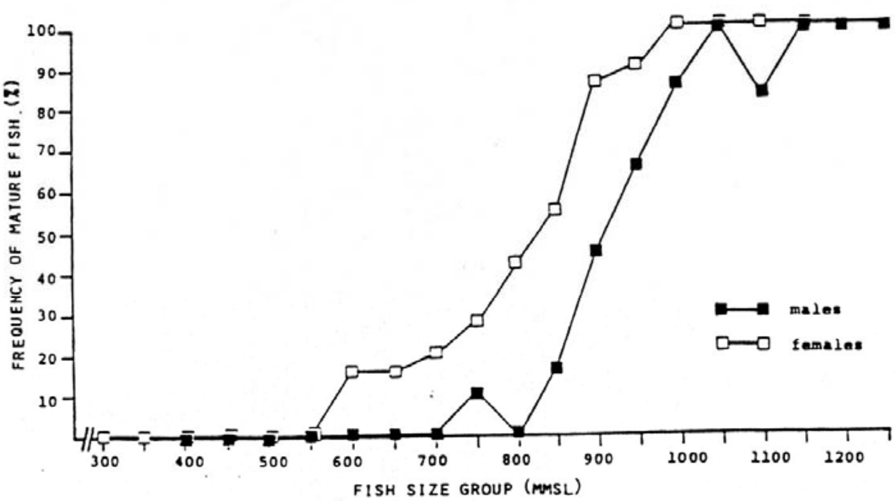
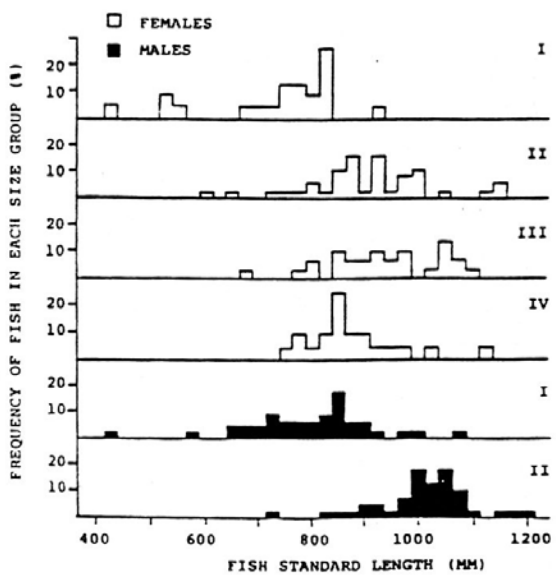
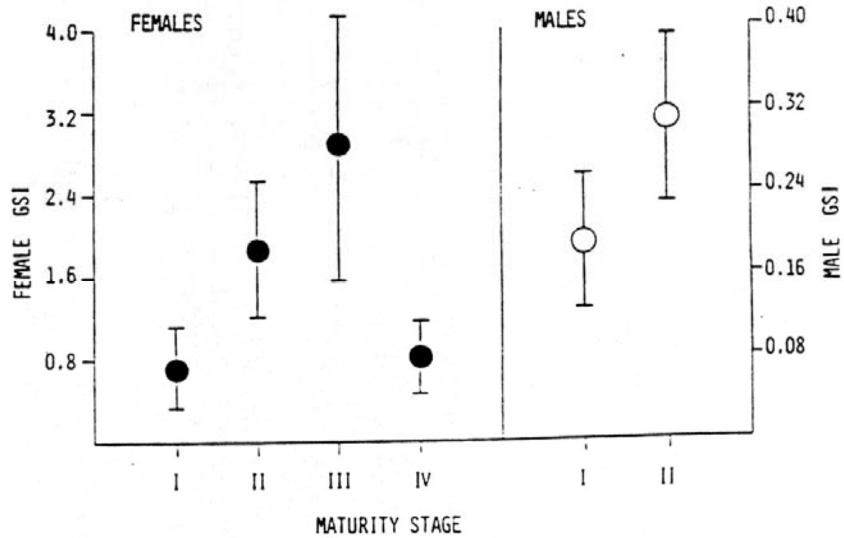


Length distribution at each maturity stage

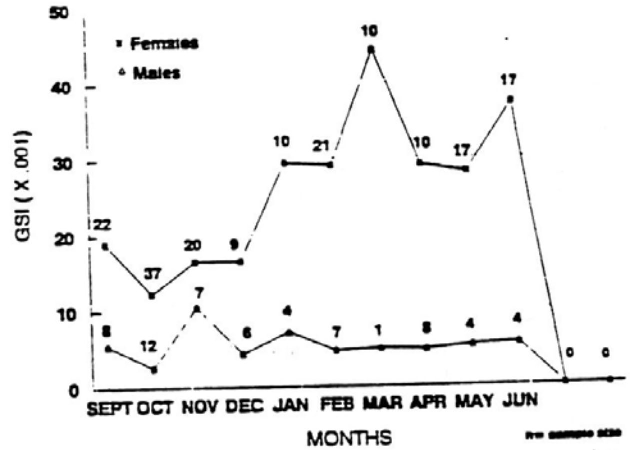


Mean GSI valves at each maturity stage



Seasonal changes in GSI values

a



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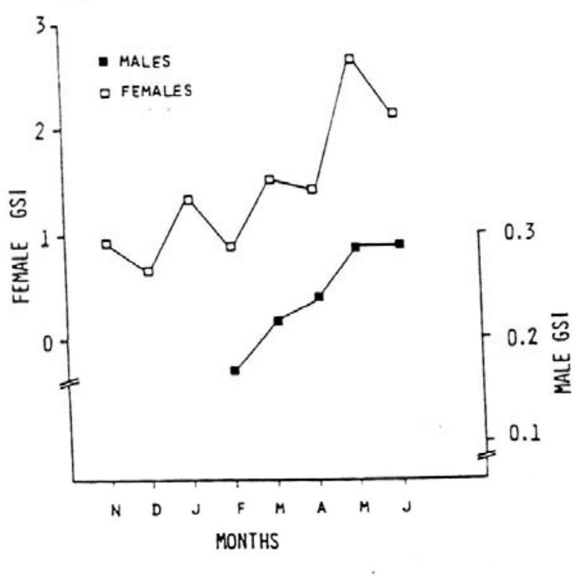
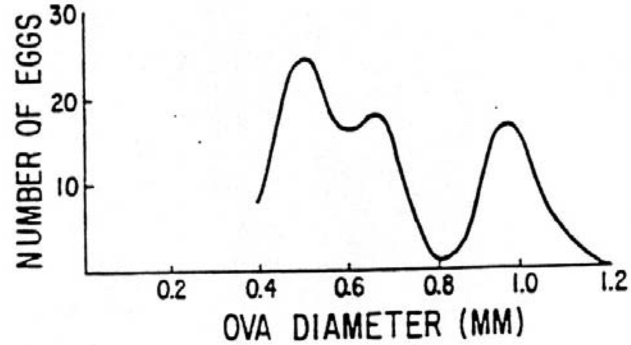


Size frequency of ova in the gonads

a



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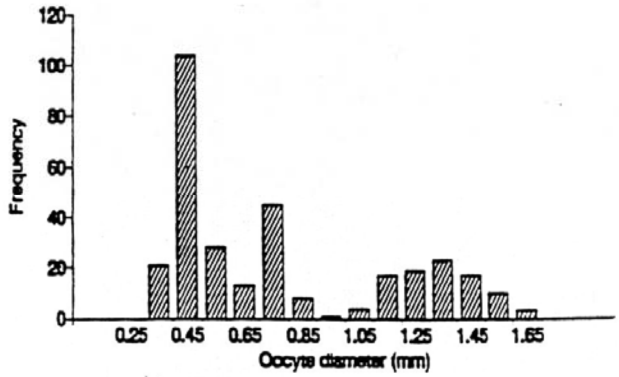

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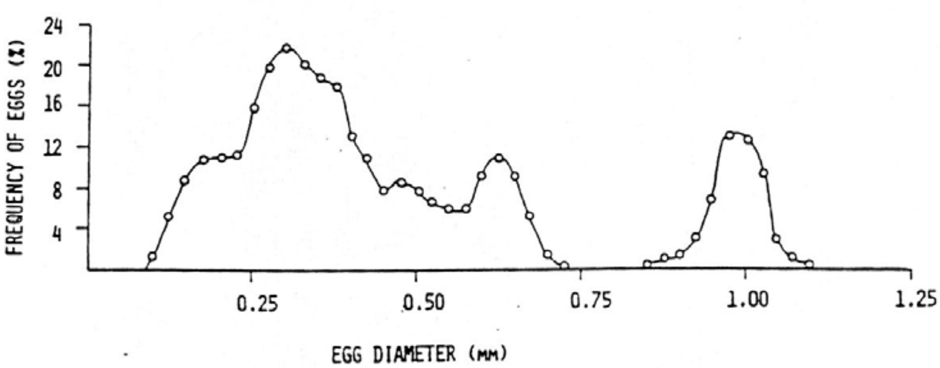
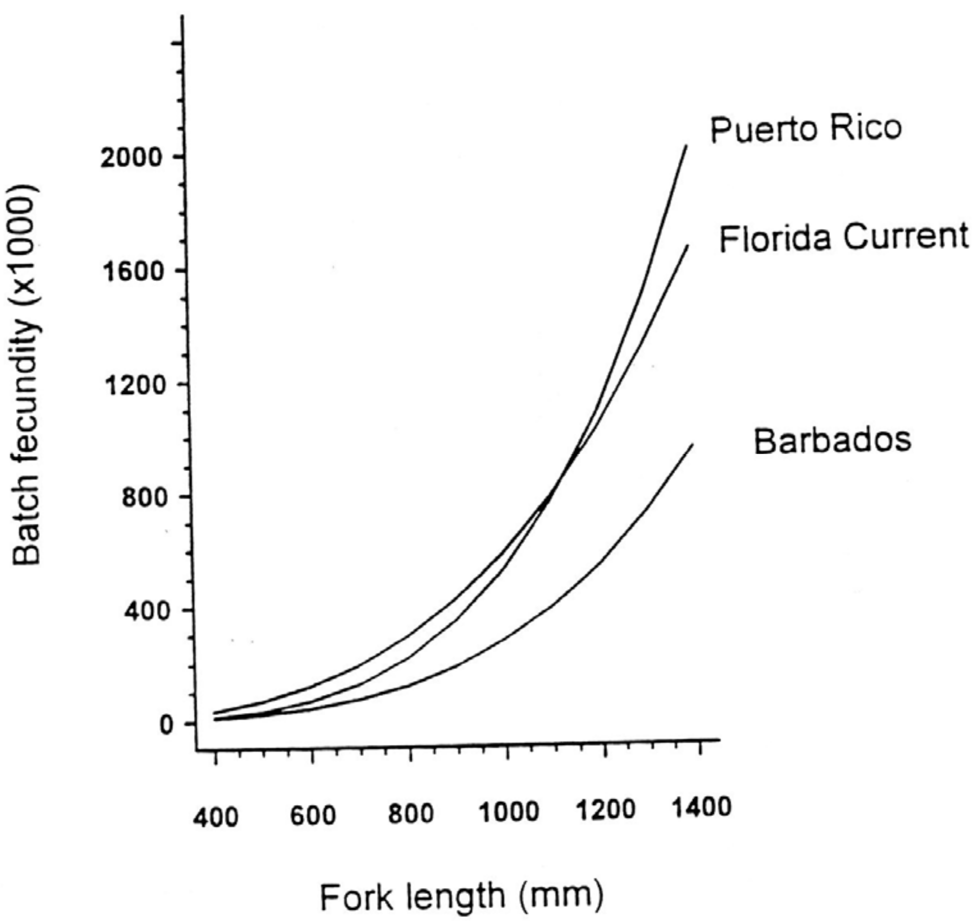
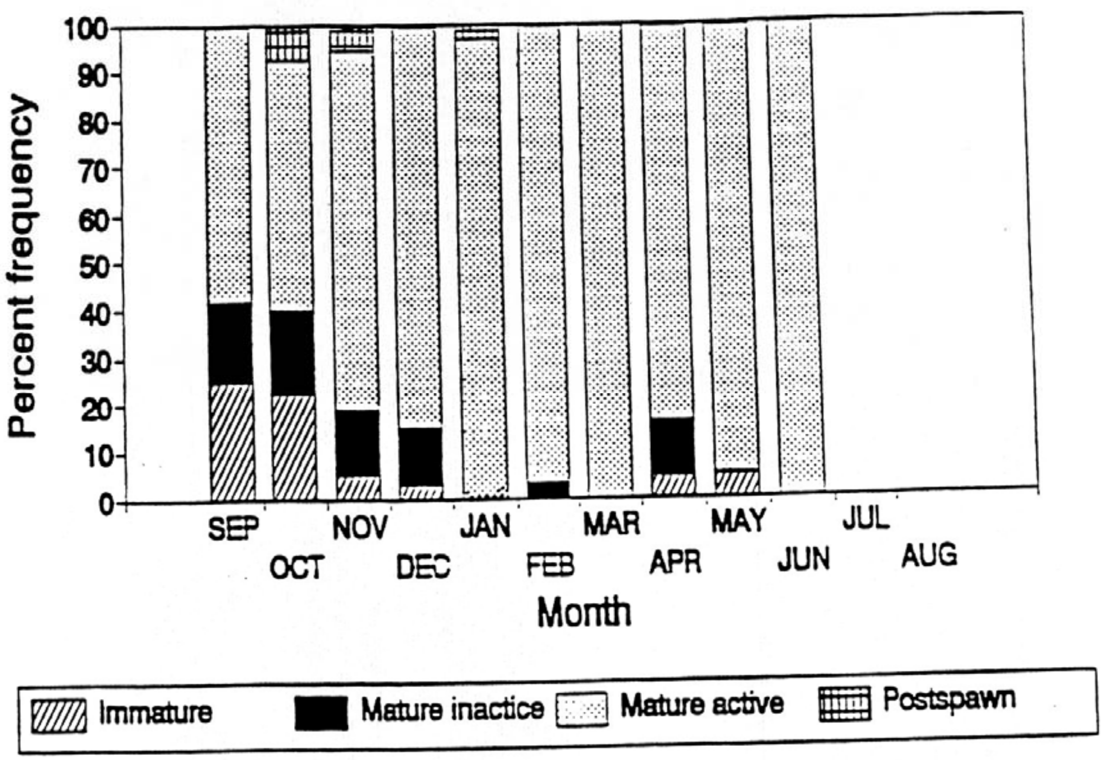


Batch fecundity-length relationships

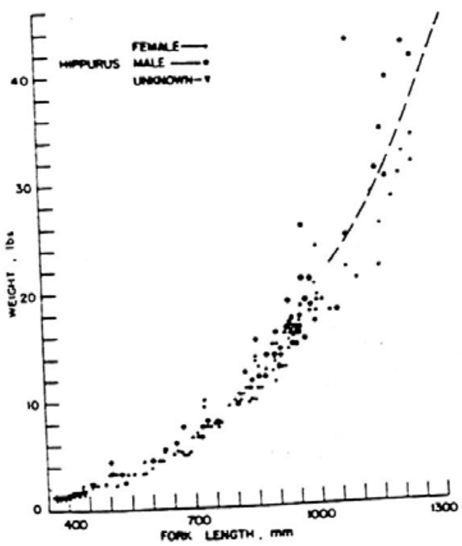


Seasonal occurrence of mature females



Male and female length-weight relationships

a



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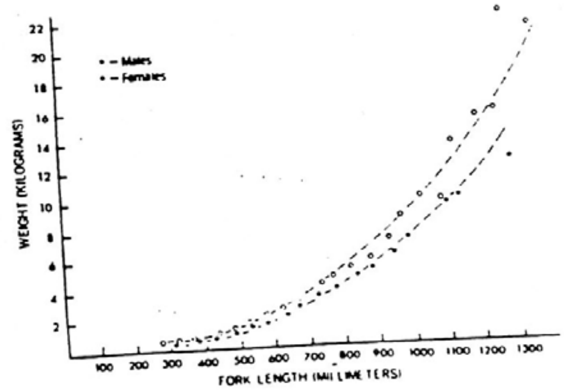

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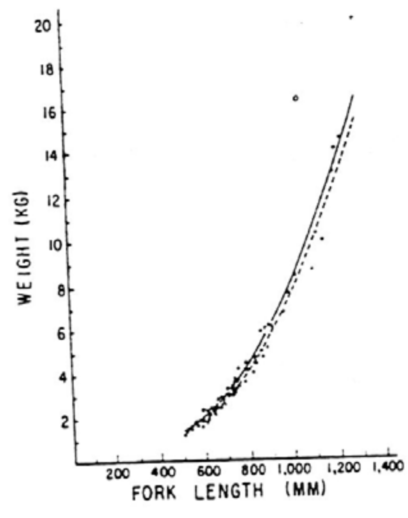

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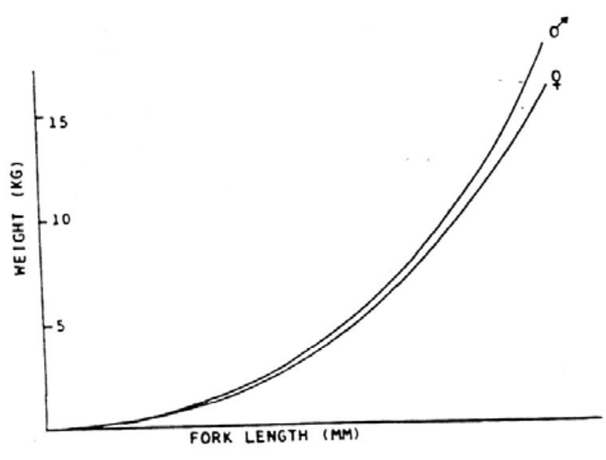
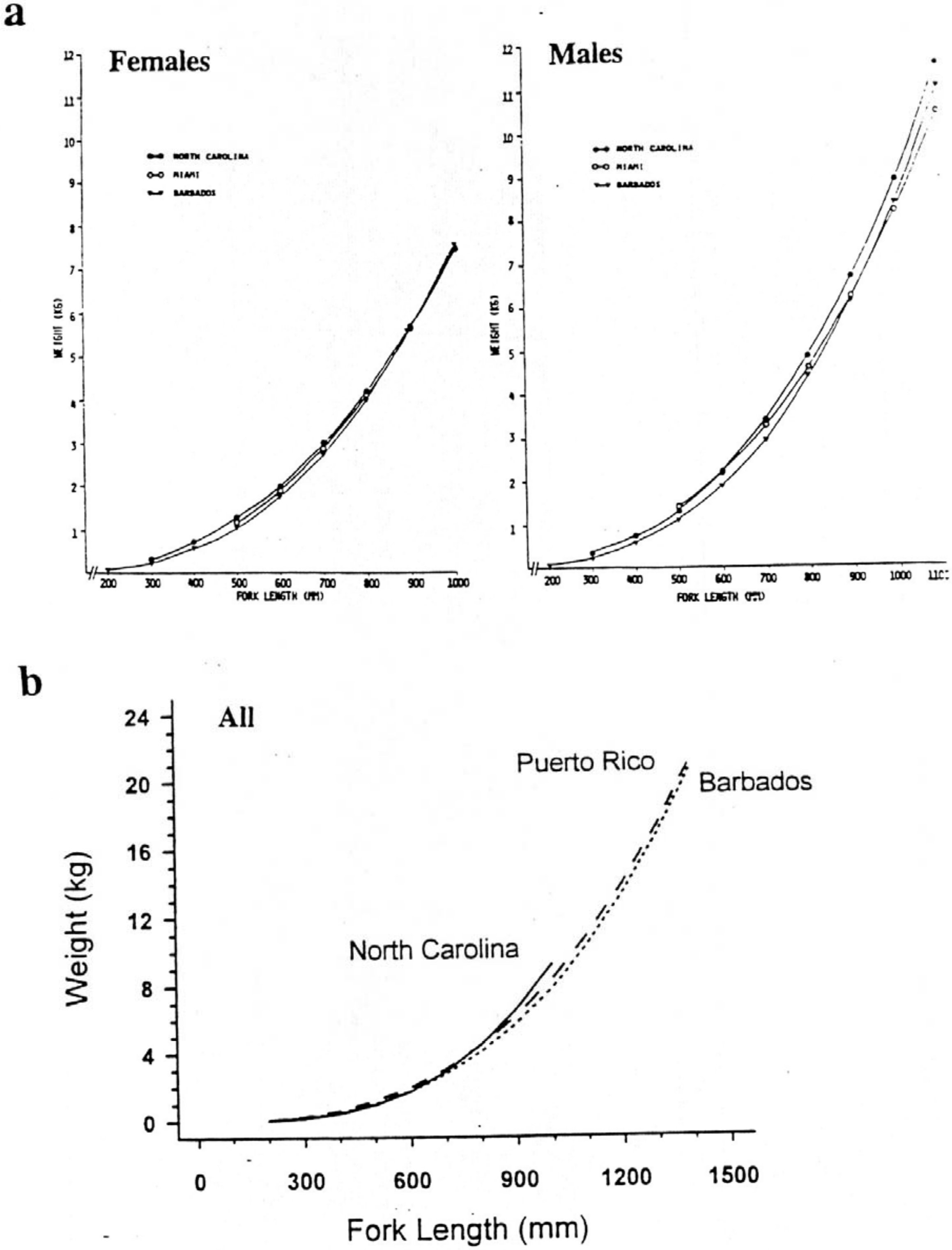
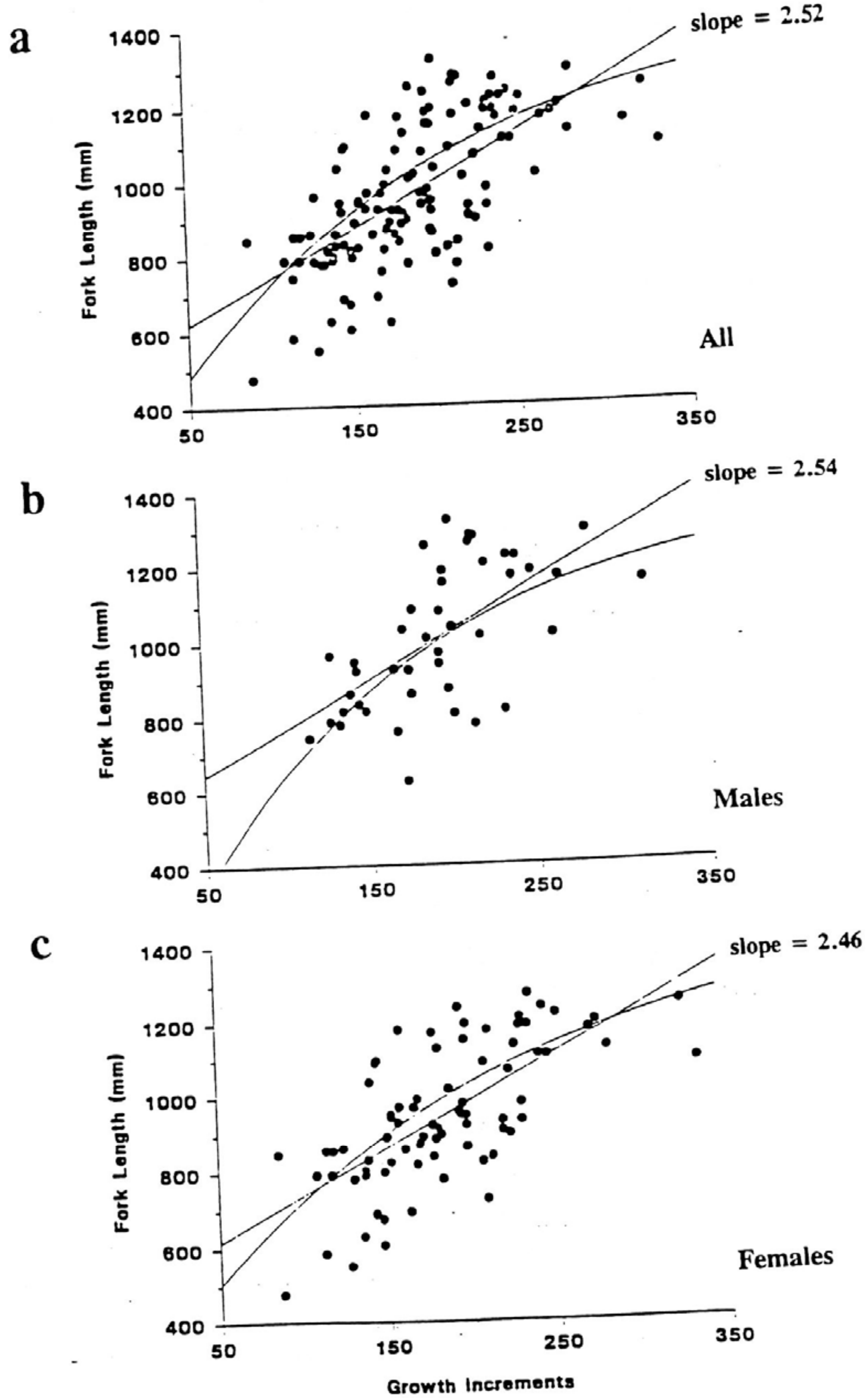


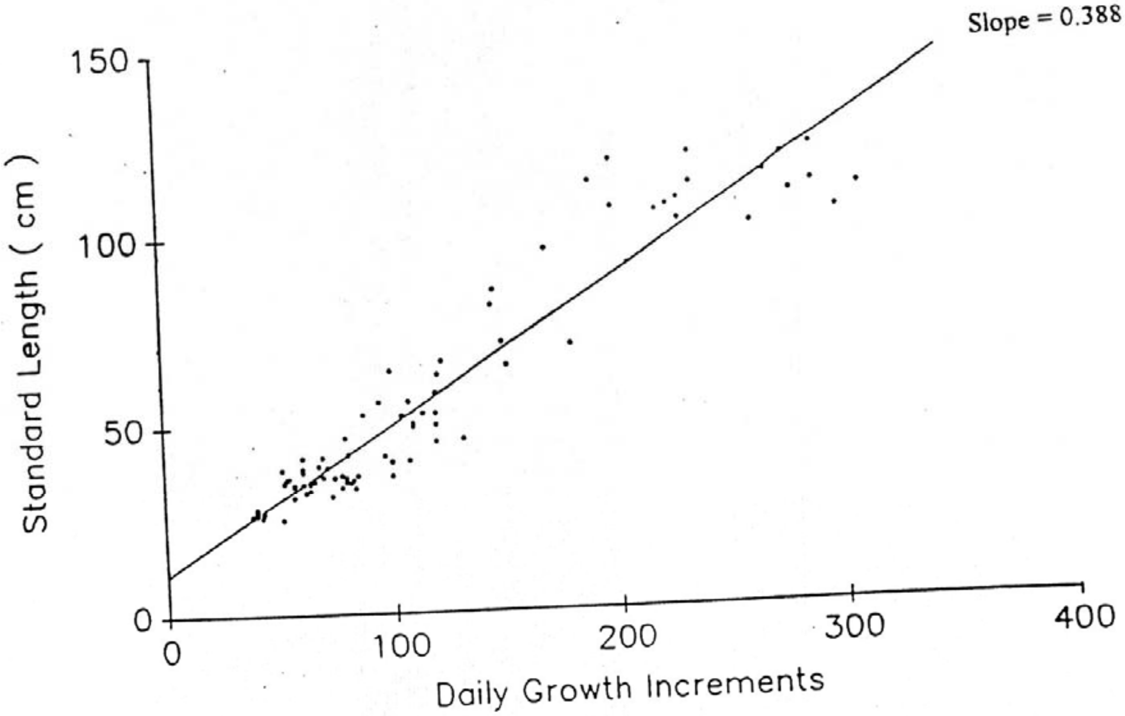
Comparison of length-weight relationships



Size at age data for Puerto Rico dolphinfish

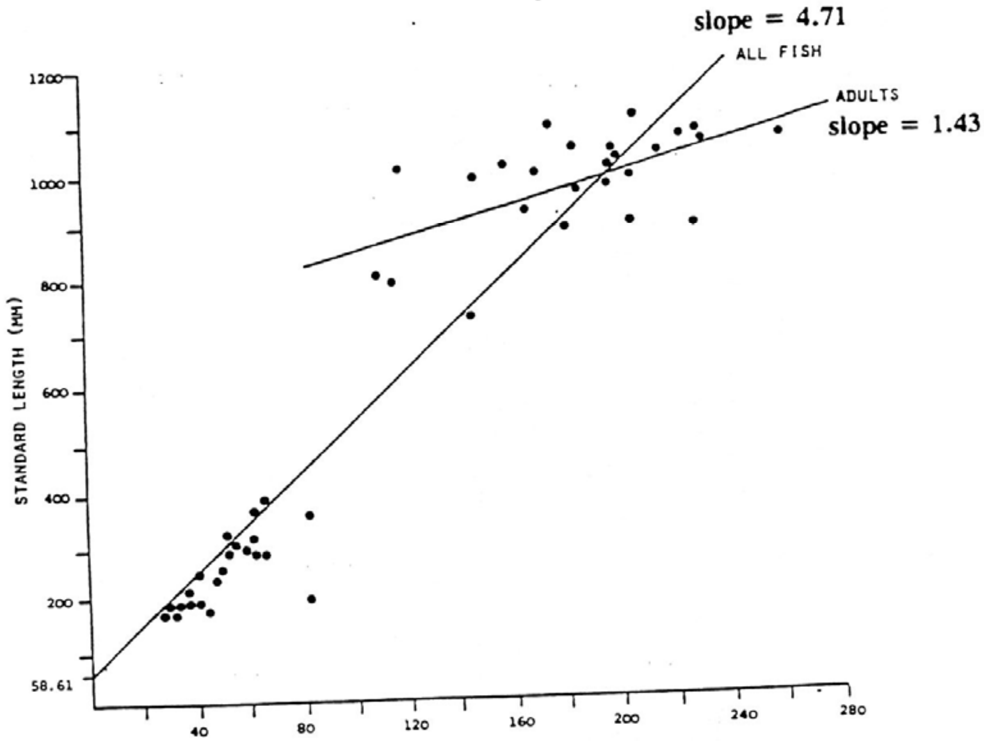


Size at age data for Gulf of Mexico dolphinfish



Size at age data for Barbados dolphinfish

a



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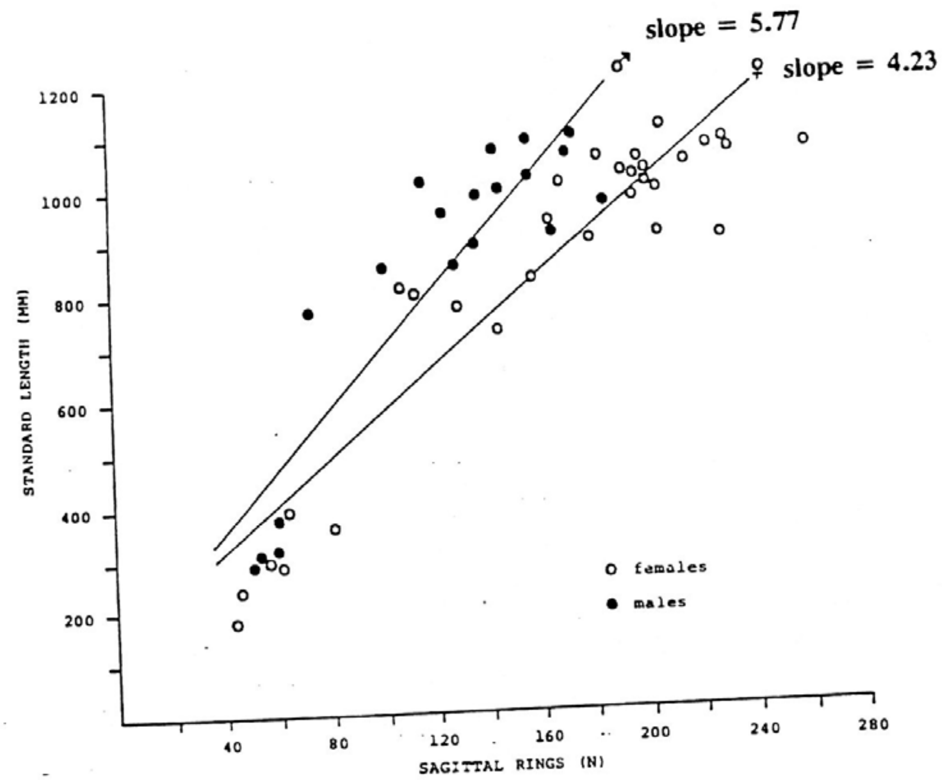
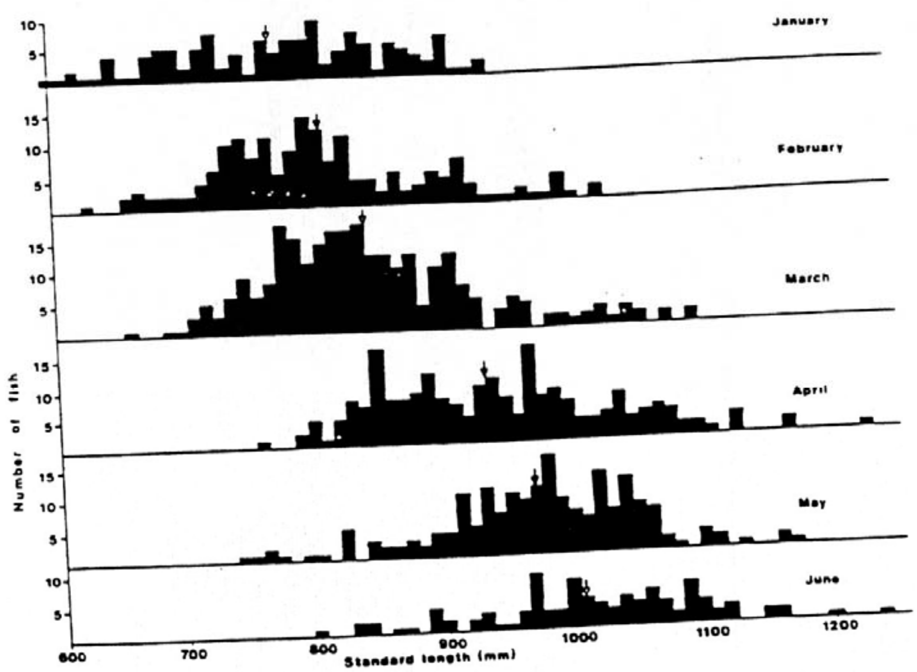
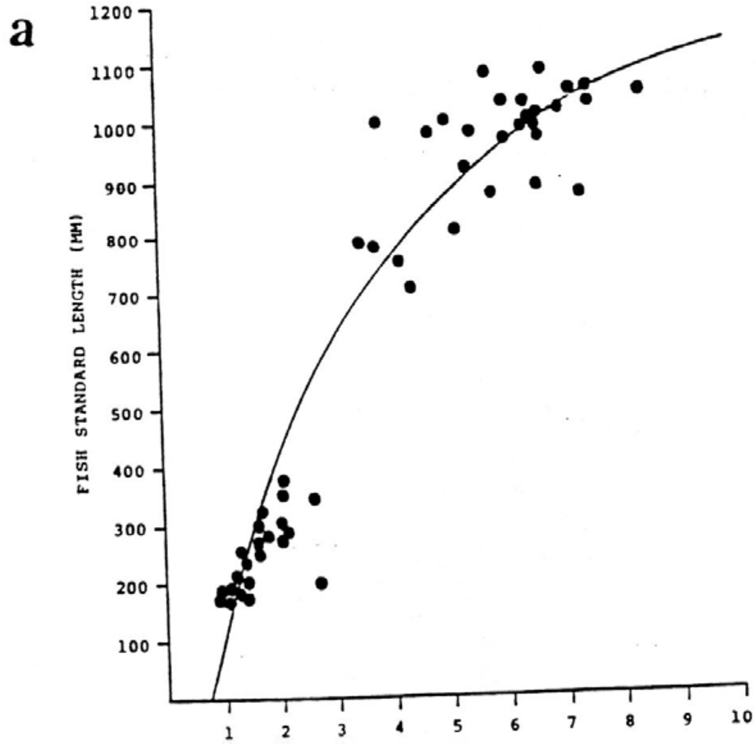
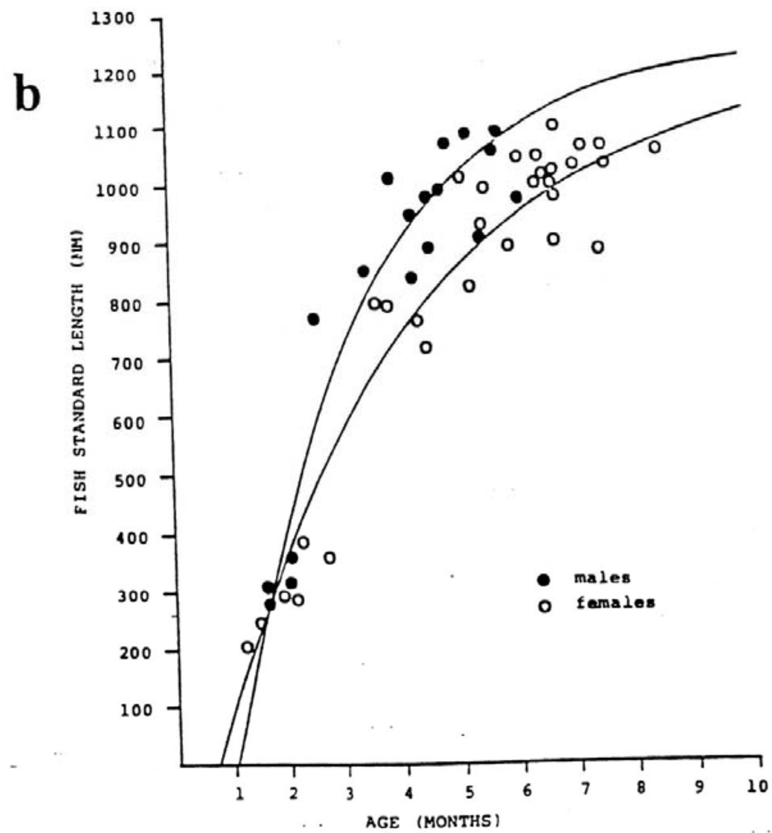


Monthly progression of length frequency data for Barbados dolphinfish



Von Bertalanffy growth curves for Barbados dolphinfish





Catch curve mortality estimate

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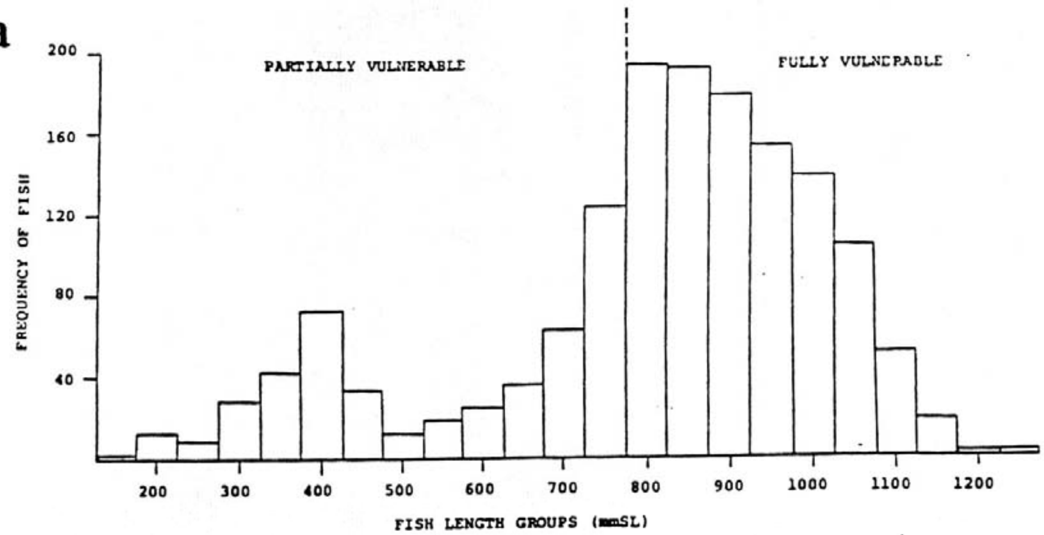

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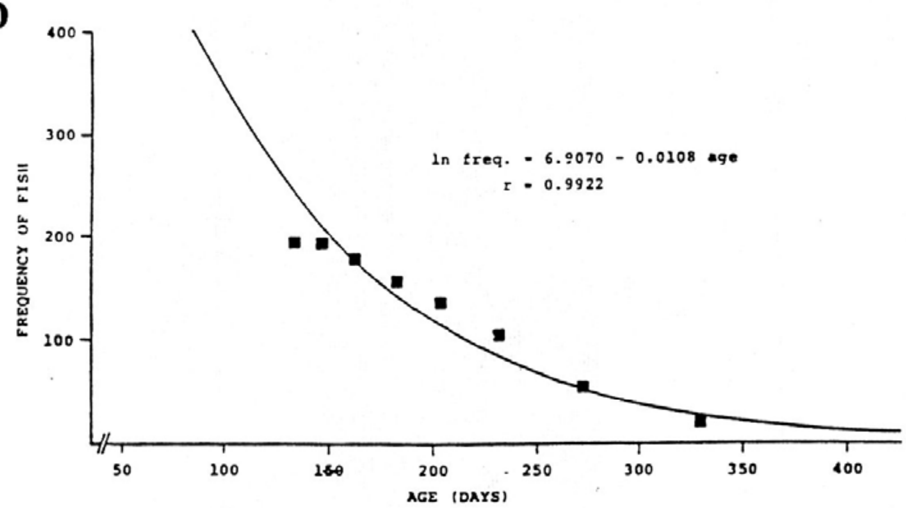
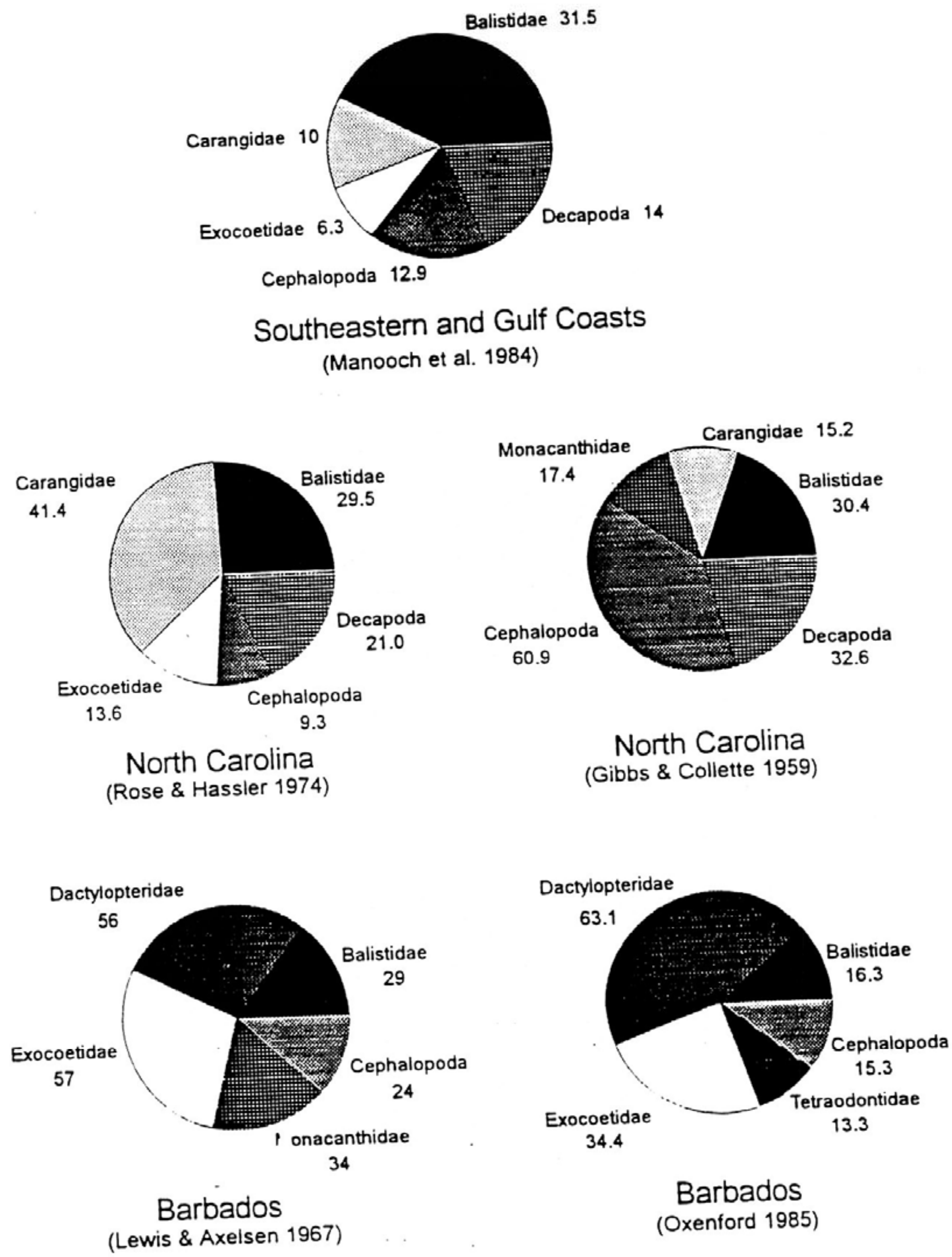
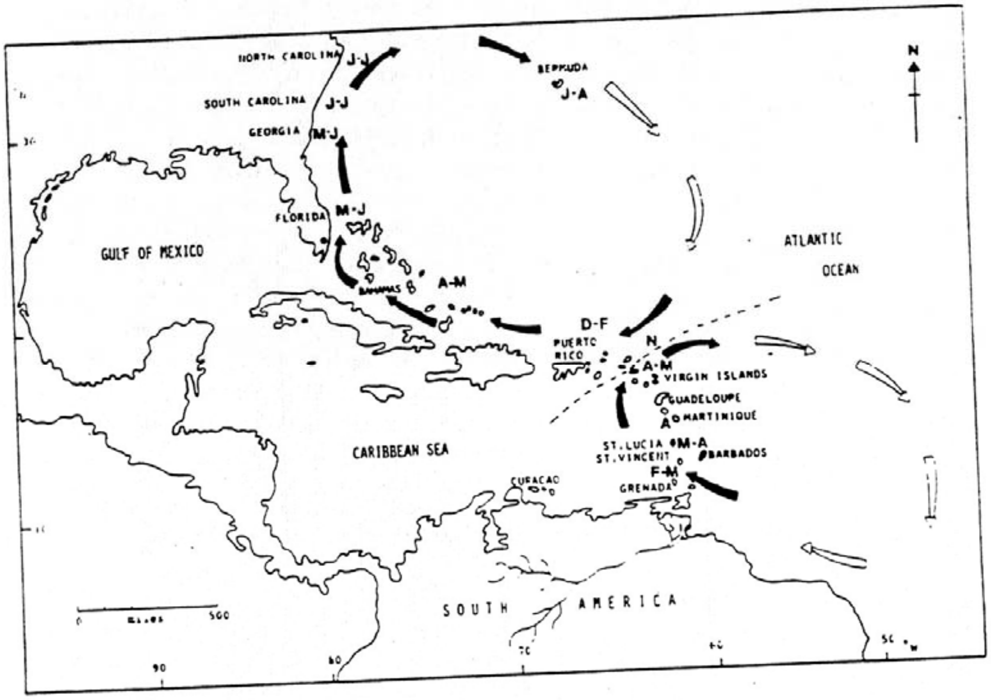


Comparison of diets



Proposed migration circuits for putative northeastern and southeastern stocks



Dolphinfish fisheries in the Caribbean region

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ABSTRACT

Dolphinfish are targeted throughout the western central Atlantic region, by recreational fishers, small-scale artisanal fishers, and small longliners. They are also taken as bycatch on large-scale commercial longlines. Catches are highly seasonal and exhibit considerable interannual variability. According to the landing statistics provided by countries to FAO, dolphinfish ranked seventh overall in reported average annual landings of large pelagic fishes in the western central Atlantic from 1989-1993. Yellowfin tuna, Spanish mackerel, skipjack tuna, king mackerel, swordfish and Atlantic bonito ranked ahead of dolphinfish. There is a trend of increasing total annual landings from about 1,700 mt in 1970-74 to about 2,800 mt in 1989-1993. Landings are reported to FAO by only eight countries, whereas dolphinfish are known to be caught in most of the region's 34 countries. Bycatch on longlines and recreational landings are also largely unreported. Therefore, it is likely that the reported landings are a substantial underestimate. The relative importance of dolphinfish to pelagic fisheries varies from one part of the region to another. In the Lesser Antilles it is the most important large pelagic fish in terms of amounts landed. The absence of a large-scale commercial fishery targeting dolphinfish appears to have resulted in a lack of recognition of its contribution, particularly in developing countries of the region. Consequently, its biology and assessment have been neglected in relation to the attention given to other large pelagic fishes, mainly tunas and tuna-like fishes which have been the focus of ICCAT assessment activities.

WORKING PAPER PREPARED FOR: Workshop on the Biology and Fishery of Dolphin-fish and Related Species, 20-23 October, 1997, Palma de Mallorca, Spain

INTRODUCTION

The "Wider Caribbean" area includes the Caribbean Sea, the Gulf of Mexico, the northeast coast of South America and the southeastern Atlantic coast of the USA. This is also the area referred to as the western central Atlantic (WCA) by FAO. It is their Fishery Statistical Area 31. The western central Atlantic Fishery Commission (WECAFC) covers all of this area as well as some of Fishery Statistical Area 41 to the south (to 10°S, and to 30°W) (Fig. 1).

The oceanography of the Caribbean region is highly variable both spatially and temporally. Four of the largest river systems in the world -- the Amazon, Orinoco, Rio Grande and Mississippi Rivers – have a considerable influence on the north coast of South America and the Gulf of Mexico (Muller-Karger 1993). Most Caribbean islands are more affected by the nutrient-poor North Equatorial Current which enters the Caribbean Sea through the passages between the Lesser Antilles. Those islands with appreciable shelf area exhibit significant coral reef development. From Isla Margarita west to Mexico, the continental shelf is also extensively occupied by coral reefs at shallow depths. Seagrass beds and mangroves are also common coastal habitats.

There is no current comprehensive review of Caribbean fisheries. However, an overview can be obtained from some early reviews (Klima 1976, Stevenson 1981), and some recent ones that address particular geographical areas or resource types (Mahon 1990, Oxenford 1991, FAO 1993, Mahon 1996). The following paragraphs provide a brief summary.

The fisheries of the Caribbean Region are based upon a diverse array of resources. The fisheries of greatest importance are for offshore pelagics, reef fishes, lobster, conch, shrimps, continental shelf demersal fishes, deep slope and bank fishes and coastal pelagics. There is a variety of less important fisheries such as for marine mammals, sea turtles, sea urchins, and seaweeds. These fishery types vary widely in state of exploitation, vessel and gear used, and approach to their development and management. The relative importance of these fisheries varies widely among the countries depending mainly on the amount of coastal shelf, and whether the shelf habitats are mainly coral reefs or river discharge influenced.

In general, shelf resources (e.g. lobster, conch, reef fish, shrimps) are either fully exploited or already overexploited, particularly near shore (FAO 1993, FAO 1994). Optimizing the returns from these resources will require careful husbandry and management.

In the western central Atlantic, large pelagic fishes comprised only 4% of total fishery landings between 1986-1990 (Mahon 1996). However, these resources, mainly tunas and swordfish, are considered by most countries to hold some potential for development. During the period 1989-1993, dolphinfish ranked seventh in importance by weight amongst reported landings of large pelagic fishes from this region (3.3% by weight)(Mahon 1996). The relative importance of dolphinfish appears to vary considerably from one part of the region to another in the period 1989-1993. Distant water fleets fishing in the area do not report any dolphinfish landings. Nor do countries of South and Central America. For the USA and Mexico the dolphinfish contribute only 2.6% of landings of large pelagics. For the Greater Antilles the percentage is 4%, whereas for the Lesser Antilles it is 40% (Mahon 1996)

TRENDS IN FISHING EFFORT FOR LARGE PELAGICS

There are no commercial fisheries outside of the USA that target dolphinfish exclusively, although in some fisheries, dolphinfish may be the main species caught. Dolphinfish are generally only one component of multispecies fisheries for large pelagics. At times they are only bycatch in fisheries directed at tuna and swordfish. Therefore, in order to evaluate trends in fishing effort that may affect dolphinfish, it is necessary to consider trends in overall effort for large pelagic species. In this section I examine trends in fishing fleets, gear and, where possible, fishing effort for the various types of fisheries which target large pelagics in the WECAFC Region. I follow the categorisation of large pelagics into coastal species (*Scomberomorus* spp., dolphinfish, cobia) and oceanic species (swordfish, billfishes, yellowfin tuna, bluefin tuna, bigeye tuna, albacore, skipjack tuna, Atlantic bonito, Atlantic black skipjack tuna, frigate tuna, wahoo) used by the US National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) (SEFSC 1994).

Artisanal and small-scale fleets

Large pelagic species have been exploited by local artisanal and small-scale fishers throughout the Caribbean from the earliest recorded times (e.g. Brown 1945, Caribbean Commission 1952). In most countries these fisheries were coastal, using small vessels such as canoes and pirogues for trolling. These methods continue to be used in many countries, but there have also been intermittent improvements in vessels and gear in several countries.

Estimates of the numbers, types and activities of artisanal/small-scale vessels are widely scattered throughout the literature. Since most of the small vessels are used to fish a variety of species, estimates of the numbers of these vessels do not accurately reflect the fishing effort being directed at large pelagic fishes in general, or dolphinfish in particular. Availability of many large pelagic species is strongly seasonal, particularly to artisanal vessels which do not venture far from shore (e.g. Mahon *et al.* 1990). Therefore, during the off-season, vessels may fish for demersal species, or small coastal species. Even within a single fishing trip, fishing effort may be divided among fishing for demersals and pelagics. In islands of the southeastern Caribbean, the focus of a trip may be primarily large pelagic fishes, or during the flyingfish season, a combination of that species (*Hirundichthys affinis*) and large pelagics. In other countries of the region, with more extensive coastal shelves and associated demersal fisheries, similar vessels may fish for large pelagics only incidentally while travelling to and from demersal fishing areas, or may occasionally focus on large pelagics when they are available.

In the southeastern Caribbean small-scale fishers depend upon the association of dolphinfish and other pelagics with drifting objects (Gomes *et al.* in press). Most fishers interviewed in Barbados, Tobago, Grenada, St. Vincent and St. Lucia reported seeking drifting objects on fishing trips. Dolphinfish did not seem to have a preference for any particular type of drifting object, being equally attracted to natural objects and those of human origin.

Details of fishing for dolphinfish in Barbados are provided by Oxenford (1985). For trolling, flyingfish is the preferred bait. The method of fishing a school of dolphinfish found under a drifting object is described, including keeping one live fish on a short line near the boat to keep the school nearby.

Despite the lack of quantitative information on trends in numbers of various types of vessels, recent development trends in local fleets in the eastern Caribbean do indicate that there is a trend of increasing artisanal and small-scale fishing effort directed at these large pelagic species. The cases presented below illustrate trends in the development of fleets and fishing effort for large pelagics that are assumed to be similar to those taking place in countries throughout the region.

In Grenada, in the Lesser Antilles, longline fishing for pelagics, introduced in the early 1980's with assistance from Cuba, was adopted by the troll fishing fleet on the island's west coast. By 1993 there were 110 converted, or locally purpose-built, small longliners fishing 1-day trips, and seven Japanese-built short-stay longliners (Samlalsingh 1995). In addition to the increased number of vessels, there were considerable changes in the size of vessels, gear used and fishing power. Over the 10 year period of development of these vessels, the catch per trip of target species increased from 43 to 120 kg.

The neighboring countries of St. Vincent and the Grenadines and St. Lucia have also emphasised increasing harvest of large pelagic fishes. Both have seen recent increases in fishing capacity. In St. Lucia, 40 new 9 m vessels (not all fishing for large pelagics) and 5 new 15 m longline vessels were introduced between 1989 and 1992. In St. Vincent and the Grenadines five new 12.5 m multipurpose vessels equipped with longline and trolling gear were acquired from Japan in 1991 (Mahon and Singh-Renton 1992). Previously, the fleet in St. Lucia consisted of about 300 canoes and skiffs, 5-8 m in length, while that fishing for large pelagics in St. Vincent and the Grenadines consisted of pirogues 6-8 m in length (Mahon and Rosenberg 1988).

Several other Lesser Antillean countries, members of the Organization of Eastern Caribbean States, reported initiatives aimed at increasing pelagic fishing, ranging from the introduction of longline gear on artisanal vessels, to the acquisition of new small-scale longline vessels (OECS 1992).

Trinidad and Tobago has also increased its longline fleet. In 1988 two locally owned longline vessels began surface longlining. By 1992, eight vessels (14-23 m in length) were in operation (Mahon and Singh-Renton 1992).

Recently there has also been a significant expansion in the fishing capacity for large pelagics in Barbados. Between 1962 and 1979 the number of vessels fishing for pelagic fishes (flyingfish and large pelagics) was relatively constant at about 400. However during that period the fishing power of these day-trip trolling vessels more than doubled from 35 kg/day to 76 kg/day due to increased boat and engine size (Oxenford and Hunte 1987, Mahon *et al.* 1990). In 1979, the development of a new fleet of larger vessels, with ice holds, capable of staying at sea for 7-14 days, and thus, fishing farther afield, began with the introduction of one vessel. By 1989, 82 such vessels were in operation. Most were locally built and many were equipped with longline gear. Towards the end of this period, there were several joint ventures with USA vessel owners. Barbados remains committed to further development of its longline fleet.

Most of the information on catches and catch rates of dolphinfish in the eastern Caribbean is based on vessels which employ the more traditional method of trolling. The proportions of dolphinfish caught by the small longliners that have recently been introduced in many countries has seldom been documented. A US swordfish longline vessel fishing in the vicinity of Grenada reported only 0.3% of its catch by weight as dolphinfish (Mahon 1993). In local vessels targeting surface species, mainly yellowfin tuna and sailfish in Grenada, fishing at depths of 30 – 90 m, the proportion of dolphinfish was higher, being in the range of 3-5% (Samlalsingh 1995, Samlalsingh and Oxenford in press).

Large-scale commercial

Large-scale commercial fleets have been fishing for large pelagics in the Caribbean region since the late 1950s. Most of the fishing effort has been by longliners. but since the early 1970s, there have been purse seine and tuna pole and line vessels as well. There is little documentation regarding the catches of dolphinfish by large-scale commercial fleets targeting tunas with longlines, purse seines and pole and line.

The US swordfish fleet which, over the period 1987-1993. expanded its operations throughout the Caribbean. reports an overall bycatch of dolphinfish of 2.66 fish/1.000 hooks (data provided by the US National Marine Fisheries Service. Southeast Fisheries Science Center (NMFS SEFSC). Considerable further analysis of these data are required to determine the spatial and seasonal variation in dolphinfish catches.

The ICCAT database provides the best available information on fishing effort by large-scale commercial fisheries in the western central Atlantic. The database includes fishing effort and catch by country, gear, year, month and square (10°. 5° or 1° on the side). Most data for longliners being recorded by 5° squares and those for surface fisheries by 1° squares. Trends in fishing effort are shown by country for longlines, purse seines and bait boats (Fig. 2). In the case of longlines. the trends are shown for two sets of squares. (1) those in the Atlantic, mainly to the east of national EEZs, and (2) those mainly in the area of national EEZs (Fig. 2). This analysis follows that presented by Mahon (1996a).

In the late 1950s. there was a steady increase in Japanese longline fishing effort in the western central Atlantic from 1958 through 1966. in both groups of squares. The decline in Japanese effort in the late 1960s was accompanied by an increase in Taiwanese longline effort from 1967 to the mid-1970s in both areas, and in Korean longline effort from 1974 through 1979. The fleets comprising this succession of peaks were targeting yellowfin tuna. There was a second peak in Taiwanese effort in this area in 1986, primarily in the Atlantic to the east of the EEZs. targeting albacore. In later years. longline activity by Cuba is concentrated mainly between 1984 and 1987. The growth of Venezuela's large commercial fleets shows clearly from 1981-1985. and the increased activity of swordfish vessels from the USA is evident from 1986 onward (Fig. 2). The distribution of longline fishing effort by 5° square in the WECAFC area for all countries combined for the period 1986-1990 shown by Mahon (1996) suggests that longline effort and catch in the Caribbean Sea are low relative that in Atlantic Ocean east of the island arc.

The Venezuelan tuna fishing fleet includes large purse seiners. small and large longliners and small baitboats. The Venezuelan purse seine tuna fishing fleet only began to expand rapidly in the early 1980s. increasing from five vessels in 1982. with a capacity of 5.600 short tons. to 25 vessels in 1988. with a capacity of 29.700 tons Weidner and Hall (1993). These vessels range in size from 900-1.500 gross registered tons (GRT). The purse seine fleet fishes mainly in the eastern tropical Pacific. but does catch appreciable amounts of tuna in the western central Atlantic.

In 1992. the Venezuelan longline fleet consisted of two large longliners (about 60 m). which operate primarily in the western Atlantic. and about 80 small vessels (20-25 m) using about 33 km of longline. The small-scale fleet in general appears to be expanding. as there were only 58-60 vessels operating in 1990-1991. The exact number of these which target tuna is uncertain, with reports ranging from 15 to 33 vessels (Weidner 1993). Eslava and Gaertner (in press) report four large longliners and only 15 small ones. noting that the latter fleet had declined recently due to difficult economic times in Venezuela.

Cuba's tuna fleet, of 1 purse seiner and 10 longliners over 500 GRT reported to be operating in 1989, is believed to have been fishing primarily off West Africa. However, there was some reported activity by Cuban longliners in the WECAFC area between 1984 and 1987. Details of the small-scale domestic fleet which fishes for large pelagics in the vicinity of Cuba are not readily available. Rodriguez (1989) indicates that there were about 60 small-scale pole and line fishing vessels and about 80 small-scale longliners in operation in Cuba in 1988.

Most commercial fishing for large pelagics in the WECAFC area by the USA is by small-scale fleets for coastal pelagics. Two notable exceptions are the longline fleet fishing for yellowfin tuna in the Gulf of Mexico (Browder and Scott, 1992), and the swordfish longline fleet. The latter shifted its operations south through the Caribbean and down to the north coast of South America from about 1986 through 1991 and withdrew partially in subsequent years.

Recreational

Throughout the Caribbean, dolphinfish are an important component of recreational fishing. There are few records of quantities caught by recreational fishers. Furthermore, the lack of information on the numbers of recreational vessels and their patterns of fishing makes it impossible to estimate the catch of this component of the fishery. A questionnaire survey by Schmeid (1989) is the most complete compilation of information for the countries of the wider Caribbean. Of 40 countries/islands surveyed, 27 replied, but many respondents were unable to supply quantitative information on the numbers of anglers (12/27 respondents provided) private vessels (17/27) or charter vessels (19/27) present in their countries.

Recreational fishing can be considered in three parts: fishing tournaments; charter boat fishing, usually by tourists; and regular fishing from privately owned pleasure craft (private fishing). There are local and international fishing tournaments for large pelagics throughout the Caribbean region. Many of these are aimed at billfish, but other species are also often caught. Between 1991 and 1994, 18% of the catch at the St. Lucia Annual International Billfish Tournament was dolphinfish (Scott in press).

In a questionnaire survey of Caribbean countries, 11/18 countries listed dolphinfish as one of the top five marine species sought in tournaments, whereas 10/20 countries listed it as one of the top five species caught (Schmied 1989). In Puerto Rico, in a 1978 survey, dolphinfish was named as the most sought after sport fish (CFMC 1983).

Dolphinfish are also a significant component of private fishing. In Venezuela, records from a single yacht club show that between 1961 and 1981, dolphinfish comprised 17.6% (numbers) of the catch (Machado and Jaen 1983). In Puerto Rico in 1979 the percentage (numbers) was 14.33% (CFMC 1983).

Fish attracting devices (FADS)

Despite the tendency for dolphinfish and other large pelagics to occur in association with drifting objects (Oxenford 1985, Gomes *et al.* in press), FADs are not in common use by commercial or recreational fishers in the Caribbean (Gomes *et al.* in press). There have been some studies of the efficacy of FADs in the Caribbean area. Friedlander (1992) found that the majority of fish caught trolling around FADs were dolphinfish (64.2%), and catch rates were higher than in a control area. Commercial and recreational fishers report increased catch rates for dolphinfish when trolling around FADs placed of the west coast of Barbados (*pers com.* S. Willoughby, Barbados Fisheries Division).

TRENDS IN LANDINGS

There is an overall increasing trend in dolphinfish landings reported to FAO by countries in the western central Atlantic (Fig. 3). However, only eight of about 34 states report dolphinfish landings (Table 1). Brazil also reports a steady increase in landings from the southwest Atlantic. However, this appears to have been in two phases, with a steep increase from 1950-1978, followed by a sharp drop from 1978-1980, and another period of increase through to 1995 (Fig. 3).

Dolphinfish are known to be caught in the large majority of countries that do not report them (Table 1). There are several reasons why they may not be reported.

- The catch may be mainly bycatch in large-scale commercial longline fisheries and may not be considered consequential. The countries that report dolphinfish are those for which coastal pelagics are most important (Fig. 4). Countries with well developed small scale trolling and longline fisheries catch a high proportion of coastal pelagics, including dolphinfish.
- The fisheries may be primarily recreational. Recreational catches are not reported by any country except the USA.
- Data collection and reporting systems may not be sufficiently well developed to record, or report recorded catches to the species level. The data may be collected or estimated at the detailed level but aggregated for reporting because national staff do not appreciate the importance of reporting the data by species.

The literature and FAO data, reflected in Table 1, suggest that dolphinfish are most important in the eastern Caribbean. Western Caribbean countries, Mexico excepted, do not frequently refer to dolphinfish as a significant species in their national reports and publications describing fisheries. In the eastern Caribbean, fishing areas for dolphinfish appear to be most commonly located to the east of the island chain.

CONCLUSIONS

Dolphinfish are widely distributed in the western central Atlantic, where they are caught by a wide variety of fisheries: artisanal, small-scale commercial, large-scale commercial and recreational. The growth in all these fleets over the past 20-30 years suggest that exploitation of dolphinfish has been intensifying. The data reported to FAO show a steady increase in landings. However, it is clear that the reported landings are substantially lower than the actual landings. Many countries do not report their dolphinfish landings separately from other species, and few countries report recreational landings.

Although there is no dramatic evidence of a decline in this resource, the lack of information on the quantities of dolphinfish landed should be a matter of urgent concern to all countries that exploit this species.

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Table 1. Dolphinfish fisheries in countries of the wider Caribbean region (R = recreational, A = artisanal, C = commercial). For co
reporting dolphinfish, landings of unidentified fishes that could include dolphinfish are shown in three categories: unidentified ma
(UIM), unidentified pelagic fishes (UIP) and unidentified tuna-like fishes (UIT).

Country	Fish-eries	Dolphinfish landings		Avg. ann. unid. landings (1990-94)		Comments and sources
		mt	Period	mt	Type	
Countries reporting dolphinfish landings to FAO						
Barbados	RAC	821	1990-1994			About 50% of total landings (Oxenford 1985)
Dominican Republic	RAC	242	1990-1994			FAO. No details provided by Appeldoorn and Myers (1993).
Grenada	RAC	135	1990-1994			Comprised 17.9% of large pelagic landings at Grenville, east coast, and 8.0% and 7.2% at we 1981-1989 (Mahon *et al.* 1990).
Guadeloupe	RAC	656	1990-1994			FAO
Martinique	RAC	345	1990-1994			Comprised 9% of large pelagic landings (Sacchi *et al* 1981)
Mexico	RAC	59	1990-1994			FAO
USA	RC	657	1990-1994		UIM	FAO
Countries not reporting dolphinfish landings to FAO						
Anguilla	RA			112	UIM	No specific information on dolphinfish (MRAG 1993)
Antigua and Barbuda	RA			884	UIM	
Aruba	RA			232	UIM	
Bahamas	RA			466	UIM	Important in rec. fisheries only (Bahamas Dept. Fisheries 1992)
				115	UIP	
Belize	R			384	UIM	
Bermuda	RA			119	UIM	
Brazil	RA				UIM	
British Virgin Islands	RAC			934	UIM	No specific information in MRAG (1993), 0.9 mt landed at BVI Fishing Co. Ltd. In 1987, co fish landed at that facility, mainly incidental catch to reef fish fishery. Recreational mentione (1983)
Cayman Islands	R			119	UIM	Not listed by MRAG (1993).
Colombia	R	15	1992	3386	UIM	Dolphinfish was second most important species in the artisanal catch in 1993 (11%)(INPA 1
		92	1993	2684	UIT	as incidental catch in deepwater fishery, but not as a major species in fisheries around San A archipelago (Mow de Peters 1988).
Costa Rica	R			65	UIM	
Cuba	AC			22096	UIM	No mention in Paez (1991) or Baisre (1993). Former gives annual landings down to 0.3 mt mentioned by Roig and de la Maza (1952).
Dominica	RAC	72	1992	677	UIM	Comprised 12.1% (25 mt) and 13 % (65 mt) of total landings in 1984 and 1985 (Anon. 198 catch from Guiste *et al* (1996).
French Guiana	R	Neg		3171	UIM	No reports of dolphinfish. Unlikely in nearshore fisheries due to river influences
Guatemala	R			102	UIM	
Guyana	R	Neg		35969	UIM	Dolphinfish are not taken by domestic fisheries (Phillips and Charles 1993)
Haiti	RA			3476	UIM	No mention of dolphinfish by Appeldoorn and Myers (1993)
Honduras	RAC			535	UIM	

Country	Fish-eries	Dolphinfish landings		Avg. ann. unid. landings (1990-94)		Comments and sources
		mt	Period	mt	Type	
Jamaica	RAC	110	1981	7200	UIM	Comprised 6% (34 mt) of pelagic and 0.03% of total landings in 1963, 3.6% (27 mt) of pelagic total in 1970, and 25% of pelagic and 1.5% of total in 1981 (Sahney 1983, Mahon 1995).
Montserrat	RAC			143	UIM	MRAG, 1993;
Netherlands Antilles	RAC			568	UIM	Zaneveld, 1962;
Nicaragua	R			694	UIM	No mention in Garcia (1989) which includes spp. with landings down to 0.1 mt.
Panama	R				UIM	
Puerto Rico	RAC			305	UIM	CFMC 1983, Appeldoorn and Myers, 1993, Perez *et al.*
				107	UIP	
				79	UIT	
St. Kitts/Nevis	RAC			254	UIM	Mentioned by Olsen (1983)
St. Lucia	RAC	211	1993	781	UIM	19% of total landings in 1993 (Gobert & Domalain 1995), and 43.2%-36.0% of pelagic landin 1989 (Mahon et al. 1990).
St. Vincent/Granadines	RAC	48	1995	1132	UIM	Comprised 38.2% of pelagic landings from 1979-1989 (Mahon et al. 1990). 1995 landings fro
Suriname	R	0		9010	UIM	No catches of dolphinfish have been noted (Charlier 1993)
Trinidad/Tobago	RC			2661	UIM	Mentioned as a recreational species but not listed as a commercial species by Kenny and Baco
Turks and Caicos Islands	R			303	UIM	Not listed as a species caught by longlines (MRAG 1993).
US Virgin Islands	R			741	UIM	Comprised 6.9% of recreational catch (Olsen and Wood 1983). Comprised 7% (1.4 mt), 4% (I (3.6 mt) of recreational catch in St. Thomas in 1983, 1984 and 1985 (Brandon 1988) CFMC 1 and Myers 1993
Venezuela	RC			27,776	UIM	Not included in Herrera-Teran (1988) which lists species with landings down to 1 mt. Recreat in Machado and Jaen (1983).
				563	UIP	
				60	UIT	

F-151

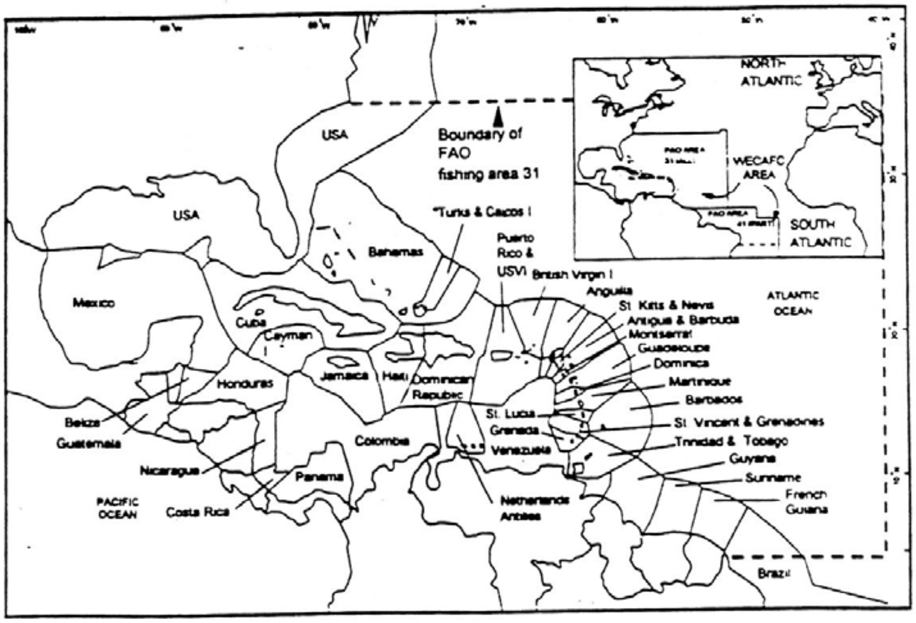


Figure 1. The wider Caribbean region and Western Central Atlantic Fishery Commission area showing approximate EEZs of countries (after Mahon 1996).

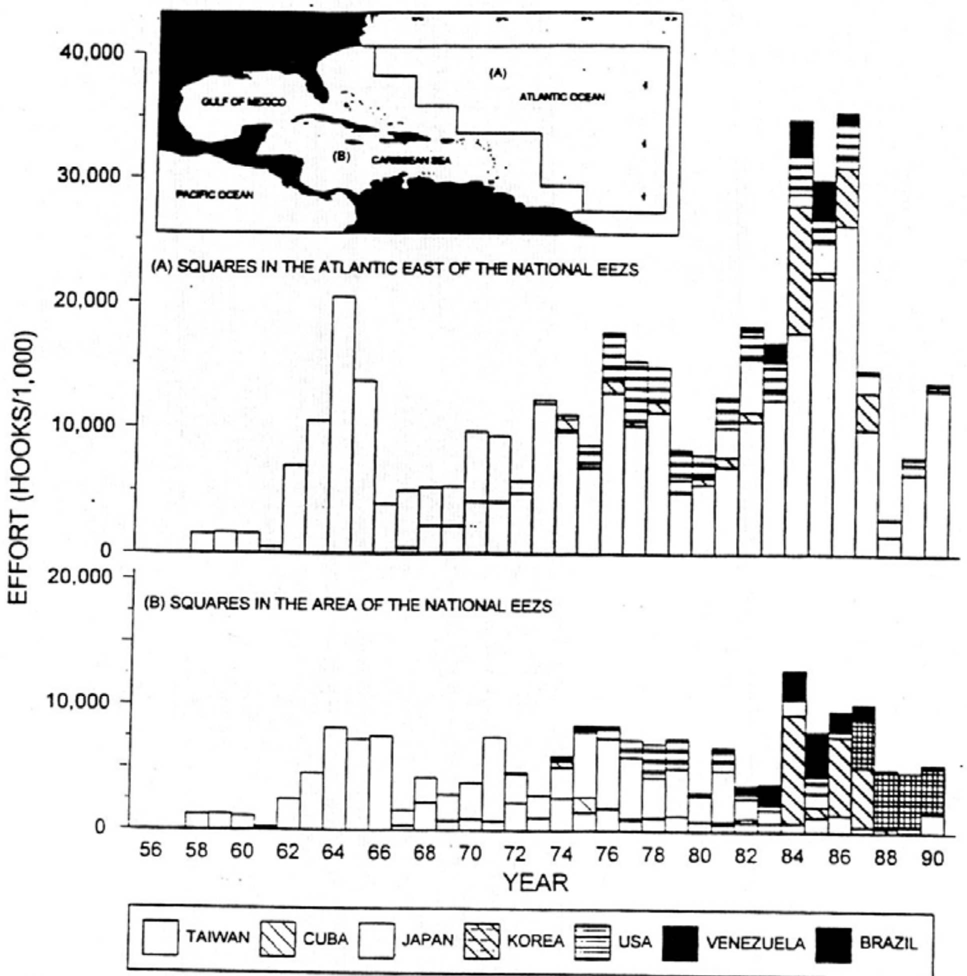


Figure 2. Trends in longline fishing effort by countries reporting landings in the WECAFC area. The data are shown for two areas: (A) data reporting squares in the Atlantic east of national EEZs; and (B) squares in the area of national EEZs.

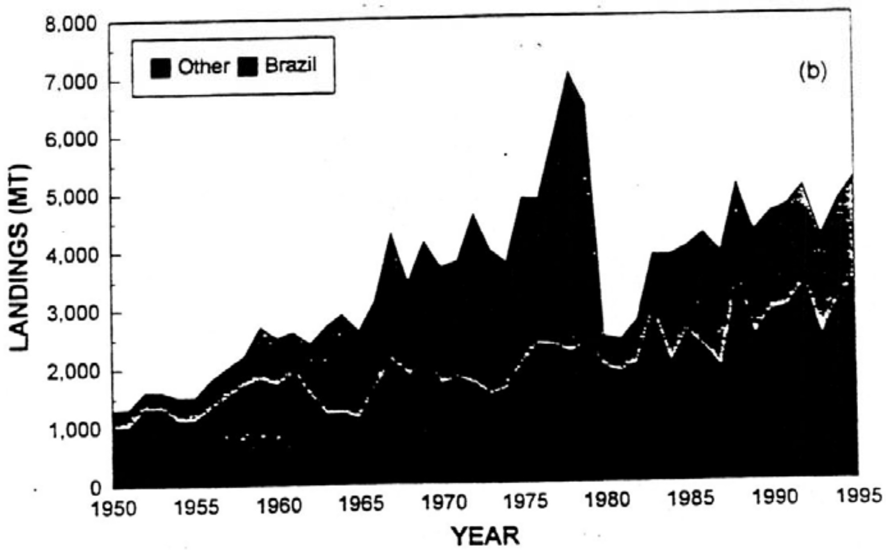
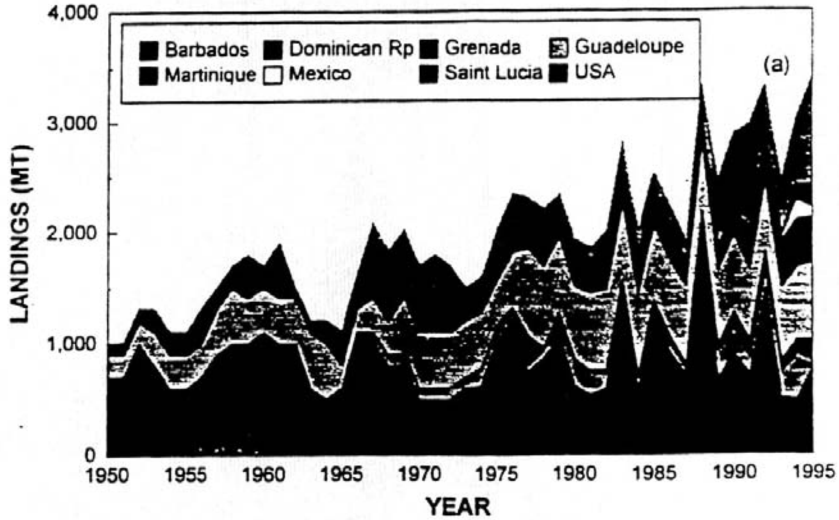


Figure 3. Reported dolphinfish landings from (a) Caribbean countries, and (b) from Brazil and the total for all Caribbean countries


4,000
3,000
2,000
1,000
0
LANDINGS (MT)
Barbados
Dominican Rp
Grenada
Guadeloupe
Martinique
Mexico
Saint Lucia
USA
(a)
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
YEAR

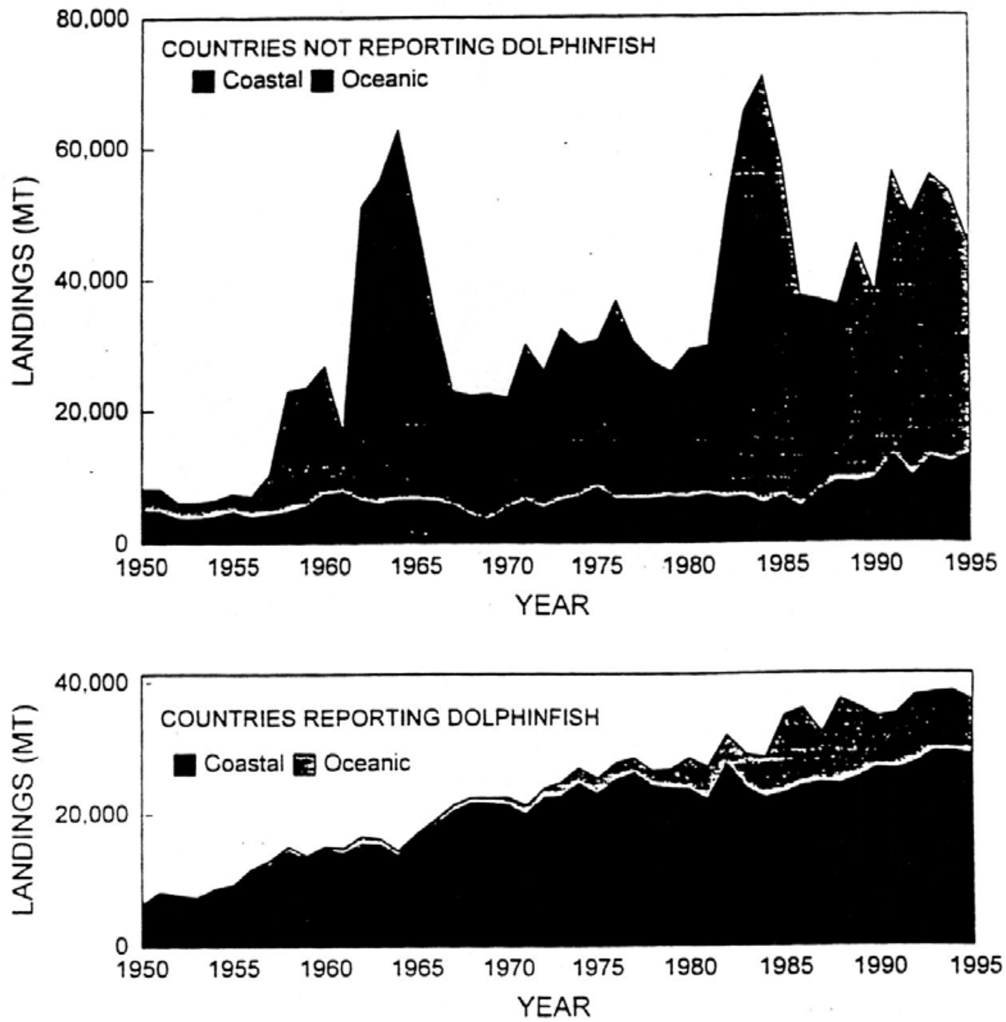


Figure 4. The reported landings of coastal and oceanic large pelagics in countries that do report dolphinfish landings and countries that do not.

A REVIEW OF RESEARCH RESULTS ON THE BIOLOGY OF DOLPHINFISH (*CORYPHAENA HIPPURUS*) AND WAHOO (*ACANTHOCYBIUM SOLANDRI*) LANDED BY ST. LUCIAN FISHERMEN

BY

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Presented at the
Dolphin/Wahoo Workshop
hosted by
the South Atlantic Fishery Commission
at the
Town & Country Inn
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ABSTRACT
Offshore pelagics constituted 65.4% of the estimated annual landings of 893 metric tonnes for 1995. These pelagic species include the dolphinfish, *Coryphaena hippurus*; wahoo, *Acanthocybium solandri*; tunas, *Thunnus* spp., *Katsuwomus pelamis*, *Sarda sarda*; mackerels, *Scomberomorus* spp.; and flyingfish, *Hirundichthys affinis*..Landings and catch per unit of effort of wahoo and other pelagic fishes in St. Lucia are discussed. Estimates of asymptotic length; von Bertallanfy growth rate parameter; total, natural, and fishing mortalities; exploitation rate; and length at first capture for wahoo from St. Lucia are presented as well as dolphinfish growth and mortality parameters. A model of wahoo life history consistent with recent observations is also presented, as are some morphometric relationships. Data needs for the determination of how management among countries can be co-ordinated to allow for sustainable development of pelagic fisheries are also discussed.

OVERVIEW
St. Lucia is an approximately 684 km^2 volcanic island located midway along the Lesser Antilles island chain which serves as the eastern boundary of the Caribbean Sea. The fisheries of this island state (Fig. 1) are considered artisanal in terms of the technologies employed in fishing, the scale of production, organisation of the markets etc. (Mc. Goodwin, 1984).

There are 625 fishing vessels (Department of Fisheries, St. Lucia, unpublished data) which make up the fleet, and 2000 fishermen (*ibid.*). The majority of vessels in the fleet (47.4%) are open canoes, five to eight metres in length, 34.1% of the fleet is made up of fibreglass pirogues, and 13.1% are open wooden "transom" boats, three to eight metres long (OECS, 1996). The primary source of propulsion is the outboard engine with horse-powers ranging from 15 h.p. (in the case of the smallest "transom" vessels) to 85 h.p. The canoes are of the traditional Carib dug-out construction with plank gunwales (Murray *et al.*, 1988).

There are 28 sites on the island where significant quantities of fish are landed. The largest percentage of vessels (16.0%) at any single site is to be found in Soufriere, though Castries' two sites together have 18.2% of the island's fishing vessels. Eight of the major fish landing sites are the homes of fishermens co-operatives. These organisations serve as the primary conduit for a government subsidy, through a duty refund on petrol and engine oil, pursuant to the Fishing Industry (Assistance) Act of 1972. This Act also provides for duty free concessions on imported vessels, gear, tackle, and other inputs into the fishing industry purchased by fishermen and their co-operatives.

CATCH AND EFFORT

During the period 1991-1995 an estimated annual average of 886 metric tonnes of fish were landed by St. Lucian fishermen (OECS, 1996). The trend noted in 1995 is that the offshore pelagics constituted 65.4% (*ibid.*) of the estimated annual landings of 893 metric tonnes for that year. These pelagic species include the dolphinfish, *Coryphaena hippurus*; wahoo, *Acanthocybium solandri*; tunas, *Thunnus* spp., *Katsuwomus pelamis*, *Sarda sarda*; mackerels, *Scomberomorus* spp.; and flyingfish, *Hirundichthys affinis*. 80% of the offshore pelagic catch, in general, comes from the east and south areas (Gobert and Domalain, 1995). These species were caught, in 1993, by 60% of the fishing trips of St. Lucian vessels. Catch per unit effort of the offshore pelagic species captured during the "high" season is on the order of 122.2 pounds per fishing excursion (*ibid.*). The wahoo and dolphinfish are the two most important species in trolling fisheries for large pelagics in this region (Mahon *et al.*, 1990). In St. Lucia, the major fishing areas for these species are on the east and southeast coasts; landings of the wahoo represented on the order of 14% of total estimated landings in 1988 (Murray and Nichols, 1990), 5% in 1989 and 10% in 1990 (unpublished data, Government Statistical Department, 1992). This suggests that landings and catch per unit of effort of wahoo and other pelagic fishes in St. Lucia in particular, as well as in the eastern Caribbean in general, are highly variable from one season to another. The sharply peaked fishing season does not appear to vary much in timing from season to season (Mahon *et al.*, 1990). In general, for the southern Windward Islands and Barbados, the pelagic fishing season can be considered to extend from September to the following August (*ibid.*), but in St. Lucia most wahoo are landed between mid-November and the end of the following July (figure 2; see also: Murray, 1989; Murray and St. Marthe, 1991). Fishing effort is thought to vary seasonally in phase with these landings (Murray, 1989; Gobert and Domalain, 1995).

GROWTH AND MORTALITY

Estimates of asymptotic length; von Bertallanfy growth rate parameter; total, natural, and fishing mortalities; exploitation rate; and length at first capture for wahoo from St. Lucia were obtained by Murray and Sarvay (1987), and Murray and Joseph (in press). These, shown in tables one and two, were predicated on estimates of growth parameters derived by use of the software tool known as ELEFAN I (Brey and Pauly, 1986; Gayanilo *et al.*, 1989). ELEFAN I provides reliable estimates of growth parameters when the modes of length frequency distributions are clearly defined and progress over time. However, in the case of the St. Lucia wahoo fishery, the observation (Neilson *et al*, in press) that the major modes of the length-frequency distribution are essentially stationary (Figure 3) probably indicates that the estimates of *Z* are likely to be biased.

Dolphinfish growth and mortality parameters have also been estimated (Murray, 1985) L_{∞}

236.05cm; k: 0.5322 y^{-1}; t_0 :-0.1734 y; M : 0.6593 y^{-1}; and Z : 3.53 y^{-1}. Figure 4 shows the monthly length frequency distribution of dolphinfish for 1982. As for wahoo, the stationary nature of these distributions suggests that the total mortality estimates (Murray, 1985) may also have been biased.

LIFE HISTORY

Examination of the length-frequency distributions (Neilson *et al*, in press) provided important insights into the life history and movements of wahoo. There is the suggestion that the fishery is a Type A one (*sensu* Shepherd *et al.*, 1987). Type A fisheries are indicative of stocks which are either highly migratory, or the fishery itself is extremely size-selective. In the fishing season 1984/85, there were some large (about 200 cm) wahoo landed, indicating that the hooks being used are capable of capturing fish larger than the usual 80-100 cm range, if such fish are present in the population. The other trolling fishery of consequence to St. Lucia is for dolphinfish, and a wide range of lengths of fish are landed even though the same hook size is employed. The troll fishery therefore is not as size selective as some may think, thus, Neilson *et al* (in press) see this as confirming the highly migratory nature of wahoo off St. Lucia.

Given the Neilson *et al* (in press) study and other available information, it is possible to summarize existing knowledge of wahoo life history as follows:

1. Wahoo appear to be available to the fishery in all months of the year.

2. The fish do not appear to increase in average size throughout the year.

3. Typically, two closely-spaced modes appear in the annual length-frequency distributions. Those modes could represent either year classes or sexes if growth rate is sexually dimorphic, as is the case in other scombrids.

4. The modes in the length-frequency distribution do not progress from month to month.

5. The lack of modal progression appears to confirm a highly migratory stock, while the hypothesis of a highly-selective fishery, does not appear supported by the available data.

6. The exploited population appears to consist of only one or two year-classes (with the possible exception of the 1984/85 fishing season).

It is possible to construct a model of wahoo life history consistent with the above observations. Neilson *et al* (in press) suggest that recruitment of wahoo to the fishing grounds occurs throughout the year. This inference is consistent with a protracted period of spawning, as suggested by Collette and Nauen (1983). Since the average size of fish in the exploited population does not increase over the fishing season (Neilson *et al*, in press)), individual fish do not stay long on the fishing grounds, at least off St. Lucia. Neilson *et al* (in press) therefore predicted that tagging studies would show relatively few recaptures close to the point of release.

They also suggested that because of the apparent brevity of residence on the fishing grounds, the seasonality and size composition of landings from waters of adjacent countries will differ only slightly.

Recent studies within the Caribbean have confirmed that the movements of regional pelagic stocks are not restricted to any single OECS EEZ (c.f. Neilson, *et al.*, in press; Singh-Renton, 1994; Finlay and Rennie, 1988). Oxenford and Hunte (1986) proposed a model for the life history and migration for dolphinfish, wherein it is suggested that two stocks occur in the western central Atlantic region, the southern stock moves sequentially north through the waters of the Lesser Antilles countries. A return migration south is hypothesised via the waters further to the east. Consistent with the results for wahoo observed in their study, Neilson *et al* (in press) presented frequency distributions for dolphinfish which showed no modal progression, probably due to the highly migratory nature of that stock, and went on to suggest that the life history and migration model for dolphinfish also applies to wahoo.

MORPHOMETRICS

Murray and Moore (in press) presented a regression of fork length (FL) on total length (TL), shown in figure 5, for wahoo given by the equation:

$$FL = 1.086 + 0.950TL \qquad r = 0.997;\ n = 75$$

The regression of the natural logarithm of gutted weight (ln GW) on the natural logarithm of total length is given (*ibid.*) by the equation:

$$\ln GW = -13.778 + 3.206 \ln TL \qquad r = 0.992;\ n = 195$$

with the regression coefficient being significantly different from three ($t = 3.375$; $t_{0.005,(2),190} = 2.840$).

Figure 6 is a graph of gutted weight versus total length expressed by the equation:

$$GW = 1.039 \times 10^{-6}\ TL^{3.206}$$

The regression of natural logarithm of gutted weight on the natural logarithm of fork length is given (Murray and Moore, in press) by:

$$\ln GW = -12.720 + 3.072 \ln FL \qquad r = 0.986;\ n = 36,$$

with the regression coefficient not being significantly different from three ($t = 0.801$; $t_{0.05,(2),34} = 2.032$).

Figure 7 shows the corresponding graph of gutted weight versus fork length as expressed by the equation:

$$GW = 2.991 \times 10^{-6} FL^{3.072}.$$

DATA NEEDS FOR MANAGEMENT

Mahon *et al.* (1990) have identified to a number of issues regarding data quality and analytical procedures as they have related to studing seasonal patterns in pelagic species caught off St. Lucia and the other southern eastern Caribbean islands:

" a) there is need for more accurate information on the species composition of groups of species, such as kingfish (which includes wahoo) ...
b) there is need to distinguish between effort ... for pelagics and that for other resources ...
c) there is need to examine the indices or units of fishing effort more closely ..."

Additionally, the annual variability in landings and catch per unit of effort for the pelagic species must be taken into account in any management strategy (Mahon *et al*, 1990).

The assessment of the pelagic species can only be properly addressed if the information available is relevant to the whole area through which the stock is distributed. The standard methods of assessment assume that all the life stages of the stock have been adequately sampled over the whole range of stock distribution. In the case of migratory pelagic species the stock may not be accessible to the individual national fishery during certain periods or in particular areas of its distribution; additionally, samples from different areas may represent different components of the stock. Thus, lack of an accurate understanding of migration routes and stock structure can result. This means that there is first a need to examine stock distribution, structure and migration to assist in the determination of how management among countries can be co-ordinated, providing support to national, zonal, and sub-regional fisheries resource management, to allow for sustainable development of the pelagic fisheries of OECS Member States.

THE WAY FORWARD

From the inception of the CFRAMP activities related to the assessment of large pelagic fisj\hes, St. Lucia has begun a systematic process of sampling the artisanal fishery for catches of wahoo and dolphinfish (C.F. CFRAMP, 1994). Landings are sampled for lengths with sampling targets of 200-300 fish to be measured every month (*ibid.*). Hard parts are also taken for ageing, and gonads are checked for maturity stage and sex. Neilson *et al.* (in press) have outlined the general plan for use of these data (c.f. figure 8). It is envisaged (after CFRAMP, 1994) that data collected for these two species from a number of islands along the eastern Caribbean chain would be combined for analysis. Hopefully, the geographic and temporal spread of samples would allow for the progression of modes not evident in the Neilson *et al.* (in press) study, to be more clearly observable and thus allow for a more rigourous determination of growth and mortality parameters and thus better assessment of those species.

The data should allow researchers to obtain a better idea of stock distribution, structure and migration. Hopefully also, improved information on fishing effort would become available; thus improving the quality of assessments carried out. Collectively, these efforts would provide better climate for the co-ordinated management of these species in the region. This becomes necessary given that efforts of ICCAT appear to always exclude or, at best, marginalise these species in terms of the effort put into their assessment as a consequence of their falling into two ICCAT categories ("Small Tunas" and "Western Atlantic Tropical Tunas") which ICCAT rarely has been able (or willing) to pay serious attention to.

Many of the OECS countries have identified pelagic fishes as having the most scope for development (Anon., 1992). In the case of both the wahoo and the dolphinfish, the sharing of the stocks has profound implications for their future management since expansion of fishing effort by one country is likely to impact on its neighbours opportunities for similar expansion (Neilson *et al.*, in press).

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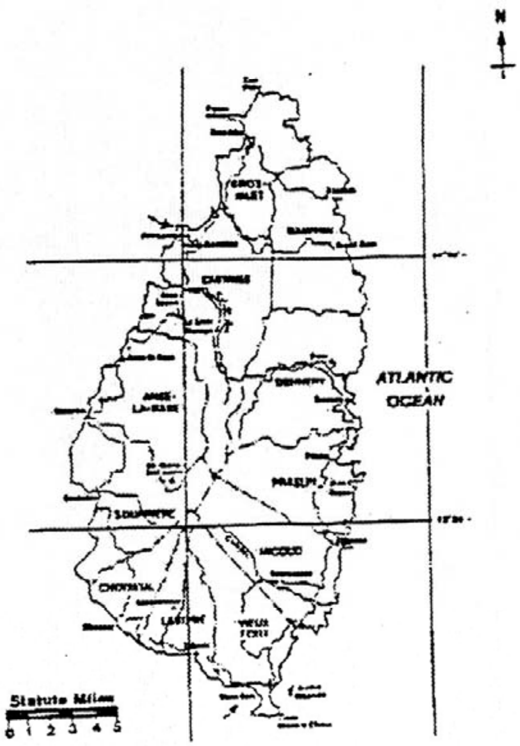
Table 1 **Estimates of L_∞ and K for *Acanthocybium solandri* caught off St. Lucia (Murray and Joseph, in press)**

	Parameter	
Year	L_∞	K
1982	158	0.34
1983	159	0.37
1988	159	0.31
1989	161	0.37
1990	156	0.33

Table 2 **Estimated values of mortality parameters and length at first capture for *Acanthocybium solandri* caught off St. Lucia (Murray and Joseph, in press)**

Year	Z	M	F	E	L_c
1982	1.17	0.56	0.61	0.52	85.8
1983	1.52	0.58	0.94	0.62	74.5
1988	1.45	0.49	0.96	0.66	72.7
1989	1.75	0.54	1.21	0.69	70.7
1990	2.34	0.54	1.80	0.77	80.0

LIST OF FIGURE CAPTIONS


N
ATLANTIC
OCEAN
Statute Miles
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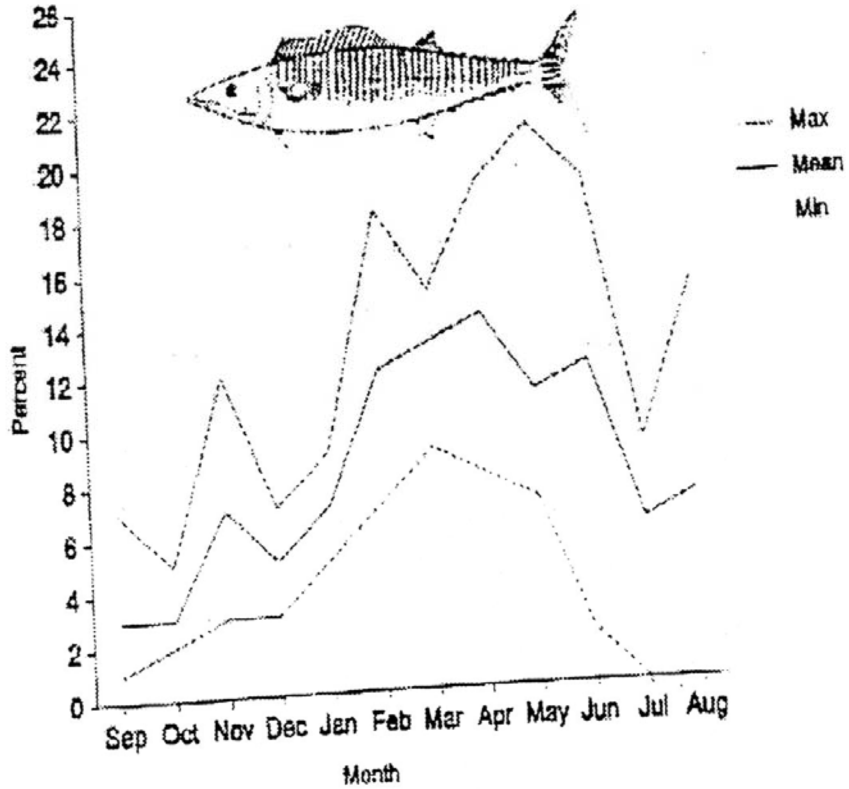
26
24
22
20
18
16
14
12
10
8
6
4
2
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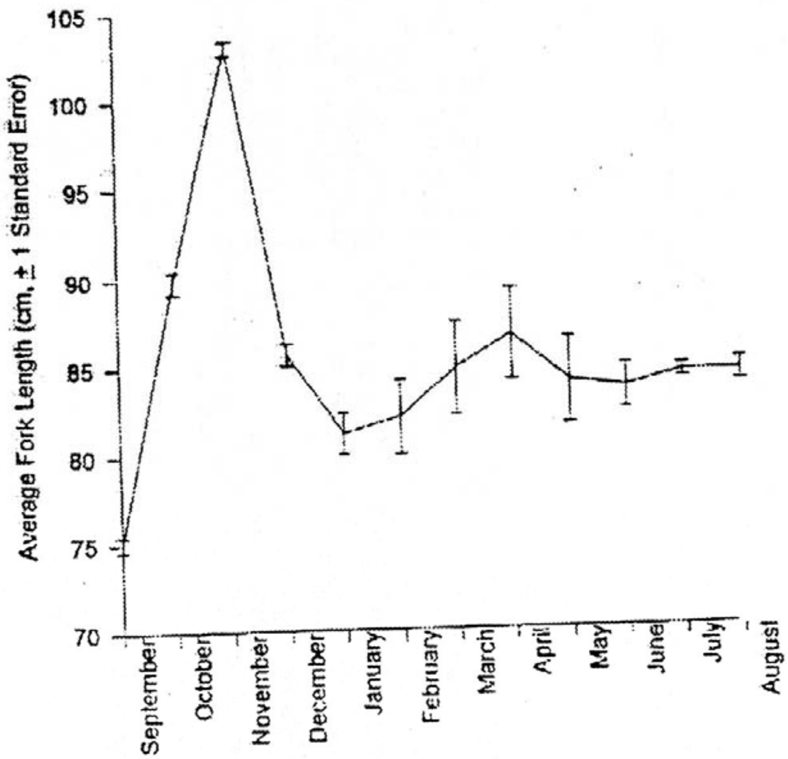
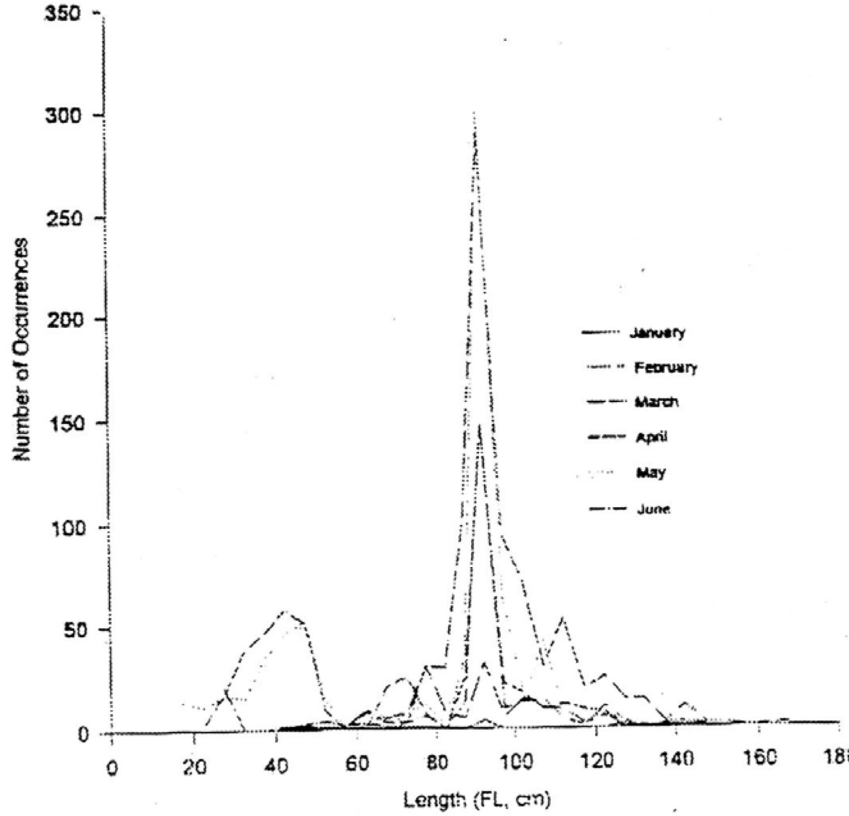
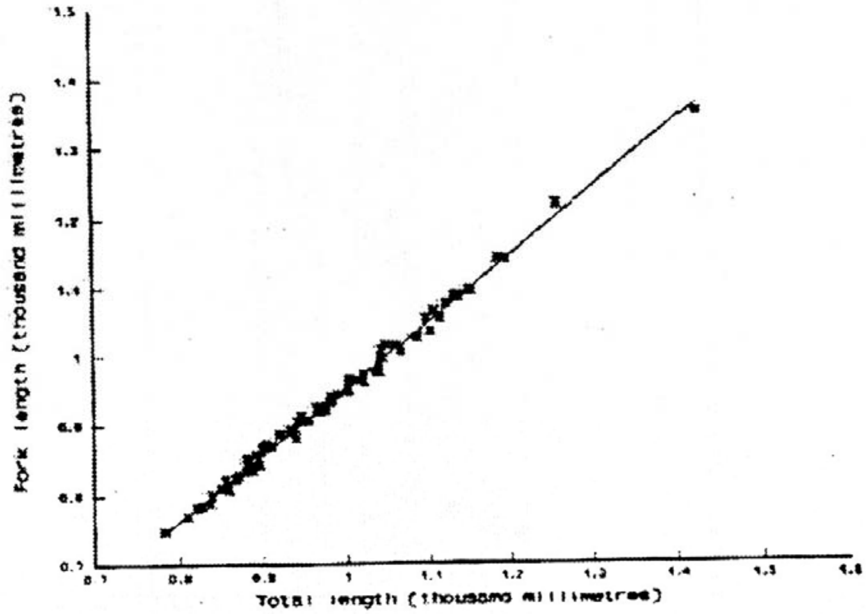
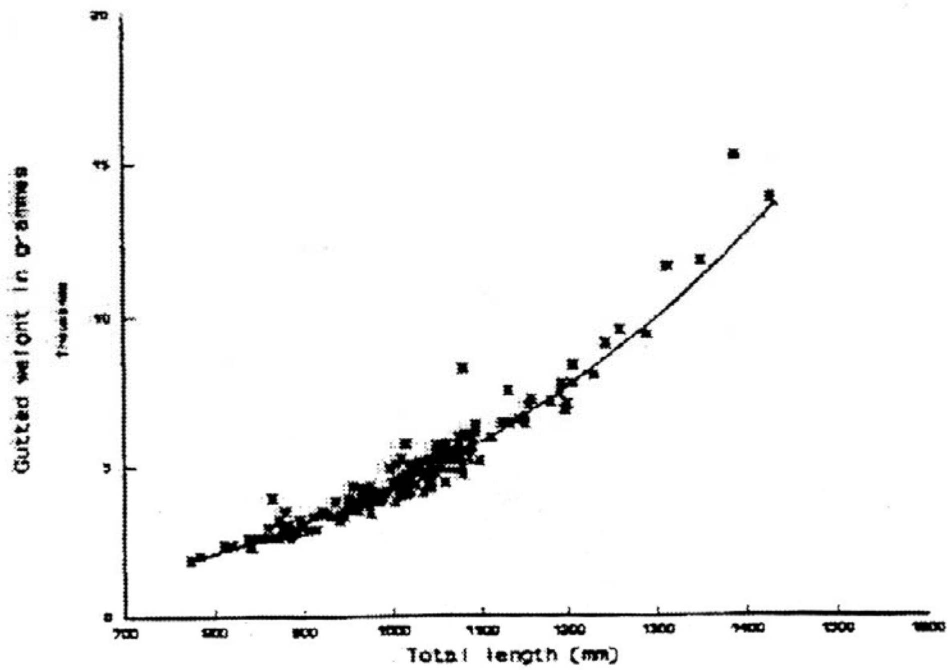
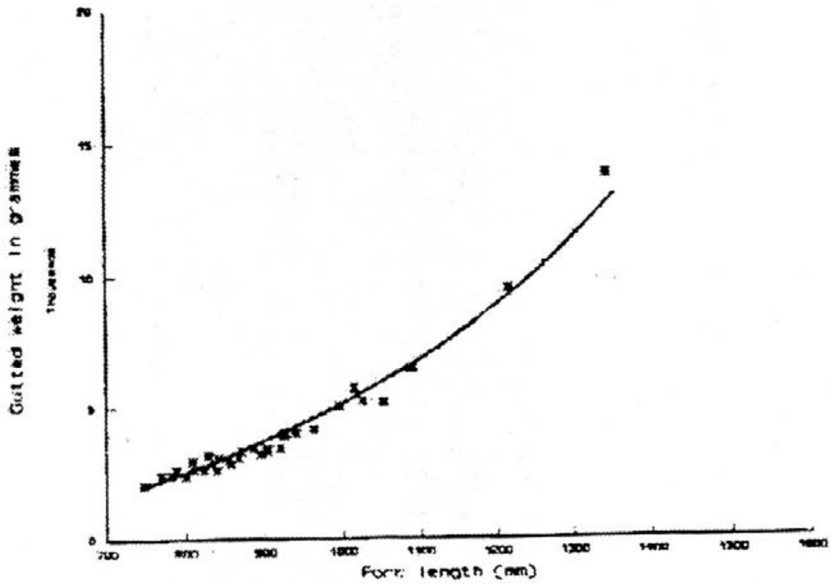
Percent
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Month
Max
Mean
Min

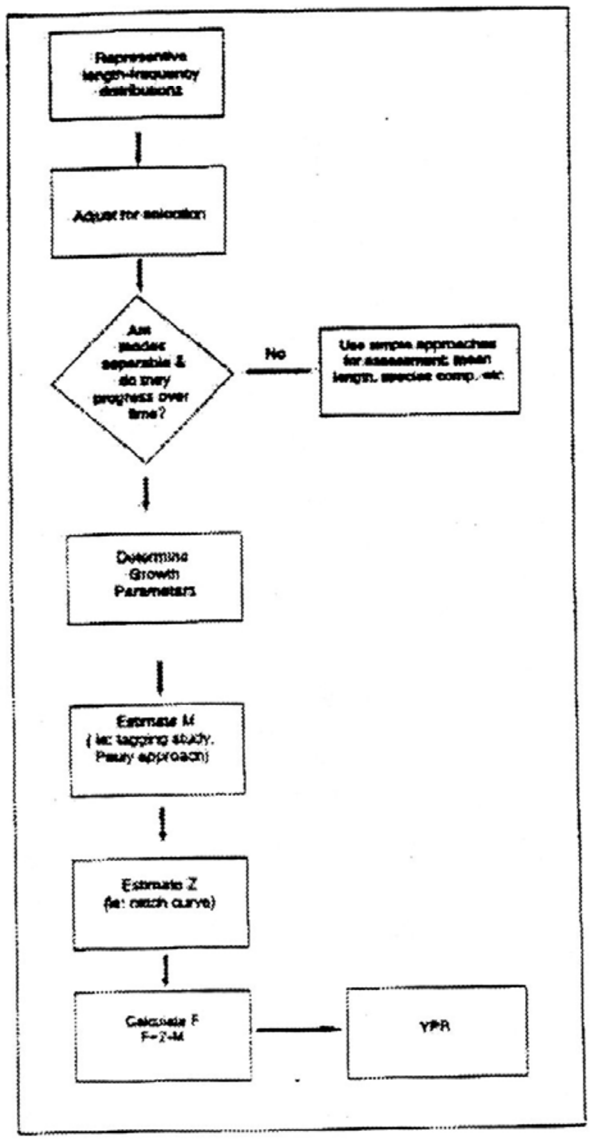

Average Fork Length (cm, ± 1 Standard Error)
105
100
95
90
85
80
75
70
September
October
November
December
January
February
March
April
May
June
July
August


350
300
250
200
150
100
50
0
Number of Occurrences
0
20
40
60
80
100
120
140
160
18
Length (FL, cm)
January
February
March
April
May
June


Fork length (thousand millimetres)
Total length (thousand millimetres)


Gutted weight in grammes
Total length (mm)


Gutted weight in grammes
Thousands
0
5
15
700
900
1000
1200
1300
Fork length (mm)


Representative length-frequency distributions
Adjust for selection
Are species separable & do they progress over time?
No
Use simple approaches for assessment: mean length, species comp. etc.
Determine Growth Parameters
Estimate M
(ie: tagging study, Pauly approach)
Estimate Z
(ie: catch curve)
Calculate F
F=Z-M
YPR

Bermuda's Commercial Line Fishery for Wahoo and Dolphinfish: landings, seasonality and catch per unit effort trends

by

Brian E. Luckhurst and Tammy Trott

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Presented at the
Dolphin/Wahoo Workshop
convened by the South Atlantic Fishery Management Council
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May 6-8, 1998

INTRODUCTION

In Bermuda, the relative importance of pelagic species to total fishery landings has increased significantly over the past 20 years. The once dominant grouper fishery declined sharply from 1975 to 1981 (Luckhurst, 1996) and the landings of pelagic species, particularly wahoo (Acanthocybium solandri) and yellowfin tuna (Thunnus albacares), increased steadily during the 1980's. This trend of increased landings of pelagic species was highlighted when wahoo became the single most important species in the commercial fishery landings in 1986 (Luckhurst and Ward, 1996) with landings of 65,406 Kg. Ten years later, the landings reached 115,436 Kg which was the highest level yet recorded in the Bermuda fishery and further served to confirm the continued dominance of wahoo. Despite the local and regional importance of wahoo, relatively little is known about its fishery biology. Luckhurst et al. (1997) provided preliminary information on age estimation of wahoo by analyzing the microstructure of sagittal otoliths using scanning electron microscopy. Research on growth, reproductive seasonality and movements is being conducted in Bermuda waters to enhance the knowledge of the fishery biology of this species.

The common dolphinfish (Coryphaena hippurus) is a regular component of the pelagic fish assemblage harvested in Bermuda but landings of this species are typically at much lower levels than wahoo and yellowfin tuna. Dolphinfish are taken by the same troll fishery as for wahoo but landings since 1975 have not shown the same increasing trend over time but rather have oscillated in a smaller range with no clear trend (up to over 7,600 Kg in 1985).

MATERIALS AND METHODS

The data used in this paper are derived from two sources, the Commercial Fishery Statistical Database maintained by the Division of Fisheries and the field sampling data from the Bermuda pelagic species research program which commenced in 1995. Total landings figures for wahoo and dolphinfish were derived from the entire database whereas the data on seasonality of landings used the last 10 years available. Reliable effort data could not be extracted from the database because directed effort for pelagic species could not be ascertained from the database. However, data records were available for each licenced commercial fishing vessel on a daily trip basis starting in 1987. This permitted the analysis of the fishing performance (catch and effort) of individual vessels over extended time periods to evaluate species trends. Catch per unit effort trends for wahoo and dolphinfish were evaluated for the fishery by selecting ten full-time commercial fishers who were known to fish primarily for pelagic species and, using the catch and effort data from these fishers, an index was derived by pooling the data from these ten fishers on an annual basis and calculating a mean catch per unit effort value for each species. The period spanned for this analysis was ten years (1987-96).

Biological sampling provided data on size, sex and reproductive condition. Otoliths were extracted for the age and growth study. Some preliminary tagging work has been done but the sample size was small and no recaptures have been recorded to date. An expansion of this tagging program is planned to examine movement patterns and possible migratory routes.

RESULTS AND DISCUSSION

Commercial Fishery Landings

Landings of wahoo have shown a clear increasing trend over the past 22 years. Landings increased from 14,462 Kg in 1975 to 115,436 in 1996 (Fig. 1a), an increase of almost 800 % during this period. The probable explanation for the rising trend in landings is the increased fishing effort for pelagic species as well as gear improvements which appear to have increased catchability. It is surmised that this increase in effort was largely a response to significant fishery management measures implemented in the fish pot fishery in 1984 and 1990 (Luckhurst,1996; Luckhurst and Ward, 1996). A number of displaced fishers from the fish pot fishery shifted their effort into pelagic species in an attempt to maintain catch levels. There are no quantitative data available for the recreational catch of wahoo but anecdotal evidence indicates that it is one of the most important species in the recreational fishery.

Dolphinfish are much sought after by both commercial and recreational fishers. Commercial landings were much lower than wahoo ranging from a low of 1,409 Kg in 1976 to 7,626 Kg in 1985 (Fig. 1b). Although there is no clear increasing trend in the landings, it is evident that the mean landings level since the mid-1980's has been significantly higher than the initial ten year period. In common with wahoo, this is probably the result of increased fishing effort for pelagic species as both species are taken using the same trolling gear. Although highly valued in the market, landings of dolphinfish have never achieved levels which would make it a major component of the pelagic catch.

Seasonality of Landings

An analysis of the the quarterly landings of wahoo and dolphinfish from 1987-96 shows strong evidence of seasonality. Wahoo landings are consistently highest in the second and third quarters and combined contribute 60-70% of annual landings (Fig. 2a). In seven of the 10 years, the landings figures for these two quarters are very similar. In the remaining three years, the third quarter has the highest landings. Historically, there is a spring (April-May) and fall (August-September) wahoo run in Bermuda which varies inter-annually in magnitude and to a lesser degree in timing. The probable explanation for the three years in which the third quarter had the highest landings is that the spring run was lower than normal and the fall run may have been particularly strong. The first quarter of each year during this 10 year span indicates that landings are typically at their lowest levels (usually 5-8% of annual landings). The first quarter corresponds with winter weather conditions which usually reduce fishing effort as well as lower water temperatures (approx. 18-19 °C) which may be near the lower end of the preferred temperature range for wahoo.

The quarterly analysis of dolphinfish landings (Fig. 2b) consistently shows greater seasonality than wahoo with the third quarter (July-September) usually comprising 45-60% of annual landings. In common with wahoo, the first quarter landings are lowest and comprise less than 8% of annual landings (1995 being exceptional). Second and fourth quarter landings oscillate over the 10 year period within consistent ranges. The third quarter peak in landings confirms the data presented for Bermuda for an earlier time period (1973-80) which was used to help develop a stock structure hypothesis for dolphinfish in the western central Atlantic based on proposed migratory routes (Oxenford and Hunte, 1986).

Catch per unit effort trends

The catch per unit effort (CPUE) index for wahoo demonstrates great consistency over the ten year period (Fig. 3). The index calculated as kilograms per hour trolling varies only from 2.2 to 3.5 Kg. The standard deviations about the means broadly overlap suggesting that there are no significant differences in the CPUE index during this period. If CPUE is used as an index of stock abundance then these results suggest that there has not been a significant change in the abundance of wahoo in Bermuda's waters over this 10 year period. This finding in conjunction with the increased landings over this same time period appears to confirm that these landings increases are probably related to increased fishing effort for pelagics.

The same CPUE index applied to dolphinfish (Fig. 3) indicates a flat trend probably because the mean weights of dolphinfish landed are much lower than wahoo and thus this index using weight is not as sensitive to changes as for the larger wahoo.

Population Size Structure of Wahoo

An analysis of the population size structure of wahoo (Fig. 4) indicates that the modal size for sexes combined is 118 cm Fork Length (FL). The smallest specimen taken in this sample was 72 cm FL while the largest specimen was 180 cm FL. The distribution appears to be unimodal although the sample size is not large (N = 365). If continued sampling confirms this unimodal size structure, this may be indicative of a highly migratory stock and can cause problems in making length-based stock assessments because there is no modal progression (Neilson et al. in press).

Acknowledgements

We appreciate the cooperation of Bermuda fishers who allowed the sampling of their catches. John Barnes kindly reviewed the manuscript.

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Figure Legends

Fig. 1 - Landings of wahoo and dolphinfish from Bermuda's commercial troll fishery.

Fig. 2 - Seasonality of landings of wahoo and dolphinfish from 1987-96.

Fig. 3 - Catch per unit effort for wahoo and dolphinfish from 1987-96. See text for details of CPUE index.

Fig. 4 - Size-frequency distribution of wahoo with sexes combined.

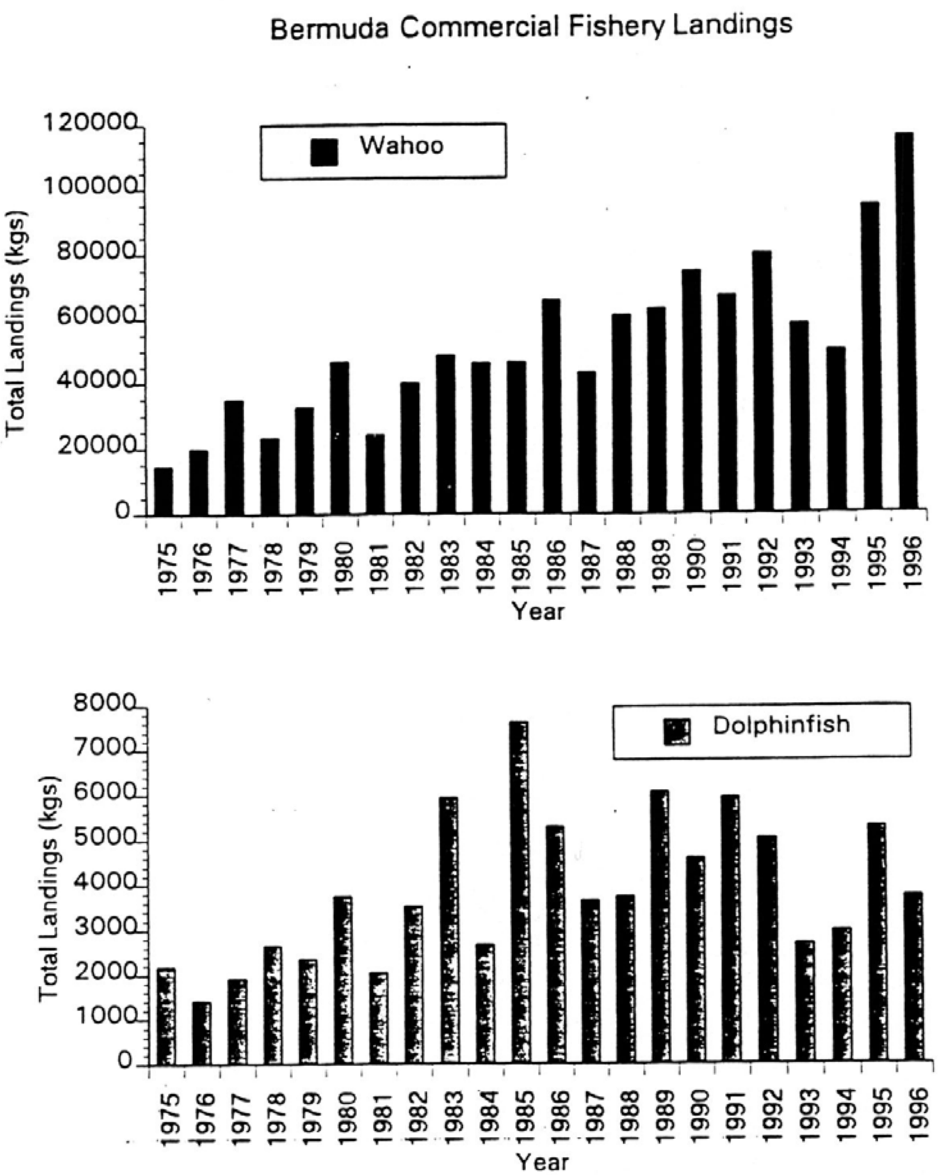

Fig. 1 - Landings of wahoo (a) and dolphinfish (b) from Bermuda's commercial troll fishery.

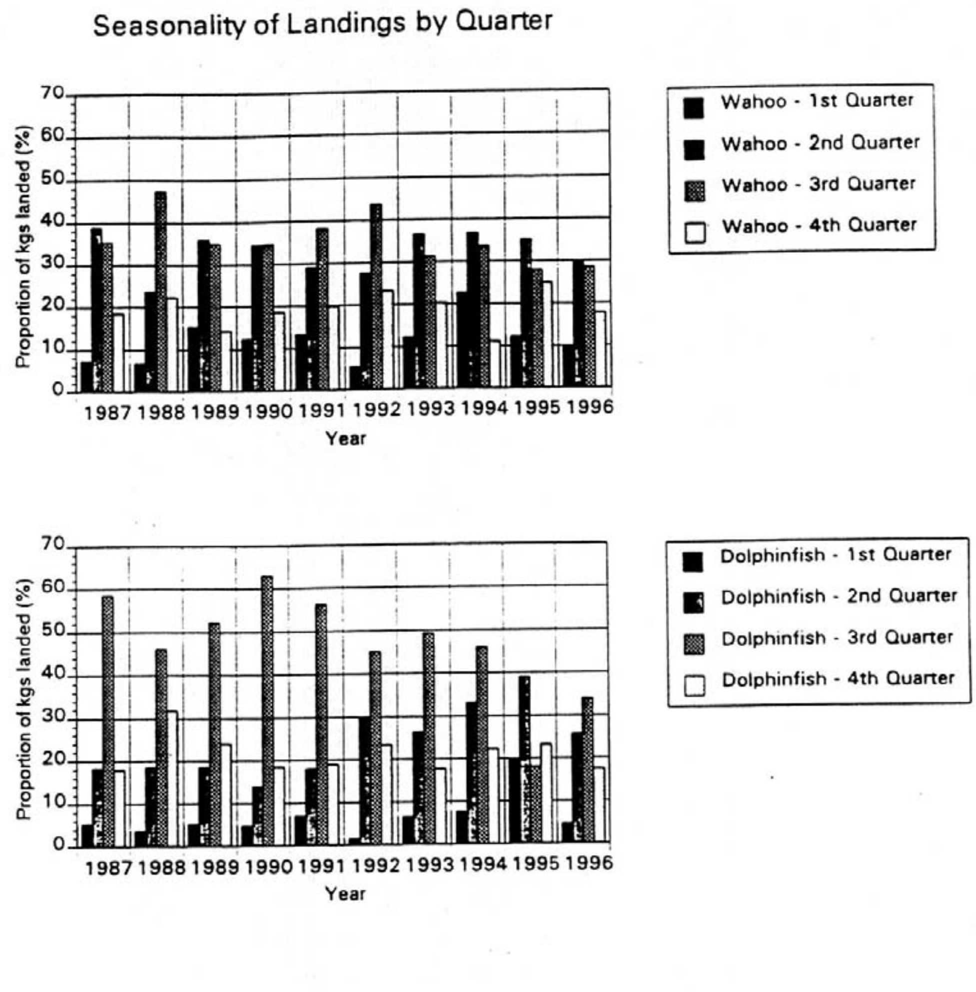

Fig. 2 - Seasonality of landings of wahoo (a) and dolphinfish (b) from 1987-96.

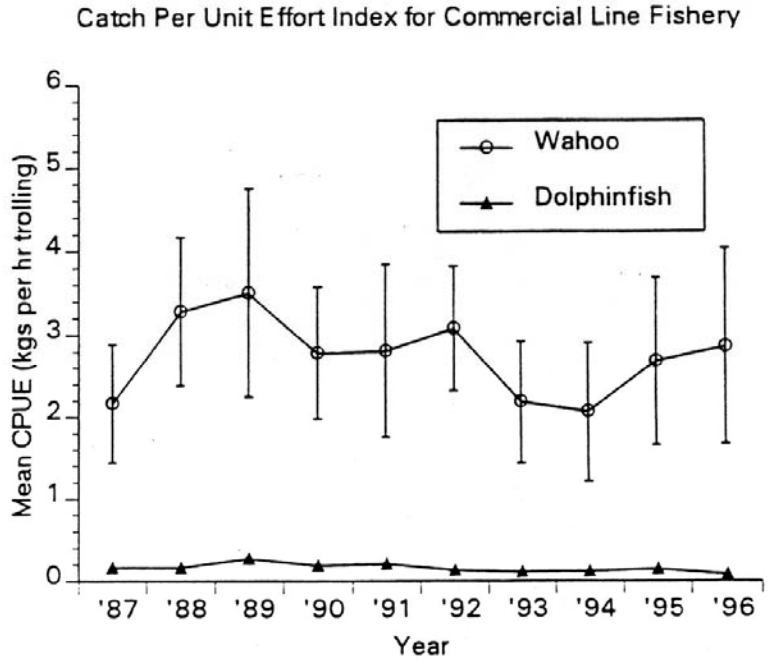

Fig. 3 - Catch per unit effort for wahoo and dolphinfish from 1987-96.
See text for details of CPUE index.

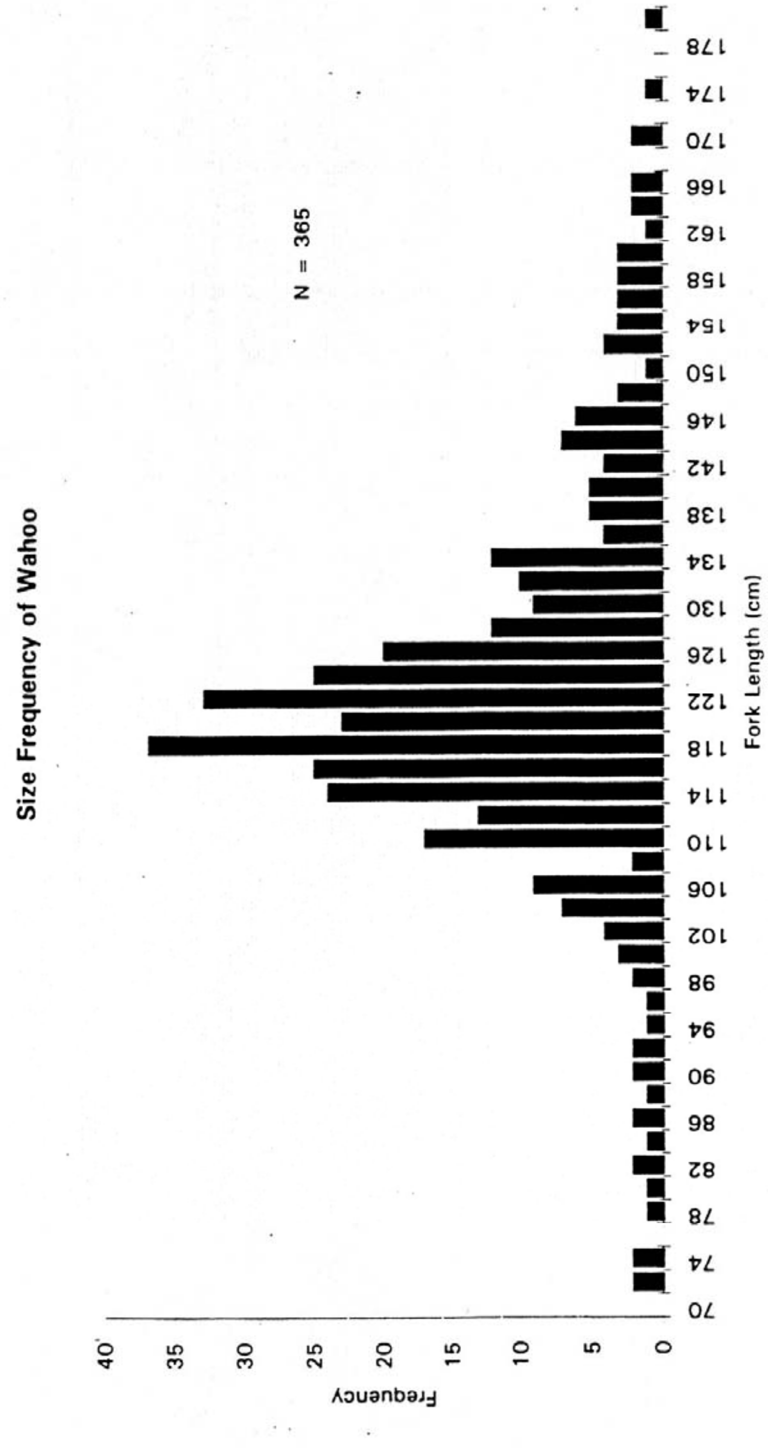

Fig. 4 - Size-frequency distribution of wahoo with sexes combined.

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Title: Characterization of the Dolphin Fish (Coryphaenidae, Pices) Fishery of the United States Western North Atlantic Ocean

Running title: Dolphin Fishery, Western North Atlantic of the U.S.

Keywords: Southeast U.S., dolphin fishery, recreational, commercial, annual landings, annual average weights, length-weight relationship, gear, CPUE

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Summary: Fishery dependent data from various commercial and recreational sampling programs U.S form the basis for characterizing the fishery for dolphin fishes (Coryphaenus hippurus) in the waters of the Gulf of Mexico and off the southeastern U.S coast. Many states in the region have implemented size and bag limits for dolphin fishes, however, there are no federal regulations in place at this time. Commercial landings in metric tons have been relatively small in comparison to recreational landings for the time series of data available from 1984 through 1996. In 1995 however, commercial landings in the Atlantic Ocean of the southeastern U.S., were almost twice in weight of the previous years. The average weight per fish was calculated for each water body and fishing sector and there appear to have been large increases in the average weight of fish landed both in the commercial and recreational sectors in the Atlantic and the Gulf of Mexico. Catch per unit of effort, measured as numbers of fish caught per angler per hour in the recreational fishery. In the Gulf of Mexico, recreational CPUE appears to fluctuate and appears to be decreasing since 1985. CPUE appears to have been increasing in the Atlantic particularly from 1984 to 1991 and appears to have been decreasing since 1991.

Introduction

Dolphin fishes (*Coryphaena hippurus)* in the Western North Atlantic waters of the United States support both commercial and recreational fishing. The biology of this species including discussions on their distributions, stock structure and migratory movements in the Western North Atlantic have been reviewed periodically (Oxenford 1986; Palko et al. Unpublished manuscript 1990; Bentivoglio, 1989; Ditty et al 1994; Palko, 1982). Their tendency to form large schools associated with floating objects makes them easy targets for fishing and there is a significant recreational fishery in the U.S Atlantic which exploits their seasonal presence particularly in the summer months in both the Atlantic and Gulf of Mexico.

Fishery management for this species in federal waters is completed under the joint responsibility of the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council. Recently, concerns have been expressed to the Councils regarding the perceived increase in commercial landings from long lining particularly off the southeast U.S. coast. Currently within this region there is no management for this species in federal waters and only Florida, North Carolina, and Georgia have regulations for their state waters. Florida currently has a 10 fish per person per day limit with a 20 inch (50.8 cm) size limit for the sale of dolphin. North Carolina also has a limit of 10 fish per person per day for the recreational fishery. Georgia has a 15 fish per angler per day limit with a minimum size limit of 18" (45.7 cm) fork length for the recreational fishery. At this time, management alternatives are being considered to insure that catches are sustainable and potential options include trip limits, bag limits, minimum size limits, and gear restrictions.

The purpose of this paper is to describe both the commercial and recreational fishery for dolphin fishes in waters of the southeast United States which is the focus of the fishery in the U.S. Atlantic Ocean. Catch information is provided for both fishing sectors, commercial and recreational, in the Gulf of Mexico and from southeastern U.S. Atlantic Ocean waters from North Carolina to the Florida east coast. Data are either provided by whole weight of fish or numbers of fish or both with samples taken to evaluate weight- length relationships. Additional information includes gear used by the commercial sector and catch per unit of effort for the recreational sector. Catches are presented by area as the Gulf of Mexico and Atlantic Ocean to better track these landings within these areas. While it has been suggested that the Western North Atlantic may include multiple stocks (Oxenford 1986), the separation of catches by area for this exercise does not imply stock separation and is simply done as a convenient method to track landings for each of the Councils.

Materials and Methods

Data

Fisheries dependent data are available from both the commercial and recreational sectors. Commercial data are reported annually in whole pounds weight which was converted to kilograms landed. Individual fish are sampled on a trip basis for length and weight and average weight per fish sampled is recorded in whole pounds and was converted to kilograms. A trip is defined as time from leaving the dock to returning to the dock and can be one or several days in length. For the most part commercial catches are primarily reported as bycatch from fishing that is directed at pelagic species including tunas, swordfish, and sharks.

Fisheries dependent recreational data are from three separate sources which are additive to sum to total landings. These data are from the National Marine Fisheries Service's (NMFS) Marine

Recreational Fisheries Statistical Survey (MRFSS), the state of Texas recreational creel survey. and the NMFS/Southeast Fisheries Science Center (SEFSC) head boat survey. The MRFSS data are collected for the charter, private, and shore fishing modes for all states in the southeast U.S. except Texas. Texas data are for all modes and include catches from head boats for the state of Texas only. The head boat survey includes all the states except Texas.

Data from the head boat survey are reported by total weight of fish in whole pounds landed per trip. Weights were converted to kilograms and a trip is defined as before as leaving and returning to the dock. These trips are generally no more than a single day in length and multiple trips can be completed in one day. The total number of anglers fishing per trip and the length of the trip in total hours are reported. These trip data were used to estimate CPUE as total numbers of fish caught per angler per hour.

The Texas creel survey data are reported numbers of fish landed. total length of each fish landed and weight of each fish in whole pounds. Average weight per fish is multiplied by the total numbers of fish reported to estimate total pounds in whole weight and was converted to kilogram weight. The total number of anglers and the total hours fished are reported and used to estimate CPUE as numbers of fish caught per angler per hour.

The MRFSS data are reported as total numbers of fish caught with samples provided on length and weight of fish to allow for the estimation of total whole pounds landed which was converted to total kilograms of fish landed. These data were added to the results from the Texas creel survey and head boat survey to determine total annual landings by weight in kilograms. The numbers of anglers and trip length are also reported and used to estimate CPUE as for the other data sets, as numbers of fish caught per angler per hour. These data which represent the majority of data for this species were also sorted and apportioned by mode, as charter, private, and shore.

All of the recreational data were pooled to develop a length-weight relationship using the natural log for weight and length and completing a linear regression. This relationship was evaluated for the Atlantic and Gulf of Mexico separately and with the areas combined. This relationship is compared with those available in the literature.

Results

Total landings in metric tons for the Gulf and Mexico and Atlantic for the commercial and recreational fishing sectors are presented in Table 1 and Figure 1. The time series for landings begins in 1984 and are considered preliminary for 1996. Commercial landings have been low relative to the recreational sector over the thirteen year time series. While commercial landings in the Gulf of Mexico have fluctuated, landings in the Atlantic appear to have been increasing since 1992 with a peak in 1995 when total landings appear to have nearly doubled as compared to previous years.

Recreational landings have fluctuated considerably over this same time period with a peak in the Atlantic and the Gulf of Mexico in 1995. While the landings from both the Gulf of Mexico and

Atlantic have fluctuated over the time series there appears to be an increasing trend in total landings since 1988.

The average weight per fish was evaluated annually for each body of water and fishing sector (Figures 2 and 3). The average weight per fish has been increasing in the commercial landings in both the Atlantic and Gulf of Mexico. In the Atlantic average weight has increased from about 1.5 kg in 1988 to 5.6 kg in 1996. In the Gulf of Mexico, the increase from 1988 to 1995 has been from 1.7 kg to about 5.6 kg in 1995.

The average weight per fish from the recreational sector has fluctuated more over the time series since 1981 however, there appears to have been an increasing trend in the average weight landed by recreational anglers both in the Atlantic and Gulf of Mexico. Average weight over the time series appears to have almost tripled in the Gulf of Mexico in the recreational sector from about 1.4 kg per fish to 3.8 kgs from 1987 to 1996 with significant fluctuations between this time period. In the Atlantic, the magnitude of increase appears to have been about from about 2.3 kg to about 3.0 kg from 1987 to 1996, about a 25% increase over this time series.

The relationship between weight and length was examined using the recreational data because the sample size for both weight and length is large from this sector. Data from each source, MRFSS, Texas creel survey, and headboat survey were combined to maximize the sample size available. The length weight relationship for the Gulf of Mexico and Atlantic were similar and data were pooled over areas with the resulting relationship described as a log linear equation with sample size (n) and r^2 from the linear regression:

$$\ln \text{weight} = 2.71 \ln \text{fl} - 10.42$$

ln weight= natural log whole weight in kg.

Ln fl= natural log of fork length in cm

$$r^2 = .97$$

n = 32,215 individual fish sampled

In the non-linear form of the equation, this relationship translates to: $A=2.98 \times 10^{-4}$ mm and b=2.71 with y=weight in kilograms and x=fork length in mm where $y=ax^b$. In comparing this result with previously published results, it compares well with the relationship provided by Beardsley (1967) where $A=2.35 \times 10^{-4}$ and b=2.63 for 40 females sampled from the southeast U.S. Atlantic Ocean. From other published studies it appears that b ranges from about 2.5 to 3.7 depending on where samples are taken. The value of b calculated for the 32.000 plus fish sampled throughout the Gulf of Mexico and the Atlantic is within the published range for this parameter.

The gear types reported for the commercial landings included troll lines, rod and reel which includes both manual and electric, and long lines which includes surface lines and traditional swordfish type long lines. The distribution of records for the commercial sector was: 6977 or 54.3% from trolling lines; 4845 or 37.7% from rod and reel; 1003 or 7.9% from long lines; and 16 or .1% from unknown gear (Figure 4). Of a total of 32906 records from the MRFSS, 32898 or virtually all records reported landing dolphin fish by hook and line.

While the gear from the recreational sector was almost always noted as hook and line. However. for the MRFSS landings are reported as from shore, charter boat and private or rental boat. A charter boat is a vessel for hire that usually includes a captain, one crew member and usually no more than 6 anglers per trip. For the Gulf of Mexico, 65.3% (2250) of the total reports (n=3513) were from the charter boat mode. A total of 1218 or 34.7% of the reports were from the private/rental mode. Less than 1% were reported as landed while fishing from the shore.

Catch per unit of effort was estimated from the three recreational data bases as the total number of fish caught per angler per hour (Figures 5 and 6). In this way, these CPUE indices can be compared between sampling programs, water bodies, and years. CPUE for the Gulf of Mexico was estimated from the Texas creel survey, the head boat survey, and the MRFSS. Notably, the total catches from the head boat survey are small as would be expected given that these trips are generally prosecuted nearshore and not in deeper shelf waters where dolphin fish are found. The Texas creel survey data are also consistently low except in from 1993 to 1995 when a significant peak in CPUE occurred. Note that the 1996 data are preliminary only and incomplete. CPUE from the MRFSS is higher as expected since the charter boat fishery is a large component of the catch where there are generally more than a single angler on board and they most likely are targeting pelagic species including dolphin. Since dolphin tend to aggregate at certain size classes they are easily caught in large numbers by several anglers. In addition, in federal waters there is no limit to the numbers which can be landed and even in Florida state waters, the bag limit is currently 10. CPUE from the MRFSS fluctuates almost annually suggesting that this species may in fact be an annual crop.

Estimated CPUE for the S. Atlantic included the MRFSS and head boat survey only since Texas is limited to the Gulf of Mexico (Figure 3). CPUE for the head boat fishery fluctuates without trend over the past 16 years. CPUE for the MRFSS appears to have increased from 1986 to 1990 and been somewhat stable and comparatively high since 1991. The CPUE estimate for 1996 is preliminary as the data are incomplete for this year.

Discussion

The fishery for dolphin fishes remains dominated by the recreational sector with the highest amount of landings by weight and number in the south Atlantic. However, except with the Gulf of Mexico commercial landings which appear stable over the time series, there appears to be an increasing trend in landings by weight in the recreational fishery in both areas and in the commercial landings in the southeast while the numbers of fish landed appears somewhat stable although also fluctuating annually. The average weight of fish landed has been increasing since the mid 1980's and this certainly must account for some of the increase seen in overall landings by weight.

Sample sizes to describe shifts in gear in the commercial sector are small when stratified annually, however, in sum the dominant gear types have been trolling gear and rod and reels, including both manual and electric. For the recreational sector, the overwhelming majority of fish are reported as caught by hook and line with the charter boat and private/rental boat modes dominating the catches. It is difficult to evaluate the sustainability of the fishery based on these trends and in the context of such large annual variability in the catches. Since 1996 data are preliminary, these data must be evaluated when available to determine if a significant shift or change in the prosecution of this fishery has occurred.

Acknowledgments

The data used in this manuscript were obtained through the efforts of various programs and people including the field samplers for the Southeast Fisheries Science Center (SEFSC) and the individual states. The actual data sets I used in manipulating these data were assembled by Ms. Patty Phares, Division of Sustainable Fisheries (DSF), SEFSC, Miami, Florida. Similar compilations of landings were completed by Mr. Josh Bennett, DSF, SEFSC, Miami, Florida and used to verify the data included in this paper. I gratefully acknowledge these people and their efforts in forming the basis for this manuscript.

Table 1. Annual dolphin landings in metric tons. Landings were estimated for the commercial and recreational sectors for Gulf of Mexico and southeastern Atlantic waters.

Atlantic X 1000 kgs.

Year	Commercial	Recreational	Total
84	72.3	1556.0	1628.3
85	64.9	2516.5	2581.4
86	86.2	3106.8	3193.0
87	96.7	1999.1	2095.8
88	96.5	2879.1	2975.6
89	193.4	4468.3	4661.7
90	230.8	3377.5	3608.3
91	295.6	5123.6	5419.2
92	148.5	2360.4	2508.9
93	236.6	2461.5	2698.1
94	281.2	4383.6	4664.8
95	529.1	5543.1	6072.3
96	248.4	3379.1	3627.5

Gulf X 1000 kgs.

Year	Commercial	Recreational	Total
84	128.6	480.2	608.8
85	122.6	630.3	752.9
86	223.8	1394.3	1618.1
87	183.6	1194.9	1378.5
88	226.9	534.2	761.1
89	502.8	1368.3	1836.8
90	761.6	2341.5	2896.8
91	324.9	2560.7	3322.3
92	271.4	1877.2	2202.1
93	271.4	2369.8	2641.2
94	309.1	1250.6	1559.7
95	535.1	3432.3	3967.4
96	474.5	2148.3	2622.7

Figure 1. Total annual landings by weight from the commercial and recreational data for the Gulf of Mexico (GOM) and the southeasern U.S. Atlantic Ocean (Atlantic).

Figure 2. Average weight of individual fish by year for the commercial fishery in the Gulf of Mexico (GOM) and southeastern U.S. Atlantic Ocean (Atlantic).

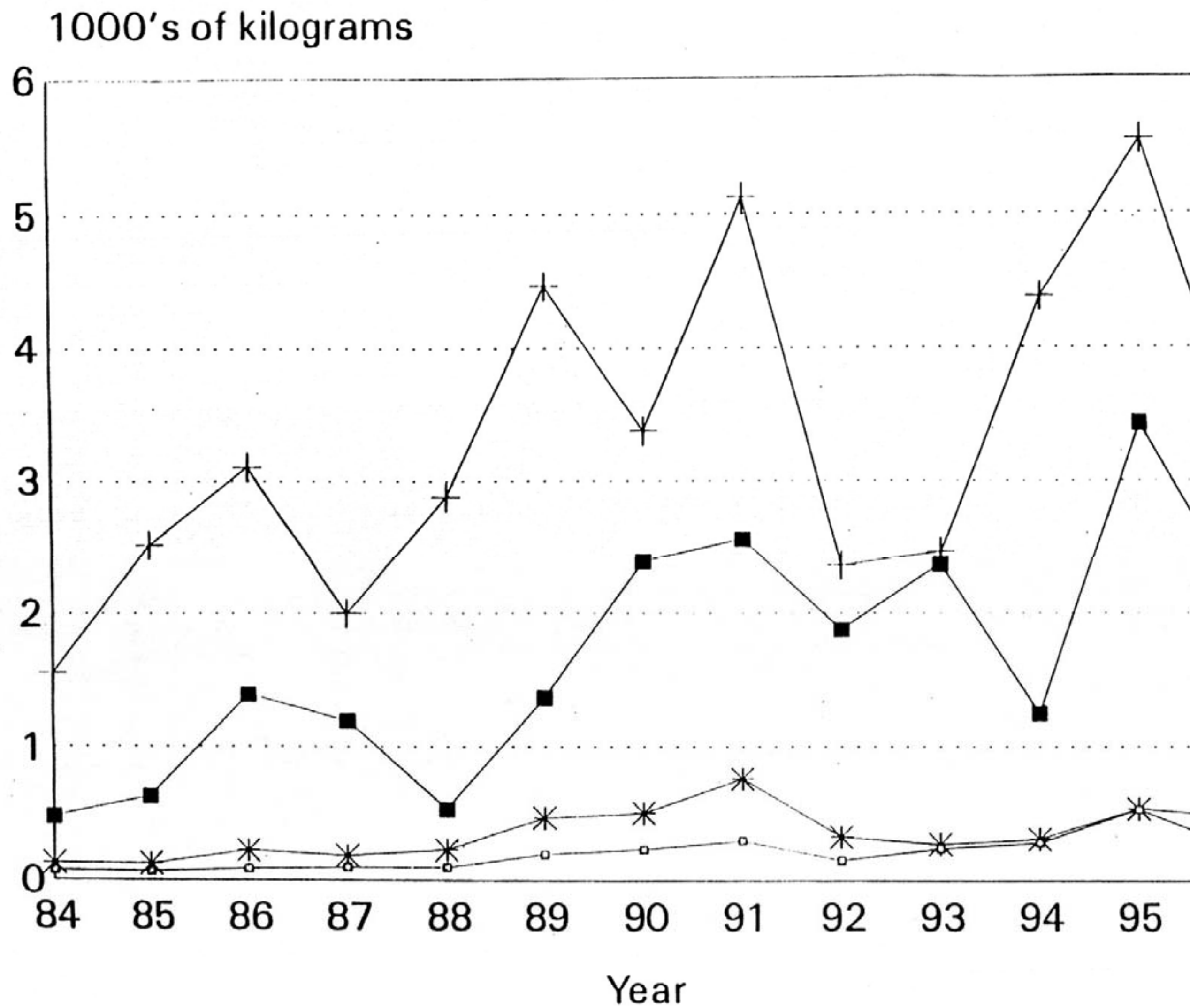
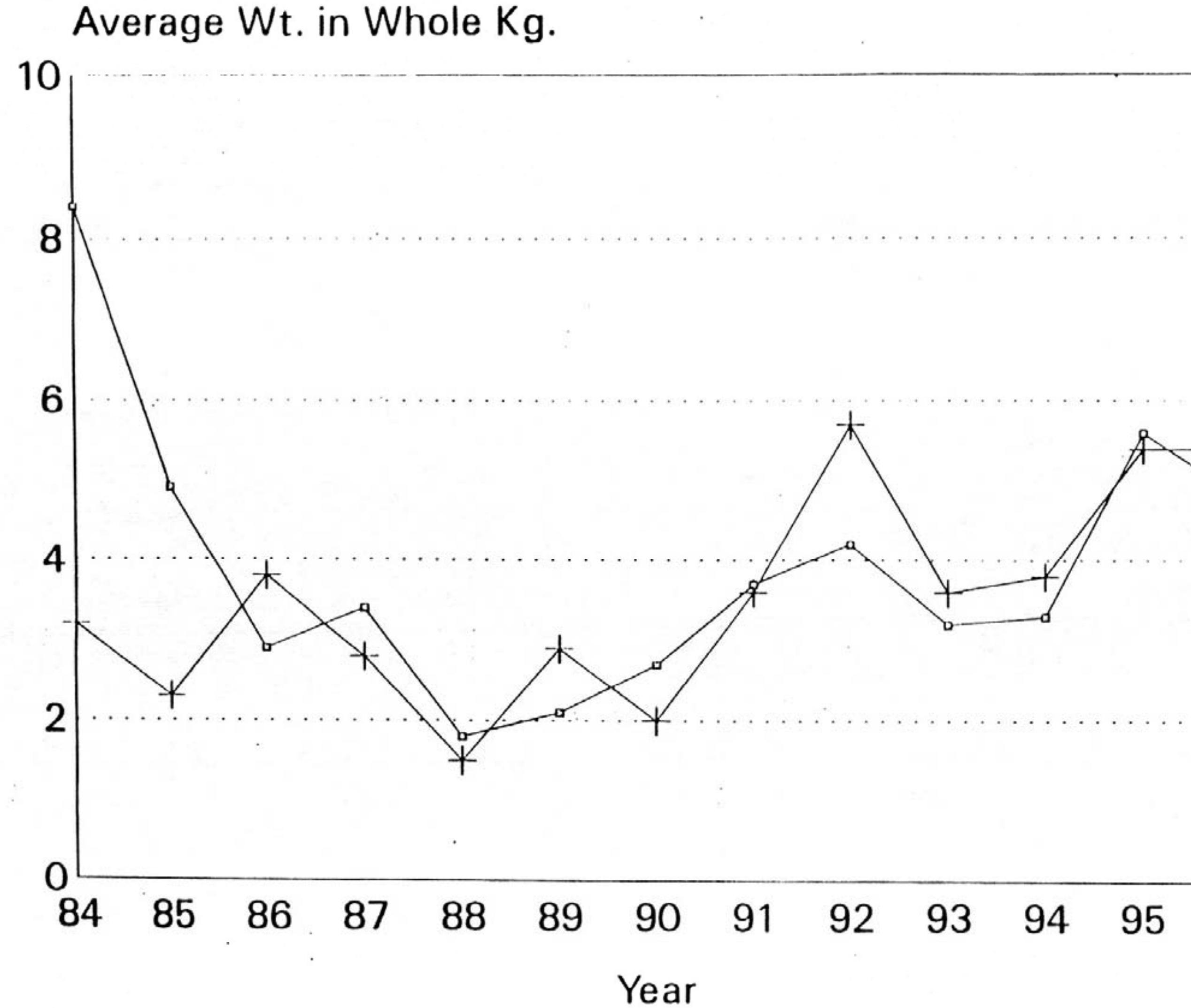

1000's of kilograms
6
5
4
3
2
1
0
84
85
86
87
88
89
90
91
92
93
94
95
Year

Figure 3. Average weight of individual fish sampled from the recreational sector in the Gulf of Mexico (GOM) and southeastern U.S. Atlantic Ocean (Atlantic).


Average Wt. in Whole Kg.
10
8
6
4
2
0
84
85
86
87
88
89
90
91
92
93
94
95
Year

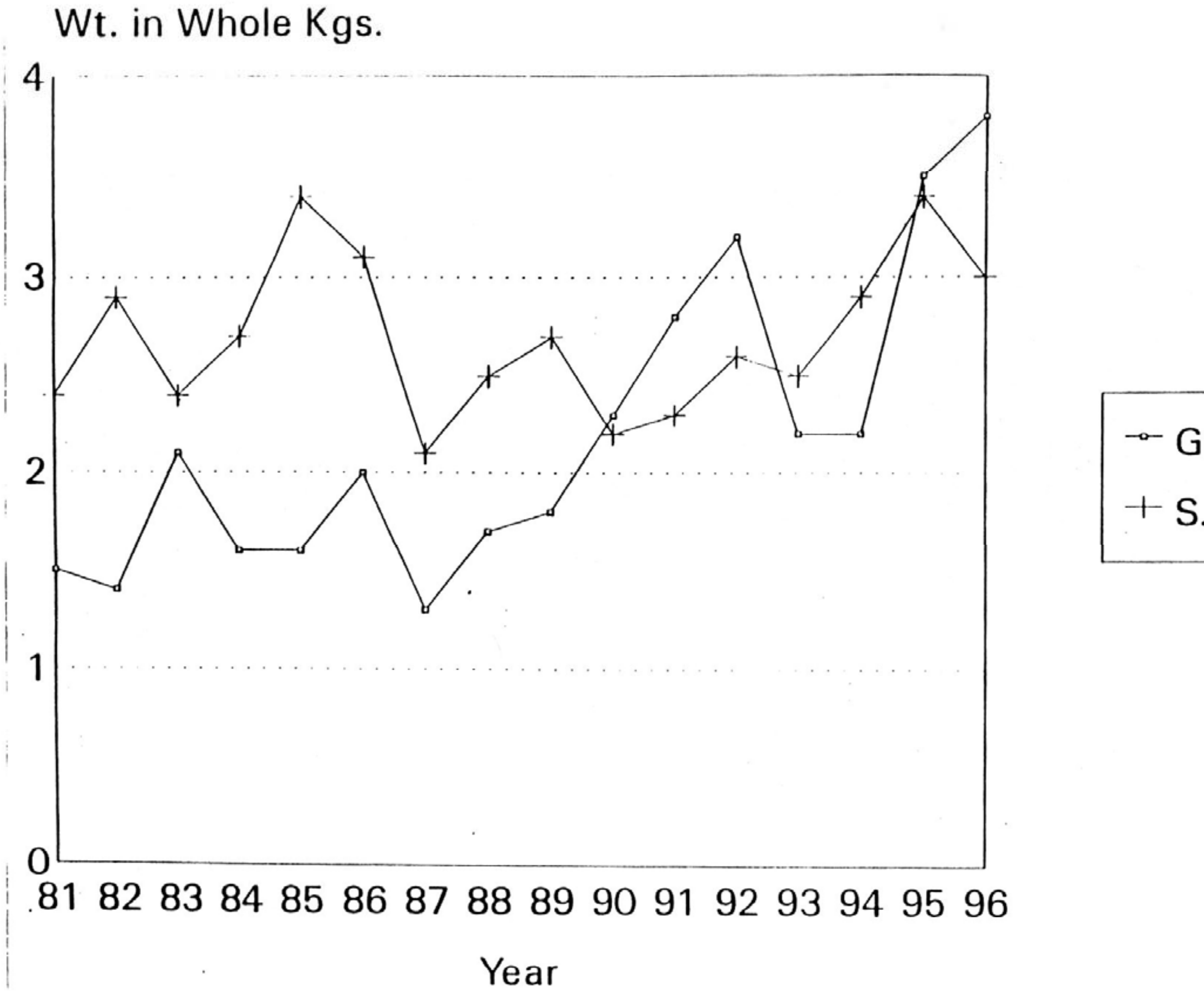
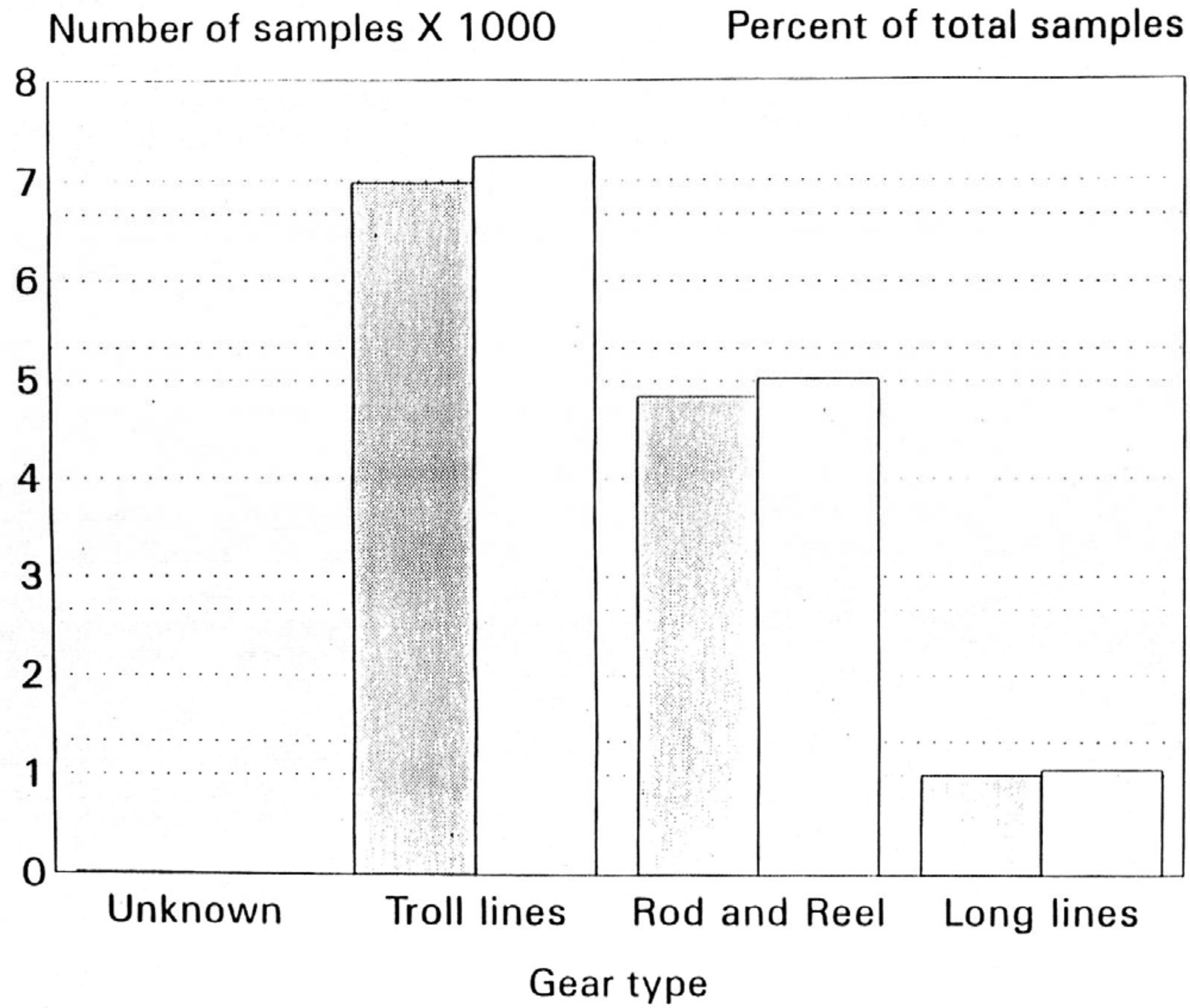

Wt. in Whole Kgs.
4
3
2
1
0
81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
Year
G
S.

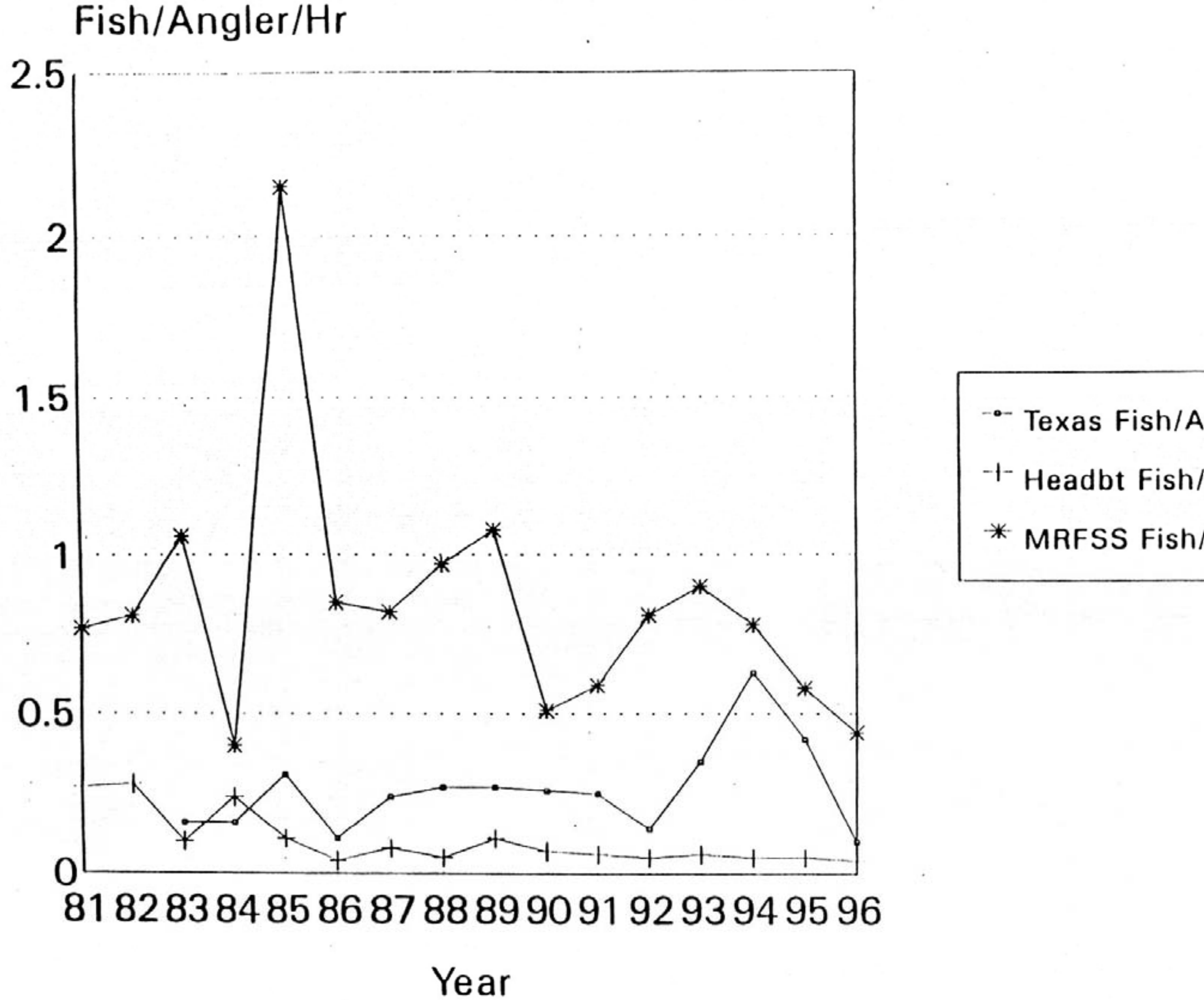
Figure. 4. Numbers of fish landed and recorded with gear identified for samples from the commercial fishery, all years, 1981-1996 combined. The total sample size is 12.841 individual fish.

Figure 5. Annual number of fish reported by each angler per hour of fishing for the Gulf of Mexico recreational fishery. The three data sources for recreational samples are the Texas creel survey (-o-); the headboat survey (+); and the Marine Recreational Fishery Statistical Survey (MRFSS. •).



Number of samples X 1000
Percent of total samples
8
7
6
5
4
3
2
1
0
Unknown
Troll lines
Rod and Reel
Long lines
Gear type

Figure 6. Annual number of fish reported per angler per hour of fishing for the southeastern U.S. Atlantic Ocean. The sources of samples were from the headboast survey (+), and the MRFSS (•).


Fish/Angler/Hr
2.5
2
1.5
1
0.5
0
81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
Year
Texas Fish/A
Headbt Fish/
MRFSS Fish/

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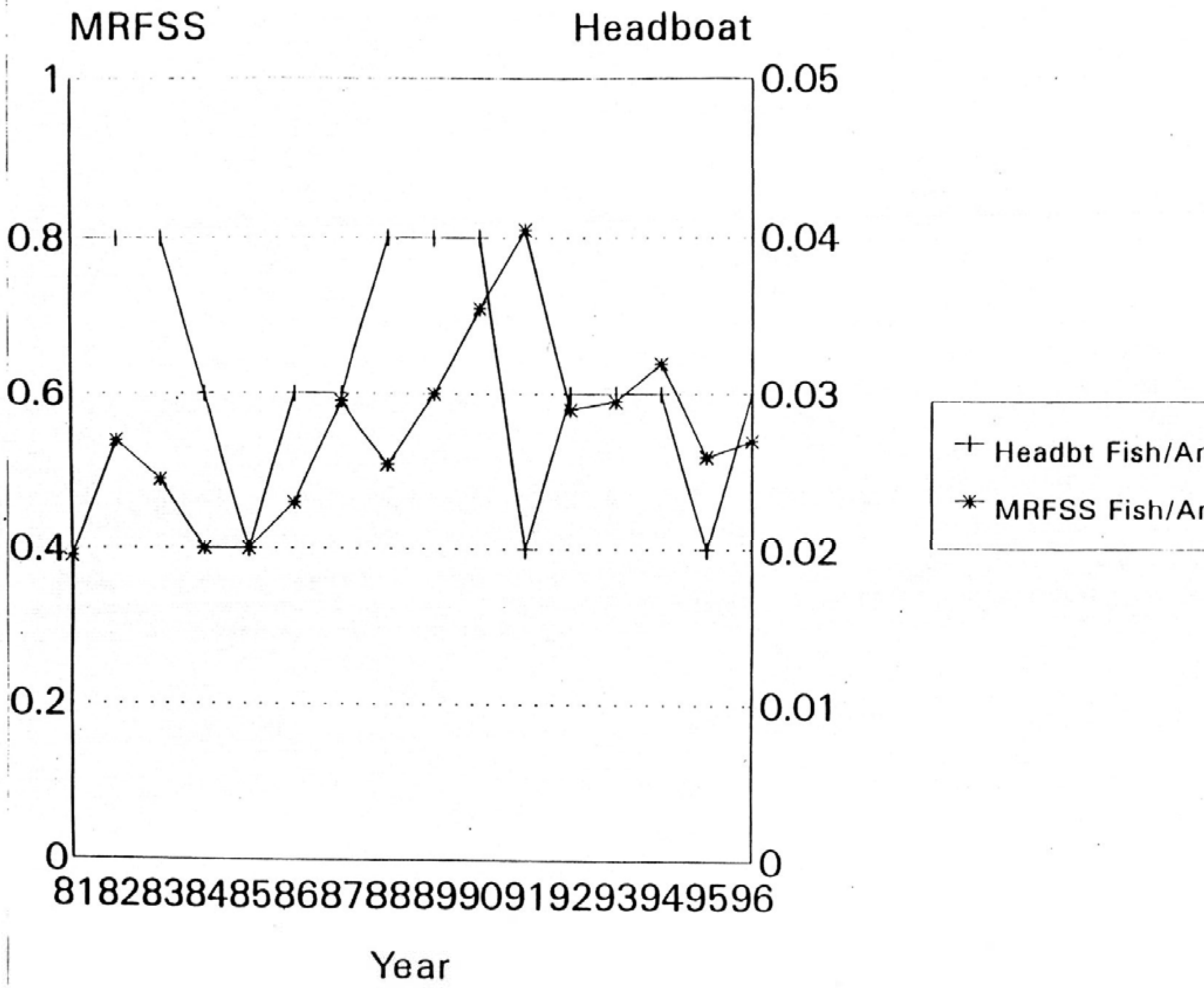
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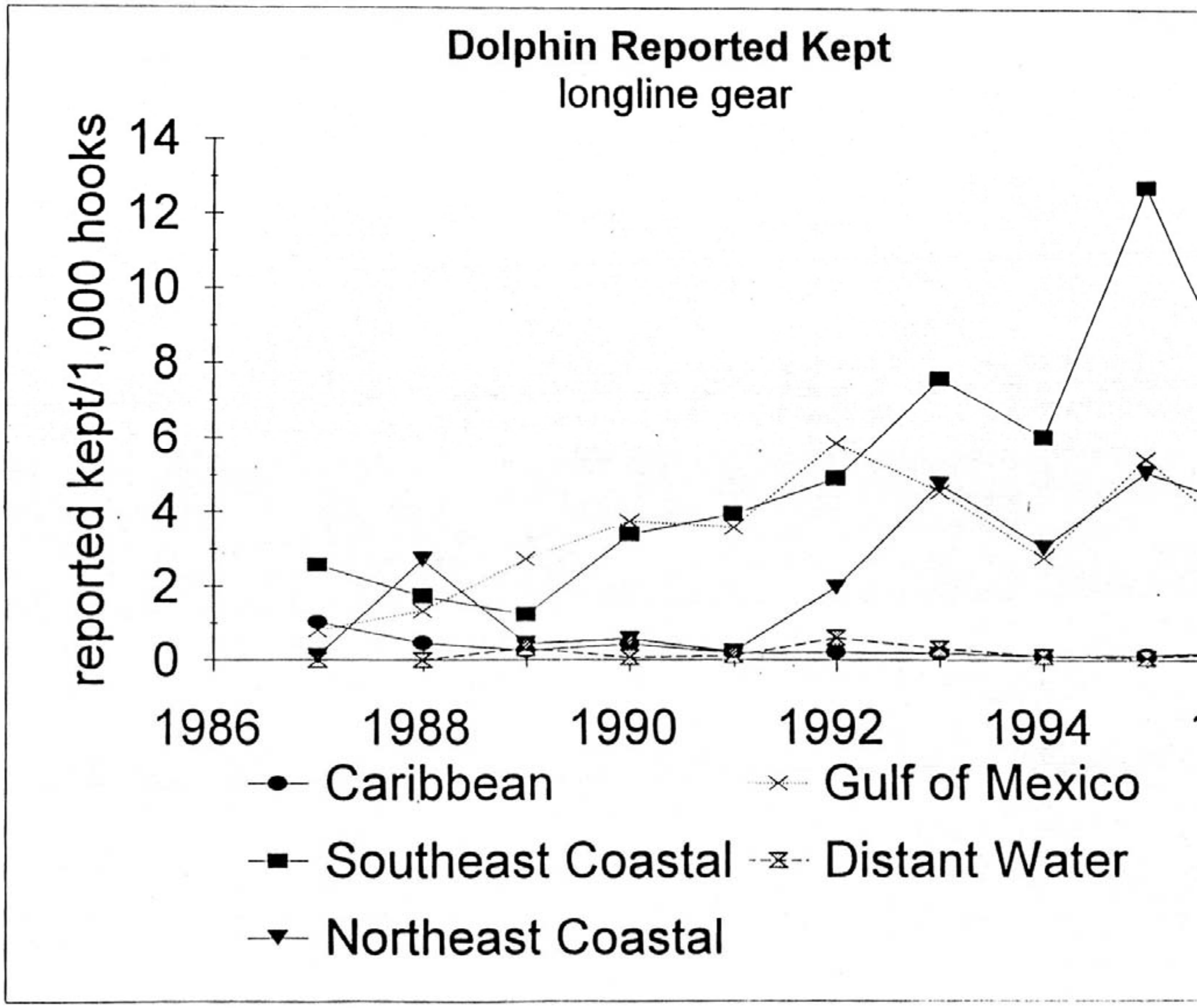
dolphin-fishes. Coryphaena hippurus Linnaeus and Coryphaena equiselis Linnaeus.

NOAA Tech. Rpt. NMFS Circular 443. 28 pages.


Dolphin Reported Kept
longline gear
reported kept/1,000 hooks
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12
10
8
6
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2
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1986
1988
1990
1992
1994
Caribbean
Gulf of Mexico
Southeast Coastal
Distant Water
Northeast Coastal

Stock structure of dolphin, *Coryphaena hippurus*, in the western central Atlantic, Caribbean Sea, and Gulf of Mexico as determined by molecular genetics techniques.

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The dolphin, *Coryphaena hippurus* Linnaeus, is a fast swimming, migratory, pelagic fish distributed throughout the tropical and subtropical waters of the world. It supports important commercial and recreational fisheries throughout its range. Currently there are no established management protocols for *C. hippurus* in the western Atlantic. In August 1997, the South Atlantic Fisheries Management Council proposed management options for the highly migratory dolphin fishery. Before effective management strategies can be formulated, an understanding of stock structure must be acquired to establish sustainable catch limits. Oxenford and Hunte (1986) suggested two distinct stocks exist in the southeastern and northeastern Caribbean. This hypothesis was based upon mean size of dolphin caught regionally and allozyme analysis. The purpose of this study is to test Oxenford and Hunte's (1986) two stock hypothesis and investigate the possible presence of additional stocks using mitochondrial DNA. In other studies on pelagic species, mtDNA analysis has revealed stronger evidence of population structure than allozyme analysis (Avise 1994, Graves 1996). If significant genetic differences exist between geographic localities, the need for independent management of individual stocks would be indicated.

Coryphaena hippurus samples have been collected by port sampling and attending offshore fishing tournaments in South Carolina, Georgia, Florida, throughout the Gulf of Mexico, and Trinidad and Tobago. Additional samples need to be collected from North Carolina, Bermuda, Barbados, Puerto Rico, the Virgin Islands, and the western Caribbean. For each fish sampled, the location of capture is noted as well as the weight, sex, total, fork, and standard lengths, and the number of fish caught from the same school at the same time. Then, approximately 3 grams of heart tissue will be collected and individually stored in a 1.5ml tube containing a Sarcosyl-Urea solution.

Mitochondrial (mtDNA) is isolated using standard procedures. Once isolated, the ND-1 region of mtDNA is amplified by PCR following standard protocols (Palumbi *et al.* 1991).). The resulting PCR products are then digested with a battery of four-base restriction endonucleases following manufacturers' instructions. The fragments are separated on 9% polyacrylamide gels photographed under UV light. The size of the amplified and restricted fragments are estimated in comparison with a size standard (pGEM, BRL). A composite mtDNA haplotype, indicating the fragment pattern for each restriction enzyme, are developed for each individual. Differences in regional frequencies of haplotypes are tested using contingency tables and a randomized chi-square test of independence (Roff and Bentzen 1989).

Preliminary analysis of 20 fish each from SC, FL Gulf, and Texas of the ND-1 region digested with 4 different restriction enzymes indicated seven composite haplotypes. There were no significant differences in the frequencies of haplotypes from dolphin caught in the waters off the coast of South Carolina, Florida Gulf, and Texas. This suggests that the dolphin in the Gulf of Mexico and along the coast of South Carolina all belong to the same stock . However additional samples from these and other locations need to be analyzed with additional markers before any definitive results can be obtained. We have applied for MARFIN funding to complete this project.

MARINE FISHERIES COMMISSION
INFORMATION PAPER
LONGLINE FISHERY AND DOLPHIN TRIP LIMITS

June 8, 1998
Prepared by: Dr. Louis Daniel

ISSUE:

Dolphin have historically been landed by offshore recreational fishermen who account for approximately 90-95% of the annual harvest in the south Atlantic. These fish are valuable components of the charter vessel fleet as well as private vessels and head boats. In 1995, recreational landings of dolphin in the south Atlantic were slightly more than 12 million pounds while the commercial harvest was approximately 500,000 pounds. Dolphin landings for North Carolina in 1996 were 2,170,856 million pounds from the recreational fishery and 126,853 pounds from the commercial fishery.

Recent increases in longline trips that target dolphin in the south Atlantic EEZ have raised concerns in terms of potential billfish bycatch, dolphin overfishing, and historical allocation between recreational and commercial user groups. As a result of these concerns, particularly in the state of South Carolina, the South Atlantic Fisheries Management Council (SAFMC) began developing a fishery management plan for dolphin and wahoo.

ORIGINATION:

North Carolina Marine Fisheries Commission

BACKGROUND:

Two information papers concerning the longline fishery and dolphin have been presented to the MFC and its Finfish Committee in 1998 (Daniel and Francesconi) and much of the data therein constitute the background for this document.

COMMITTEE REPORT:

The MFC Finfish Committee voted 4 in favor and 4 opposed to recommending a 2,000 pound trip limit for dolphin taken with longline gear.

CURRENT RULE:

.0507 Dolphin

DISCUSSION

The MFC, at its April 30-May 1 meeting in Buxton, voted to publish subject matter notice on a proposed 2,000 pound commercial trip limit on dolphin for all gear types. This decision was based on trip ticket data that showed the increase in catch per trip of dolphin in the longline fishery over the past several years and that gears capacity to take large numbers of fish. Data presented to the MFC indicated that the 2,000 pound trip limit in 1995 would have had very little impact on those fishermen that apparently take dolphin incidental to other species, but could prevent the uncontrolled expansion in this fishery.

If the MFC decides to take to public hearing a rule specifying a trip limit on dolphin taken commercially, the DMF recommends the following language changes from the current rule:

State of North Carolina
Department of Environment
and Natural Resources
Division of Marine Fisheries

James B. Hunt, Jr., Governor
Wayne McDevitt, Secretary
Preston P. Pate, Jr., Director

DEHNR

NORTH CAROLINA DOLPHIN COMMERCIAL LANDINGS BY GEAR (1995 - 1997)

I. Total landings and trips from all gears

1995 = 2423 trips; 355,647 pounds
1996 = 1413 trips; 126,853 pounds
1997 = 1520 trips; 226,483 pounds

The majority of trips each year that landed dolphin (86-92%) were reportedly taken with rod and reel or trolling.

II. Total Longline Landings (Bottom, Shark and Surface)

1995 = 222 trips (193 surface); 177,117 pounds (50% total com. landings)
1996 = 182 trips (166 surface); 56,391 pounds (44% total com. landings)
1997 = 104 trips (68 surface); 132,140 pounds (58% total com. landings)

III. Average catch per trip for primary gears with min and max trips.

Longline average = ~900 lbs/trip
Minimum = 3 lbs.
Maximum = 28,229 lbs.

Hook and line/trolling average = ~75 lbs/trip
Minimum = 1 lb.
Maximum = 4,130 lbs.

RECREATIONAL DOLPHIN LANDINGS

1994 = 2,939,616 pounds
1995 = 3,548,862 pounds
1996 = 2,170,856 pounds

Overview of South Atlantic Exvessel Price Trends For the Common Dolphinfish (*Coryphaena hippurus*)[1]

By

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July, 1998

[1] Based on a presentation at the Dolphin/Wahoo Workshop, South Atlantic Fishery Management Council, Charleston, SC, May 6-8, 1998.

Introduction

Reported commercial landings of dolphin (aka mahi-mahi) or the common dolphinfish (*Coryphaena hippurus*) have increased substantially during 1990's in the South Atlantic Region[2]. This trend along with other issues (e.g. concern over the apparent shifting of longlining effort from swordfish to other pelagic species like dolphin, etc.) (Daniel, 1998) has drawn attention to analyzing factors influencing commercial landings of pelagic species. In South Carolina (SC), a proposed leasing of the Charleston Maritime Center to a commercial longline fishing oriented business stimulated concern regarding longlining effort off SC (Moore et al., 1997).

One of the factors that influences commercial fishing effort is the exvessel (dockside) price expected and/or received by commercial fishermen. Unfortunately, sometimes the most obvious price trends to those involved in harvesting and marketing commercial species may not be clearly understood by those influencing regulatory policies. In addition, one of the perceived potential benefits of recommended fishery management plans in the South Atlantic Region is facilitating "price stability" for a fishery because proposed regulations (e.g. trip limits) are expected to buffer large short-term changes in landings, and hence mitigate large fluctuations in exvessel prices (SAFMC, 1998). Of course, whether this objective is feasible will depend upon the understanding of various factors influencing exvessel prices including those factors (e.g. the availability of imported substitute products) usually beyond the control of fishery regulations. Therefore, the purpose of this paper is to begin a preliminary exploration of

[2] In the context of this report, the "South Atlantic Region" or "South Atlantic" is only comprised of landings in the US coastal states of Florida (Atlantic coast landings only), Georgia, North Carolina, and South Carolina.

exvessel price trends with special emphasis on the South Atlantic Region. It is hoped that this preliminary analysis will enhance the understanding of exvessel prices for those that might propose future regulatory actions regarding this species.

Data Sources

All of the data used in this analysis was derived from the National Marine Fisheries Service (NMFS) (Personal communication from the NMFS, Fisheries Statistics and Economics Division and Vondruska, 1998). The NMFS actually obtains the data from the United States (US) Bureau of Census[3]. It should be noted that there was no import data available from the NMFS before 1997, and dolphin fillets are the only product form that has currently been differentiated in the US imported seafood data that the NMFS receives from the US Bureau of Census. This is unfortunate because interviews of seafood distributors in the South Atlantic states indicate that substantial quantities of fresh deheaded and gutted ("H & G") dolphin and other product forms are also imported by US buyers.

Exvessel Price Trends

When reviewing data from the US Gulf and Atlantic states, reported annual exvessel prices, nominal[4] and deflated, have generally increased during the 1982 -1997 period. This trend in exvessel dolphin prices has occurred despite the substantial increase in pounds landed. During the 1982-89 period, annual dolphin pounds landed averaged 640,000 while the 1990-97 annual average, 1.8 million pounds, was nearly 3 times the 1982-89 period. Moreover, during the 1990-94 period, deflated exvessel prices increased

[3] The Foreign Trade Division of the US Bureau of Census compiles information provided by importers to the US Customs Service.

[4] Unless indicated otherwise all prices are "nominal" exvessel prices. Vondruska (1998) deflated nominal prices by using the Producer Price Index (Crude Foodstuffs and Feedstuffs).

steadily, about 14% per year, even though there was a poundage fluctuation between 1.1 million and 2.4 million (Fig. 1). It is possible that this general increase in the exvessel price since 1982 was partially derived from an increase in demand for species and product forms amendable to restaurant menus, like grilled mahi-mahi fillets. Regardless, the annual price declined for the first time in the 1990's when reported landings reached a record level, 2.6 million, in 1995 (Fig. 1). It is assumed that the relative price decline in 1995 is attributable to a large increase in dolphin landings that year.

After leveling off in 1996, the annual price declined again relative to the previous year and the 1997 annual price, $1.34/lb., was even 15% lower than the 1995 price (Fig. 1). Annual prices for the South Atlantic poundage appear to follow the same pattern (Fig. 2) as the Gulf and Atlantic price, i.e. in the 1990's the price peaked in 1994 and declined in 1995.

Monthly prices and pounds landed during the 1994-97 period (Fig. 3 and 4) display obvious seasonal fluctuations. In the South Atlantic Region, prices reached their lowest level in the first half of the year, usually May or June (Fig. 4). In contrast, the monthly highest prices for a given year did not display any apparent pattern during the 1994-97 periods (Fig. 4). For example, the highest monthly exvessel price, $2.26, was reported for March, 1997, but the highest monthly exvessel price in 1994, $1.89, occurred in August (Fig. 4).

Imports

As previously mentioned, US dolphin import data (i.e. fillets only) did not become available until 1997. Imported dolphin fillet pounds reached a maximum in the second quarter of 1997 with a corresponding low in the reported import price[5] (Fig. 5). The lowest import price, $1.06, occurred in May, 1997 (Fig. 5). A comparison of the imported fillet price and South Atlantic exvessel price suggests a similar price trend in the second quarter including the lowest monthly prices in May, 1997 (Fig. 6). Dolphin fillet imported pounds vs. South Atlantic landed pounds also tracked very closely during the second and third quarter of 1997, which included a poundage maximum in May, 1997 (Fig. 7). In 1997, 49% of the imported dolphin fillet poundage and 76% the South Atlantic Region landed pounds were recorded during the second quarter. It is interesting to note that lowest 1997 exvessel prices occurred in May and June. South Atlantic exvessel prices compared to import fillet poundage (Fig. 8) display the lowest prices in the second quarter, when fillet imports reached the highest monthly levels.

Summary and Conclusions

Annual exvessel prices for dolphin landed in the Gulf and Atlantic states have generally increased since 1982 despite a major increase in pounds landed. This price trend may indicate increasing derived demand for pelagic fish species by US consumers. Monthly data in the 1994-97 period suggests that the seasonal increase in landed dolphin pounds may cause supply induced declines in South Atlantic exvessel prices. The lowest monthly exvessel price in 1997 occurred in the second quarter, when monthly dolphin fillet imports were the highest. Consequently, it is possible that imported dolphin supplies may also play a role in reducing domestic exvessel prices in the South Atlantic Region. It is also possible that the increase in the fillet imports and the decline in

[5] The imported price was calculated by dividing the monthly import (customs) value by the imported pounds.

exvessel prices are coincidental and may not have a significant immediate effect on exvessel prices. For example, some seafood distributors that purchase imported H & G dolphin believe that imported H & G prices have a substantial immediate effect on South Atlantic exvessel prices. Since there is no time series data currently available on imported H & G dolphin, it is difficult to examine the possible effects of this product form on South Atlantic exvessel prices. Additional research is needed to better understand factors influencing US dolphin prices and possible fishery management implications.

References

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FIG. 1. DOLPHIN ANNUAL ATLANTIC & GULF POUNDS VS. DEFLATED & NOMINAL EXVESSEL PRICES, 1982-97.

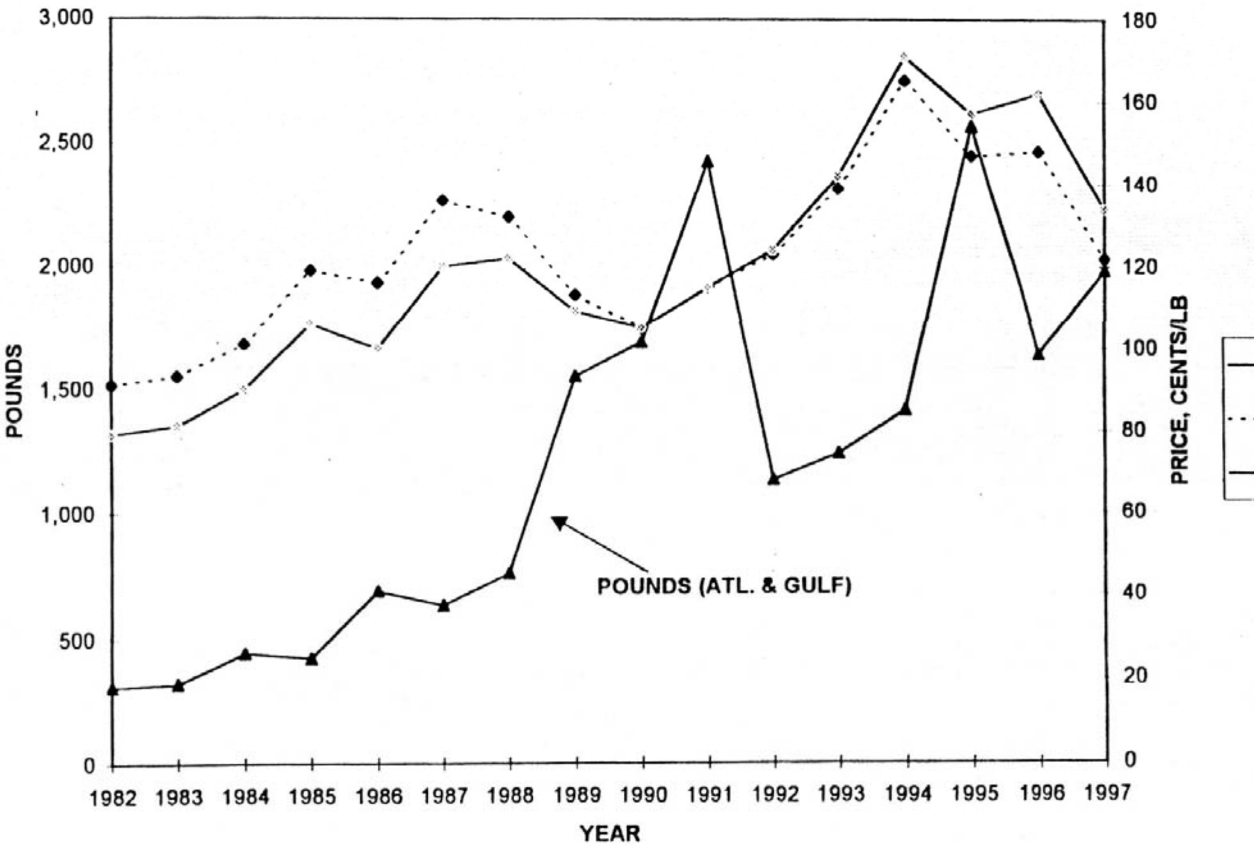

FIG. 2. DOLPHIN ANNUAL SOUTH ATLANTIC (SA) POUNDS VS. DEFLATED & NOMINAL EXVESSEL PRICES, 1982-97.

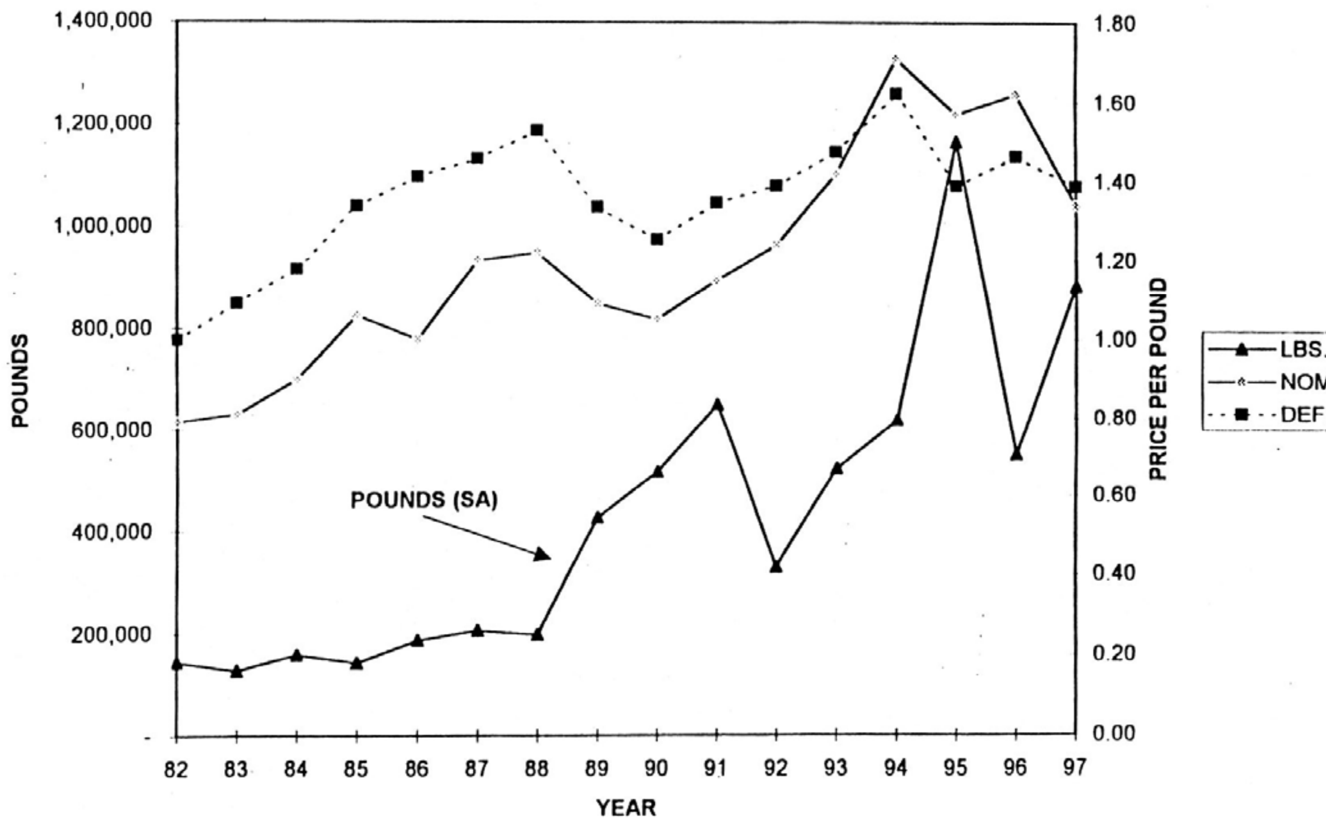

FIG. 3. DOLPHIN MONTHLY EXVESSEL PRICES VS. US ATLANTIC & GULF POUNDS, 1994-96.

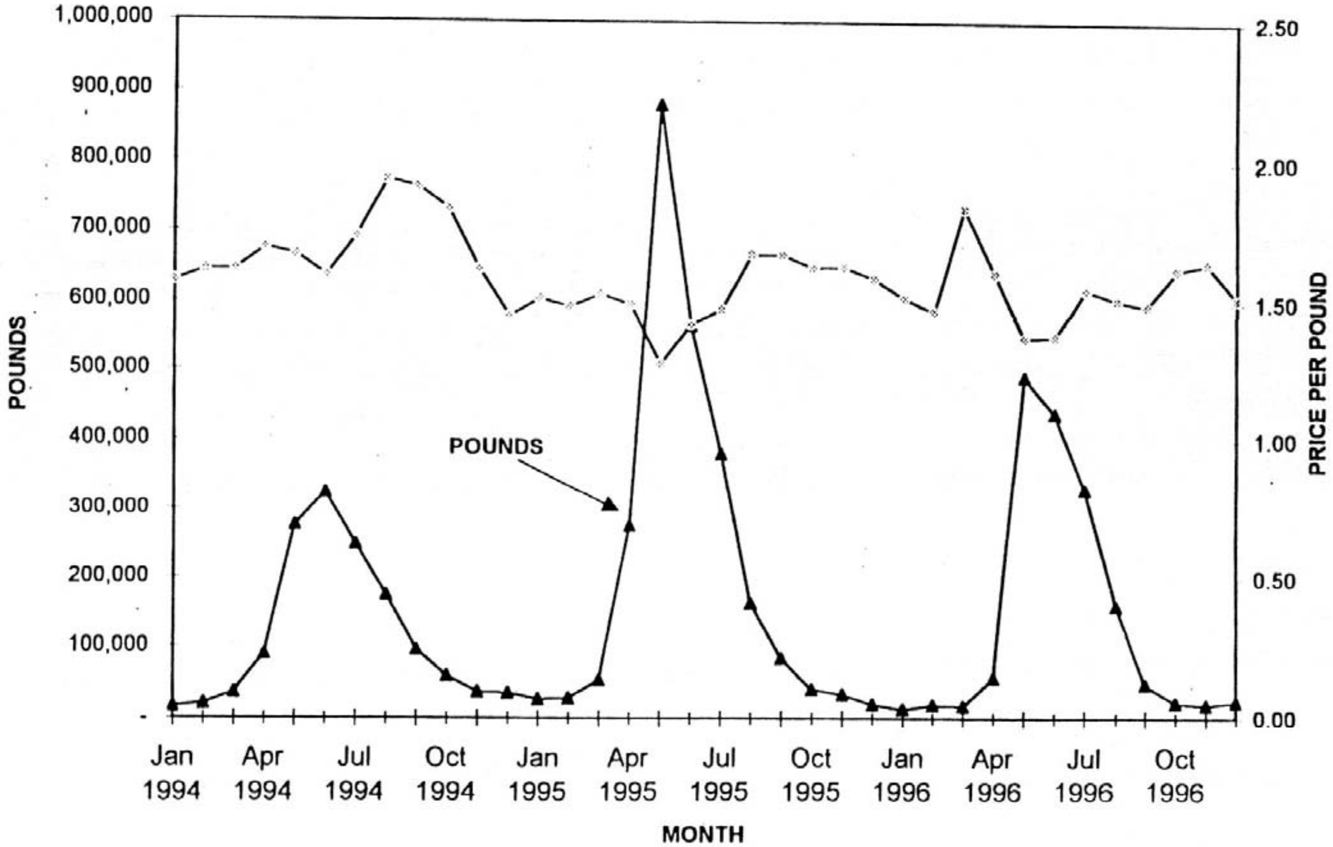

FIG. 4. DOLPHIN SOUTH ATLANTIC MONTHLY EXVESSEL PRICES VS. SOUTH ATLANTIC POUNDS, 1994-97.

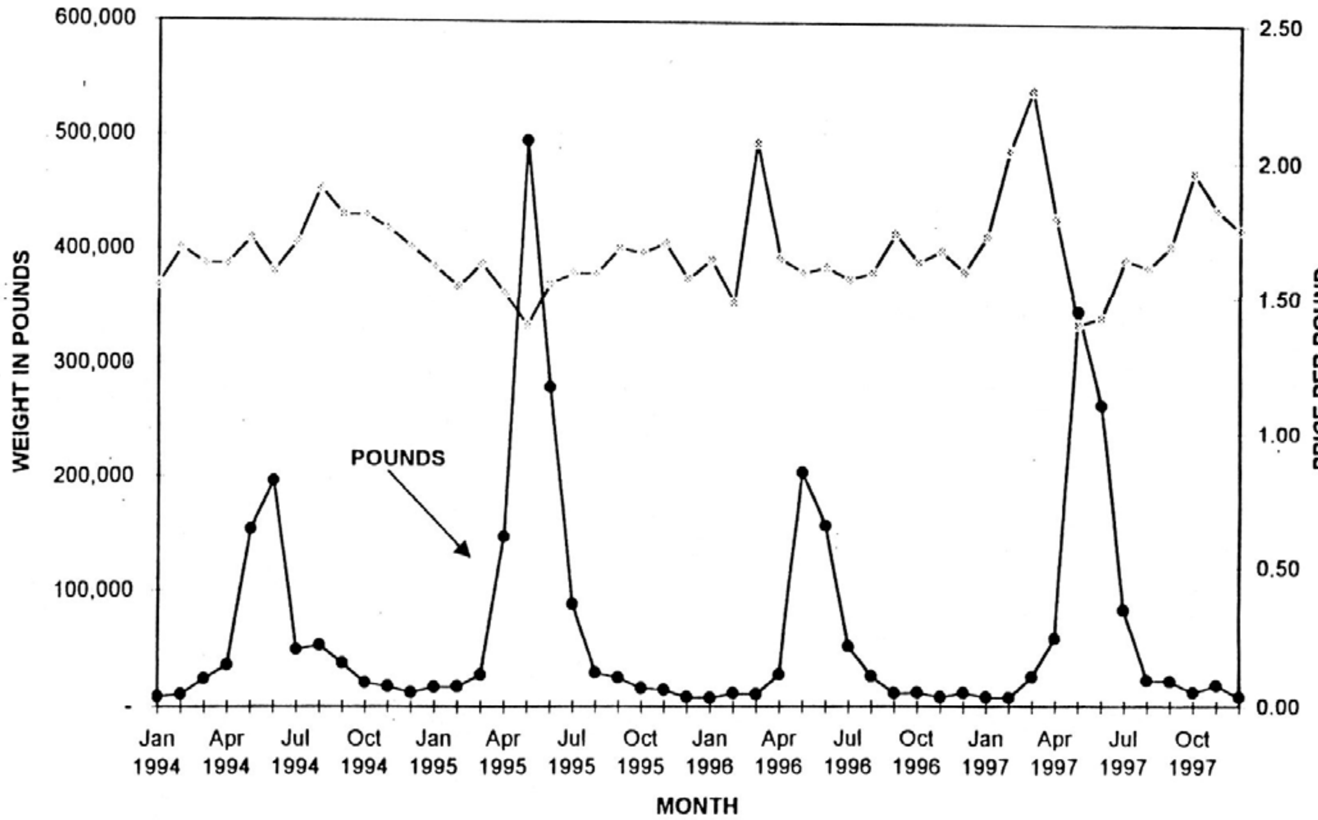

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FIG. 5. MONTHLY U.S. IMPORTED POUNDS VS. IMPORTED PRICES OF DOLPHIN FILLETS, 1997-98.

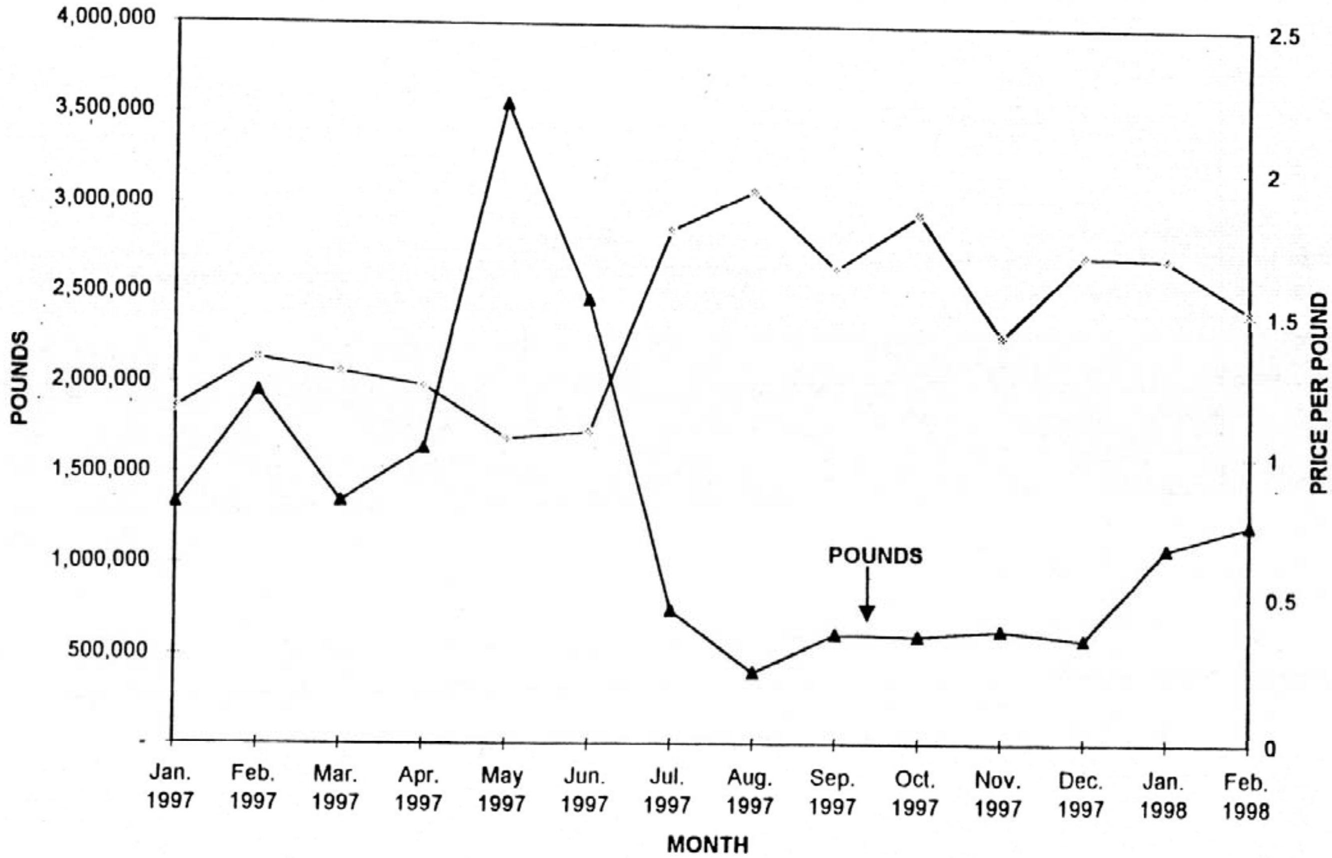


FIG. 6. MONTHLY SOUTH ATLANTIC EXVESSEL PRICES (SA) VS. IMPORTED (IMP) PRICES OF DOLPHIN FILLETS, 1997.

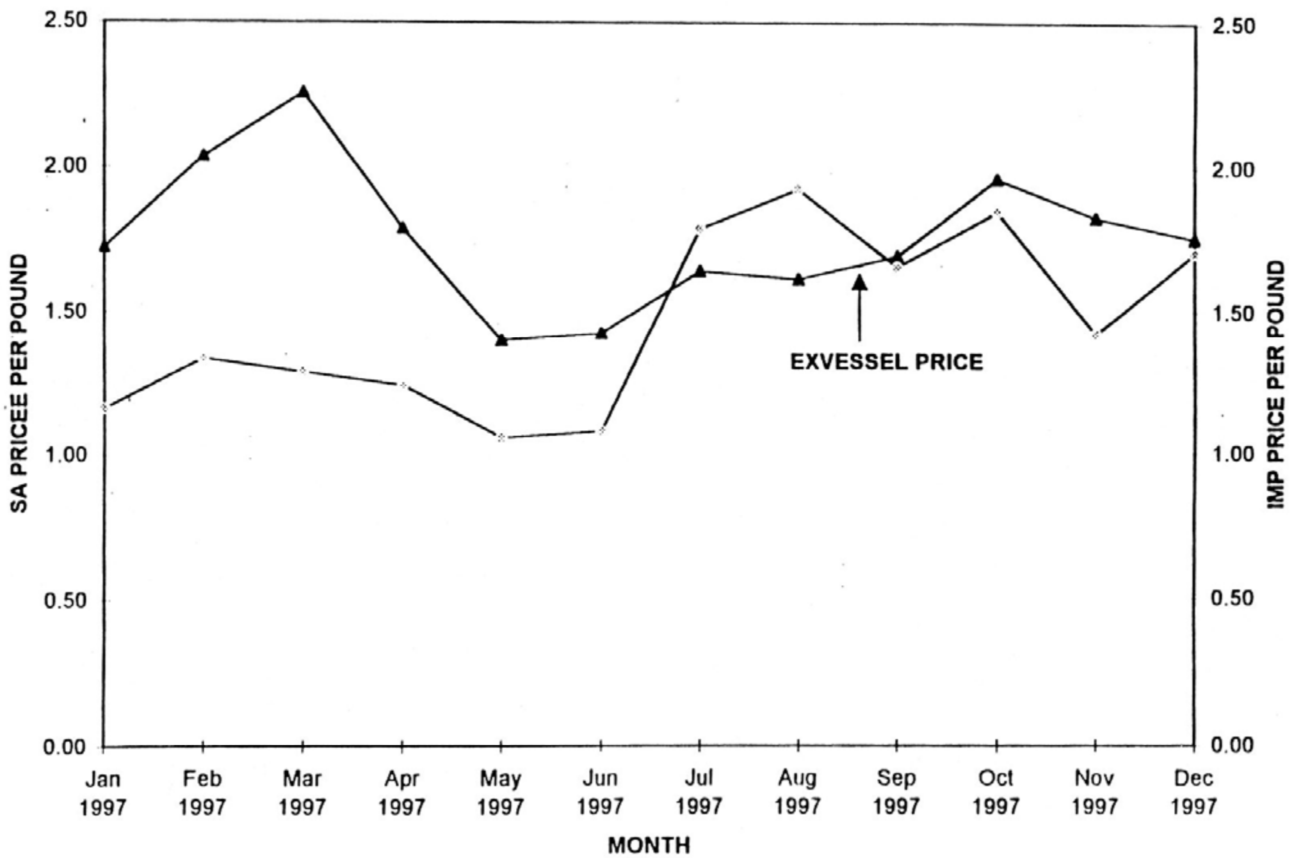


FIG. 7. MONTHLY SOUTH ATLANTIC POUNDS (SA) VS. U.S. IMPORTED (IMP) POUNDS OF DOLPHIN FILLETS, 1997.

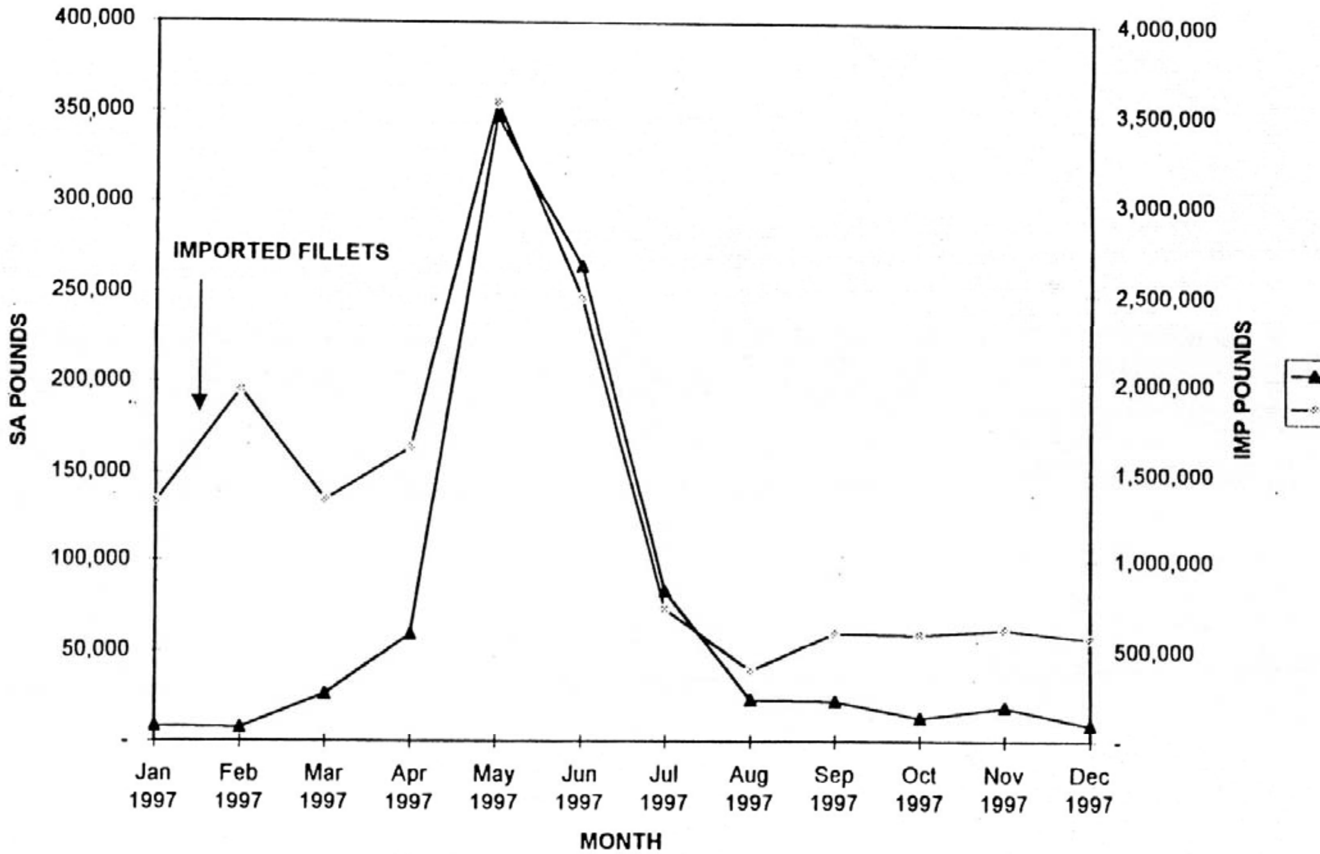
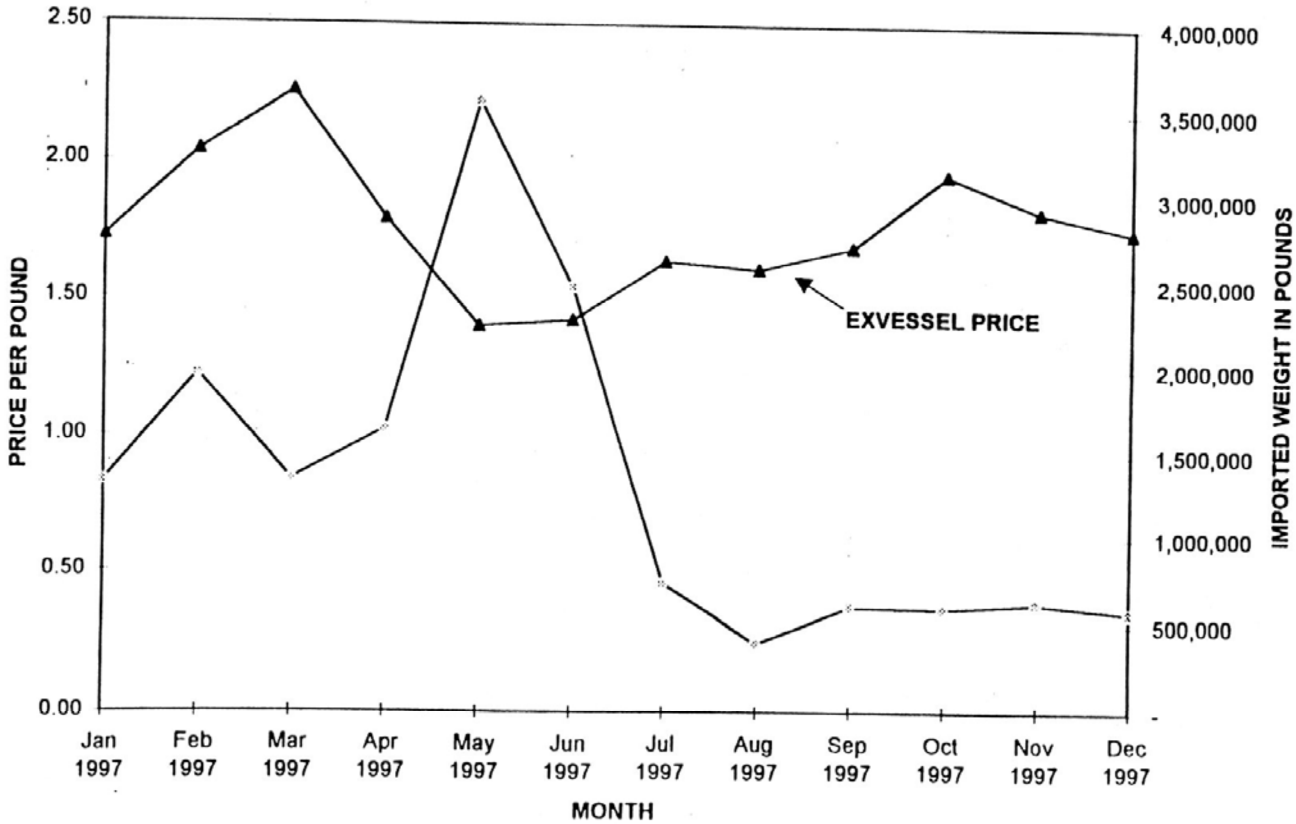


FIG. 8. MONTHLY SOUTH ATLANTIC EXVESSEL PRICES VS. IMPORTED POUNDS OF DOLPHIN FILLETS, 1997.



SOUTH CAROLINA

RECREATIONAL DOLPHIN FISHERY

A SPECIAL REPORT TO THE

MARINE ADVISORY COMMITTEE

SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES
MARINE RESOURCES DIVISION
OFFICE OF FISHERIES MANAGEMENT

FEBRUARY 10, 1998

PREPARED BY

DONALD L. HAMMOND

SOUTH CAROLINA RECREATIONAL DOLPHIN FISHERY

DOLPHIN BIOLOGY

The common dolphin, *Coryphaena hippurus*, is found world wide in tropical, subtropical and temperate waters (Palko, et. al., 1982). It is an extremely fast growing fish with a short life span (Beardsley,1967). Rose and Hassler (1968) found one year old dolphin to range in size from 18.7 in. to 46.3 in. in fork length. Dolphin maintained in large aquariums have exhibited growths of 3 to 4.7 lbs. per month (Herald, 1961; Beardsley, 1967). Males are heavier per length and grow to larger size than females (Beardsley, 1967; Rose and Hassler, 1968). Few dolphin reach the age of four years with the vast majority falling in the zero to one year class (Beardsley, 1967; Rose and Hassler, 1968). They start to become sexually mature at about 13.7 in. fork length and all are mature at about 21.7 in. fork length (Beardsley, 1967). Spawning takes place in the open ocean, probably in Gulf Stream waters in the South Atlantic region. Dolphin are multiple spawners with an extended spawning season, possibly year round in tropical water (Gibbs and Collete, 1959; Beardsley, 1967). Peak abundance of dolphin off Puerto Rico occurs in February to March (Erdman, 1956), off Florida east coast in late April and May (George Poveromo, pers. comm. Jan.,1998), off South Carolina in May and June and off North Carolina in June and July (Joe Smith, pers. comm. Jan., 1998). Little tagging information is available, but a small study by the Mote Marine Lab showed these fish are capable of traveling 70 to 80 miles in a 24 hour period.

SOUTH CAROLINA RECREATIONAL FISHERY

Dolphin have been captured off South Carolina every month of the year. However, the primary fishing period is mid April to November. Large dolphin are primarily harvested in May and June and catch rates rapidly taper off in July. Bob Low's summary of the South Carolina Charter Boat Log Book (CBLB) data shows that over 80 percent of the dolphin harvest is landed in the spring (Figure 1). Likewise, the Oceanic Pelagic Game Fish Monitoring Program (tournament) has observed a sharp decline in dolphin cpue in tournaments beginning in July. Large schools of small, 16 to 24 in. FL, "chicken" dolphin are most common from mid July through October. Dolphin normally are found in the warmer waters of the Gulf Stream during the cooler periods of the year, but will commonly enter waters of 90 ft. deep during July and August. Small juveniles of 2 in. FL have even been collected in Charleston Harbor (personal observation). Historically, dolphin have been harvested primarily by recreational fishermen. Catch/effort and biological data collected at sportfishing tournaments, have shown dolphin to be the primary species taken in the blue water sportfishery. A directed commercial fishery has only recently been developed.

INFORMATION SOURCES

Information on recreational dolphin harvest is available from the tournaments and the CBLB. The tournament survey has collected catch per unit of effort (cpue) data on dolphin during billfish tournaments since 1977 and size data since 1987. May, June and July represent the peak in both billfish, Istiophorid, and dolphin fishing. For this reason, the largest billfish (blue water) competitions are held during this period. These major billfish tournaments, which have historically targeted billfish, have also provided incidental catch data on dolphin and other blue water game fish. This has resulted in a long term data base (21 years). The number of dolphin caught per eight net boat hours of fishing, with no regard to number of lines fished, was used as a standard index to assess fluctuations in the harvest of dolphin by recreational fishermen over this 21-year period. Under the CBLB, only charter boat trips which resulted in the catch of one or more dolphin were utilized.

HARVEST DATA

Annual dolphin cpue has varied significantly during the last 21 years (1977 - 1997) as recorded by the tournament survey (Figure 2). During the first half of the period being examined, 1977 through 1987, the average annual cpue (fish per boat day, fpbd) was 1.61 with an average annual tournament minimum cpue of 0.60 and a maximum of 2.87. This index has doubled in the last ten-year period, 1988 through 1997, with the average annual cpue reaching 3.35 and an average annual tournament minimum of 1.25 fpbd and maximum of 5.68 fpbd. This increase indicates that during the last ten years, sportfishermen catch rates are twice that of the eleven years prior. The three highest annual cpues since 1977 were 1989 (4.49 fpbd), 1990 (4.10 fpbd) and 1995 (4.802 fpbd). These data very clearly show an apparent increase in dolphin abundance during the last ten years.

Annual cpue data are not provided by the CBLB survey as only boats successful in catching dolphin were used in the summary. Tournament survey data indicate that during this period from 7.7 percent to 21.3 percent of the tournament boat trips resulted in no dolphin being caught. It is highly unlikely that every charter trip targeting dolphin caught them.

Length frequency information for dolphin has been collected since 1987 under the tournament survey. Staff attempted to measure all dolphin in a creel or to sub-sample the complete size range present when that was not possible. In this 11-year period, 3,505 dolphin taken in conjunction with billfish tournaments were measured and fork length (FL) recorded in millimeters (Figure 3). The 50-mm size class increments used to initially examine the data were converted to inches for ease in relating to possible size restrictions. These data indicate that less than 1.0 percent of the dolphin caught (0.7 percent) are below the size of sexual maturity (21.7 in. FL). Fish under 29.5 in. FL comprised 9.2 percent of the catch. Dolphin measuring from 33.5 to 41.3 in. FL accounted for 53.6 percent of the harvest. The overall average dolphin was 37.4 to

39.4 in. FL. Large fish, those in excess of 45.3 in. FL, represented only 11.9 percent of the catch.

Length, weight and sex data were recorded on 464 specimens. Length and weight, but not sex, were noted on an additional 88 specimens. The majority of these data was obtained as special efforts in 1995 and 1997. Dolphin are sexually dimorphic with males weighing more per length and growing to a larger size. However, fishery dependent data noting length seldom records sex, therefore, for practical application of length verses weight, sex should be disregarded. Figure 4 presents the average weight in pounds observed for each size class and attempts to depict the large weight variations observed in every length class by presenting the minimum and maximum weight noted for each length category. The average dolphin measuring 37.4 to 39.4 in. FL weighed an average of 16.0 lbs. However, fish in this length category weighed as little as 11.5 lbs. and as much as 22.5 lbs.

Creel frequency for dolphin was examined per boat trip without regard to the length of time fished in the tournament survey. The CBLB presented creel frequencies based both on a per-trip and per-angler basis. While the tournament survey has collected dolphin creel frequency information since 1977, only the last five years will be examined for the purposes of this report since it represents the most current activity. A total of 1,414 boat trips was documented under the tournament survey for 1993 through 1997 (Figure 5). About 94 percent of the trips had catches of 10 or less dolphin and less than two percent had catches of more than 15.

CBLB creel frequency data were summarized on a total of 1,336 boat trips that caught dolphin during May and June in 1995, 1996 and 1997. Figure 6 shows that from 64 to 85 percent of the trips caught 10 or less dolphin annually and only 7 to 18 percent caught over 15 dolphin. To provide for a direct comparison the last three years, tournament data were re-examined discounting boat trips that had zero dolphin creels (Figure 7). Tournament data now showed that annually 82 to 92 percent of the trips caught 10 or less dolphin and 2 to 7 percent caught over 15 fish per boat trip. Clearly, charter boat trips tended to make larger catches of dolphin than tournament trips. This is probably a manifestation of charter boat captains being more focused on putting fish in the boat because their clients, anglers, have paid to catch fish. This is substantiated by comparing the number of dolphin caught per boat trip successful in catching dolphin (Table 1.). Charter boats averaged twice as many dolphin per successful trip as tournament trips.

Table 1. Comparison of the number of dolphin caught per successful boat trip between charter and tournament trips.

	CHARTER BOATS			TOURNAMENTS		
YEAR	FISH	TRIPS	AVE.	FISH	TRIPS	AVE.
1995	4218	452	9.3	1704	373	4.6
1996	3178	461	6.9	1172	307	3.8
1997	4641	423	10.9	1512	393	3.8

Tournament data in 1995 - 97 showed that an average of 6.2 people were aboard each boat trip (Table 2). The number of people aboard each vessel in a tournament normally varies from 4 to 8 with the number tending to increase with increasing boat length. Boats fished the same number of lines regardless of the number of people aboard. Charter boat trips catching dolphin averaged carrying 5 people during the three years examined.

Table2. Average number of people per boat trip observed in sportfishing tournaments and on charter boats.

YEAR	AVERAGE NUMBER OF PEOPLE PER CHARTER	AVERAGE NUMBER OF PEOPLE PER BOAT TRIP
1993	-	6.3
1994	-	5.9
1995	5.0	6.1
1996	4.9	6.3
1997	5.1	6.2

The CBLB also presents creel data on a per person per trip basis (Figure 8). This indicates that roughly 73 percent of the anglers caught 2 or less dolphin. Slightly less than 16 percent of the angler trips caught over 3 dolphin a trip. For comparison the overall tournament creel data was revised deleting zero creel trips and basing creels on 6 people per trip (Table 3). This showed that 95.4 percent of the trips resulted in 2 or less dolphin per person. Only 0.5 percent of the tournament boat trips resulted in 4 or more dolphin per person.

Table 3. 1995 - 1997 tournament creel data for dolphin on a per person basis when zero creel trips are factored out.

PER PERSON CREEL SIZE	PERCENT OF TOTAL ANGLER TRIPS
<1	70.0
1 - 2	25.4
2+ - 3	3.0
3+ - 4	0.9
>4	0.5

EXISTING REGULATIONS FOR SOUTHEASTERN STATES:

North Carolina:

10 per person per day bag limit; No minimum size; Charter vessels limited to 60 per trip.

Georgia:

15 per person per day recreational bag limit; 18 inch fork length minimum.

Florida:

10 per person per day recreational bag limit; 20 inch fork length minimum size for commercial only.

SUMMARY

Data from the tournament survey and CBLB show that an average of five to six people fish on each tournament and charter boat blue water trip. This is probably representative of the overall fishery, considering the small boat/ large boat makeup. Dolphin abundance appears to have increased two fold in the late 1980s and 90s compared to the late 1970s to mid 80s. Removal of apex predators such as sharks and billfish may have contributed to this increase. The majority of dolphin caught in recreational tournaments (68.9 percent) weigh between 11 and 26 lbs. Only 17 percent of the harvested fish fall under the 11 lbs. size with less than one percent of the total catch potentially being sexually immature. Tournament boats were shown to catch an average of 3.4 dolphin per boat day over the last ten years with the highest annual cpue of 4.8 dolphin per boat day observed in 1995. Charter boat trips which were successful in catching one or more dolphin averaged 9.0 dolphin per trip during 1995 through 1997, with a high of 10.9 dolphin per trip reported in 1997. Of boat trips successful in catching dolphin, between 2 and 7 percent of the tournament trips and 7 to 19 percent of charter trips caught over 15 dolphin.

Virtually all dolphin caught off our coast are sexually mature, indicating that a size restriction would offer little benefit for reproduction. Existing data does not indicate a need to reduce the current level of dolphin harvest. However, man has amply shown his ability to overfish any stock. Creel limits, as set in other southeastern states, would restrict few fishermen. Vessels in these states with five to six people aboard would be allowed 50 to 90 dolphin per day which could translate into a potential of 600 (12 lb. ave.) to 1,440 pounds of fish (16 lb. ave.).

Data are not available on catch rates or total catches of small "chicken" dolphin that are usually caught after the billfish tournament season. However, Low's CBLB summary of monthly contributions to total catch indicates this harvest is probably minor.

While data are not immediately available on headboat catches for inclusion in this report, Gene Huntsman (formerly with NMFS) may be able to address this question. Low reports th... SC headboats probably seldom take more than 15 dolphin in a day. But headboats and charter vessels carrying more than six people would probably oppose a boat limit.

Based on the available data, a daily boat limit of fifteen dolphin would impact very few private boat trips and only a small portion of the charter trips. Such a limit would allow a boat the potential to catch from 180 lbs. (12 lb. Ave.) to 240 lbs. (16 lb. Ave.) of dolphin in addition to any tuna and wahoo caught, certainly a reasonable limit. If an angler bag limitation is preferred over a daily boat limit, then a three dolphin per person per day bag limit would be recommended. This would have even less impact on the recreational fishery as it exists today.

Consideration should be given to the public's impression if restrictions are placed against just one of the two consumer groups utilizing dolphin stocks. This could be interpreted as limiting one user group to benefit the other. Therefore, consideration should be given to balancing management between the user groups or at least preparation of a clear justification as to why only one group is being restricted. A minimum size restriction for commercially caught dolphin set at 22 to 24 in. FL would probably have little impact on the current fishery, but would prevent a future fishery from developing on small fish and demonstrate that management was being applied to both user groups.

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Figure 1. Monthly Contribution to Total Dolphin Harvest by SC Charterboats, 1994-1996 (Low, 1998).

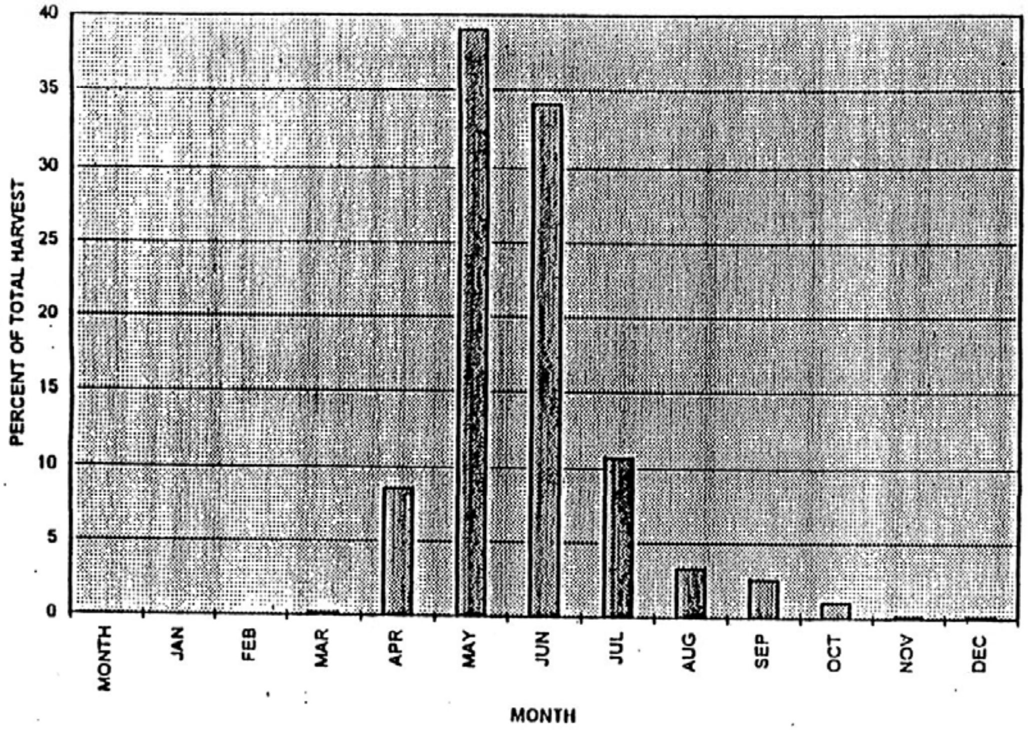


Figure 2. Observed Average CPUE for Dophin Caught During Survey Billfish Tournaments With Minimum and Maximum Tournament CPUE's.

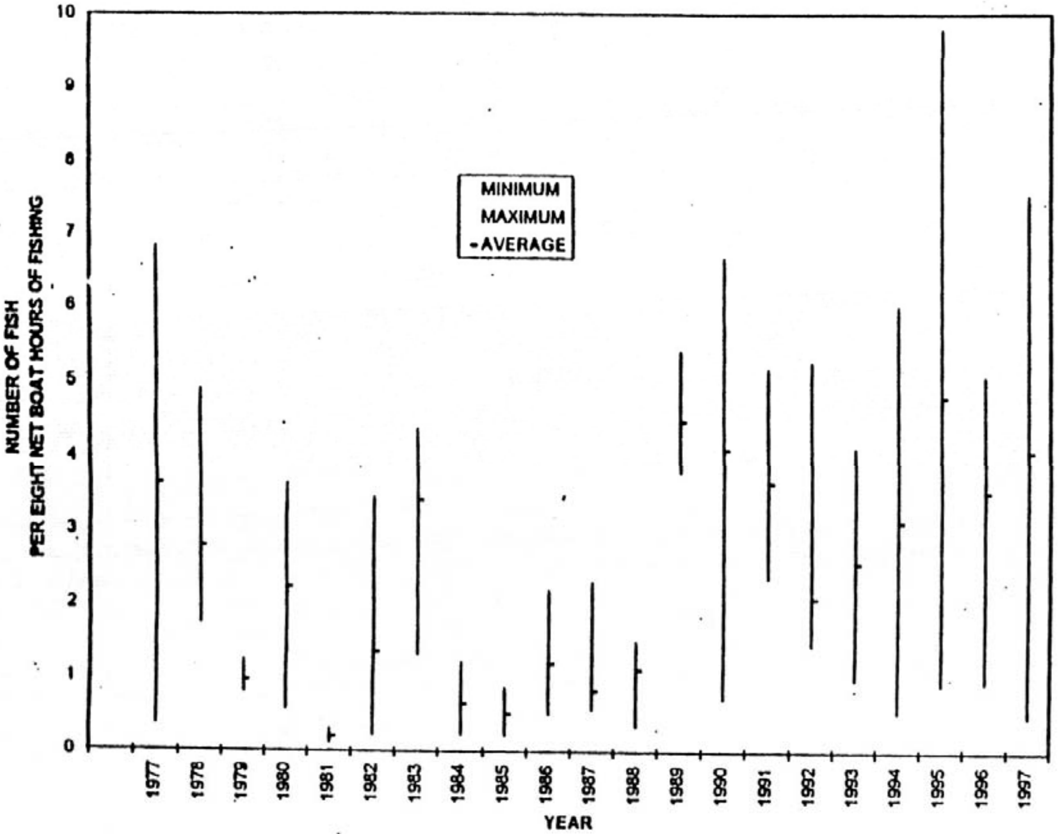


Figure 3. Size distribution of tournament caught dolphin, 1987 - 1997 combined. N = 3,505

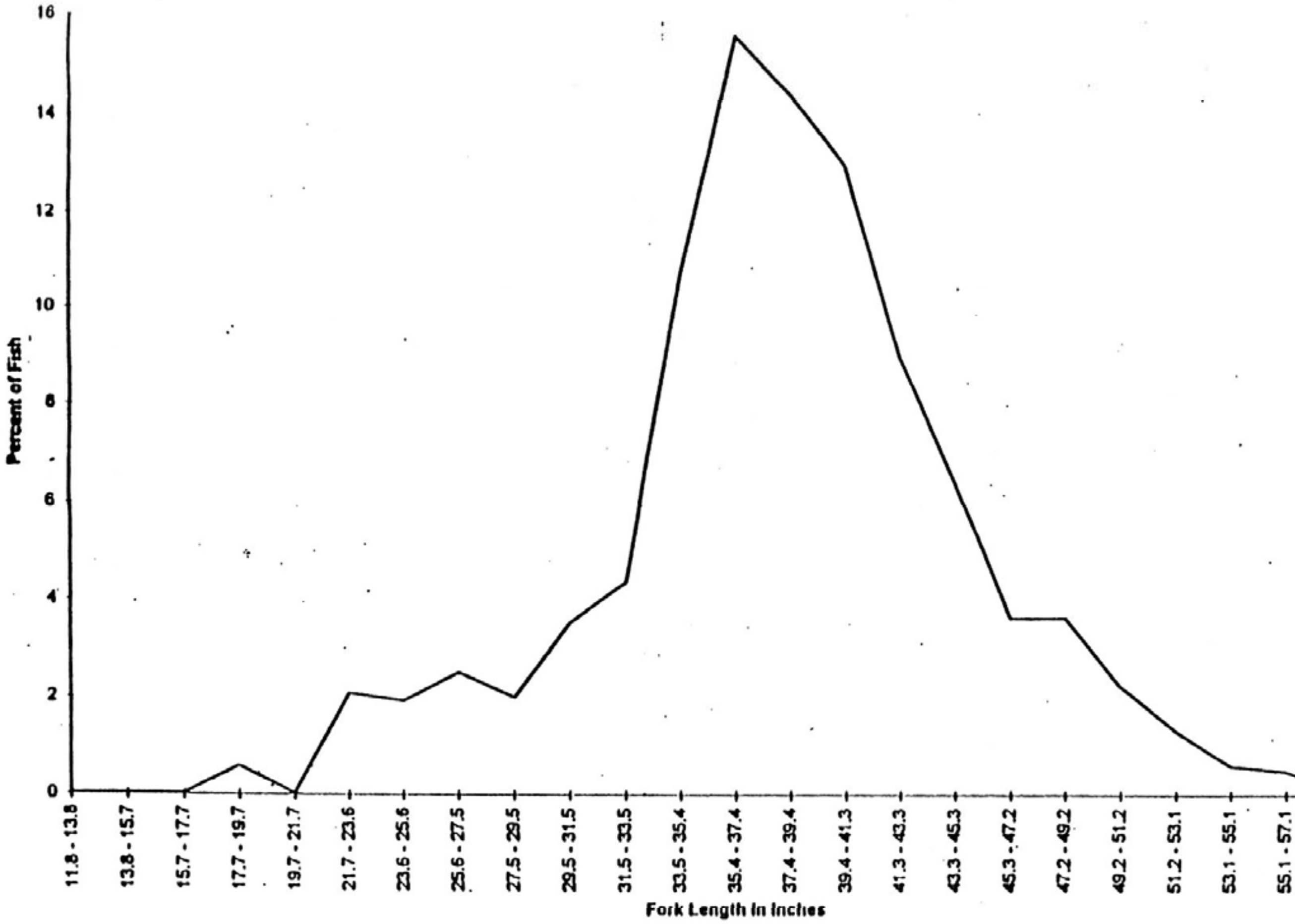


Figure 4. Average weights and ranges observed for dolphin when sexes are combined. Observations from specimens.

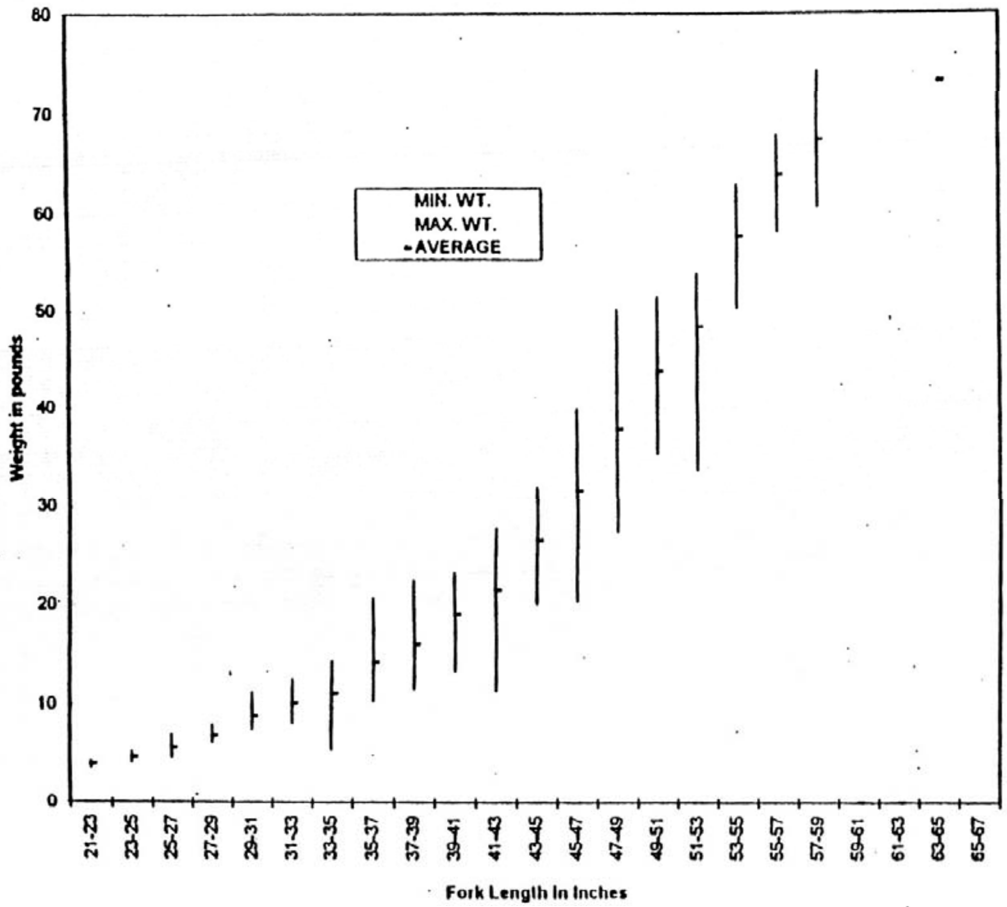


Figure 5. Overall Creel Frequencies Observed for Dolphin 1993 to 1997 in Sportfishing Tournaments. Num of Boat Trips Surveyed = 1,414.

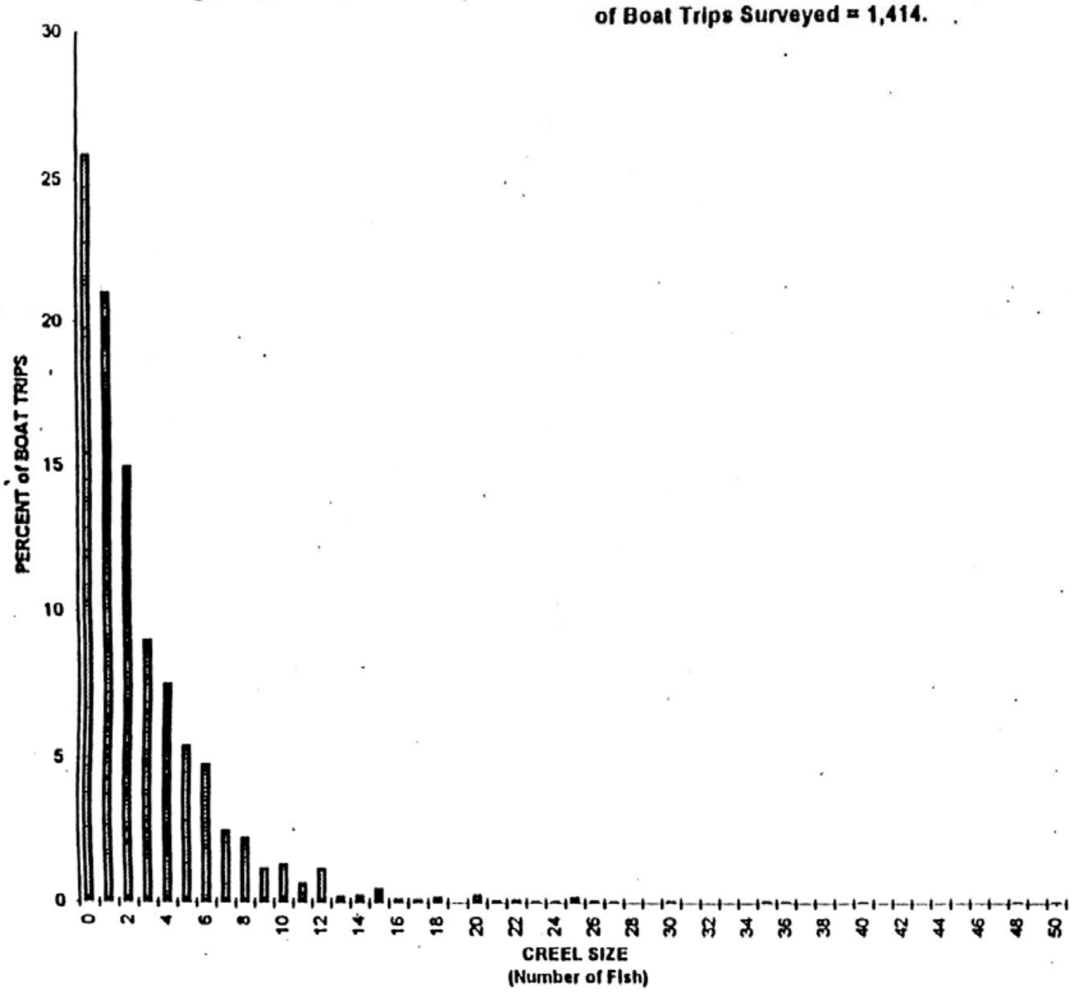


Figure 6. Annual Distribution of Dolphin Creels on SC Charterboats, 1995-1997 (Low, 1998).

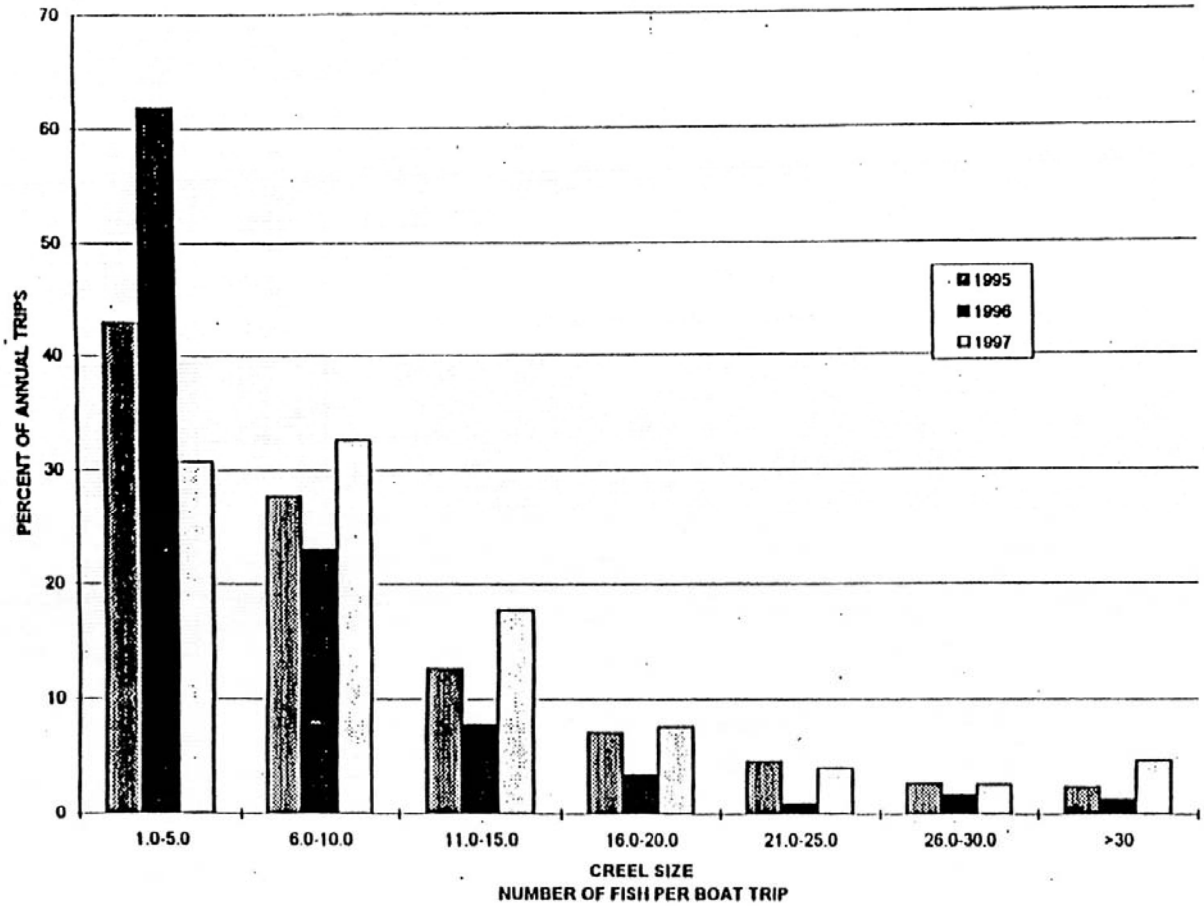


Figure 7. Annual Dolphin Creel Frequencies for Tournament Trips That Caught One or More Dolphin.

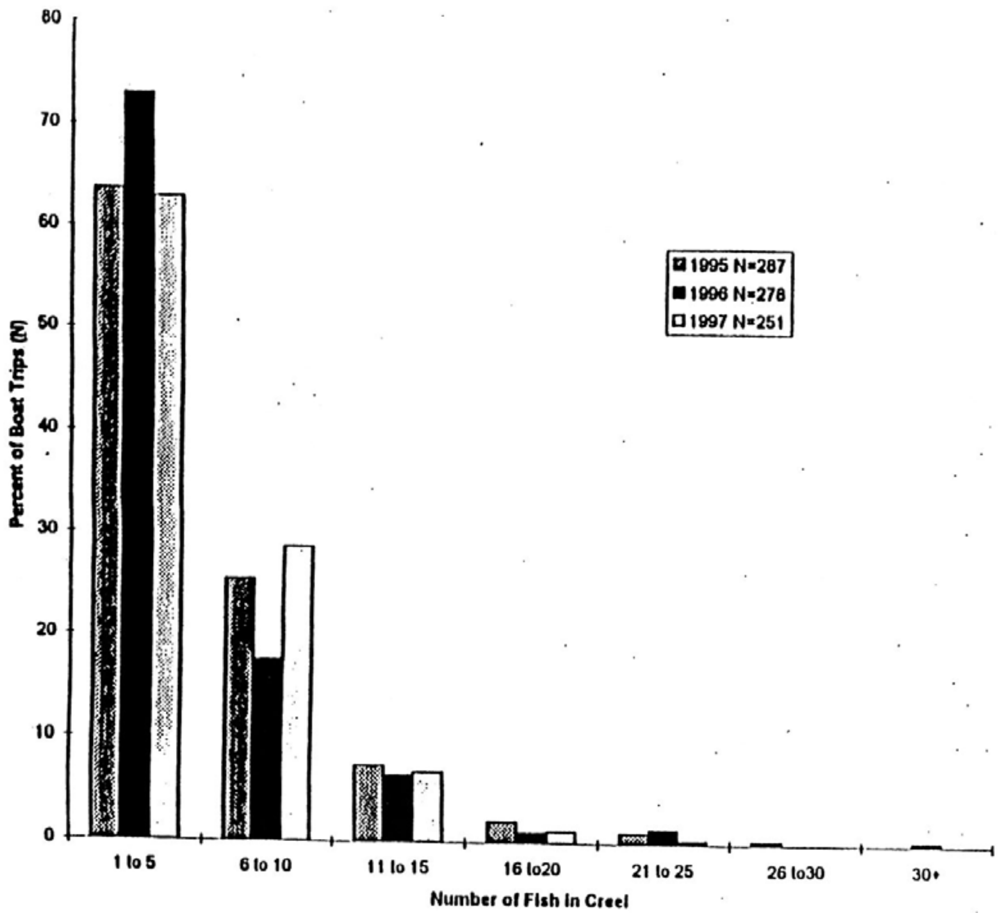
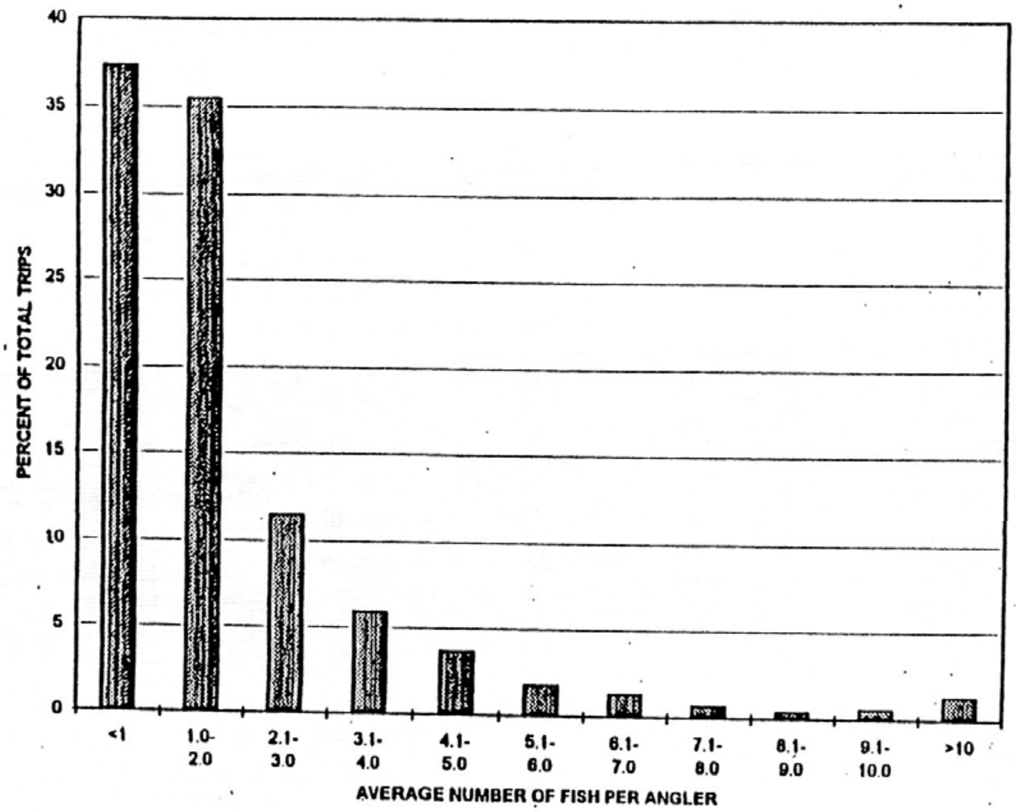


Figure 8. Distribution of Dolphin Creels by Anglers on SC Charterboat Trips, 1995-1997 (Low, 1998).



SOUTH CAROLINA GOVERNOR'S CUP BILLFISHING SERIES
Advisory Board of Directors Meeting
Tuesday, February 24, 1998, 2:00 PM
Administration Building Conference Room, Third Floor
Marine Resources Center, Charleston, SC

Meeting Agenda

I. Old Business:

A.	Review and Approval of Previous Meeting Minutes (October 10, 1997) -	Chrmn. Cox
B.	Modification of IGFA Rules -	Henry J. Finch
C.	Increase of Minimum Size for Blue Marlin -	Henry J. Finch
D.	Tenth Annual Awards Ceremony -	Don Hammond
E.	Tenth Anniversary Lapel Pin -	Henry J. Finch

II. Tournament Committee Report: Henry J. Finch

A. Recommendation: Establish Safety Margin for Billfish Measurement

III. New Business:

A.	Financial Restructuring - 1. Association with Hampton Fund 2. Available Options	Dr. Miglarese
B.	Board Appointments -	Mr. Buck
C.	Research Grant Recommendations -	David Whitaker

IV. Program Director's Report: Don Hammond

A. Pate Fund Donation
B. 1998 Sponsors
C. R&S Lure Status
D. Georgia Inquiry
E. 1998 Revenues Received

V. Information:

A.	King Mackerel Governor's Cup Series Status -	Mr. Andy Nettles
B.	Marine Laws Rewrite (Chapter 5) -	Dale Theiling
C.	Economic Survey Update -	Kim Iverson
D.	Longline Issue Status -	Charles Moore
E.	Dolphin Issue Status -	Don Hammond

VI. Additional Business:

VII. Scheduling of Next Meeting: Chrmn. Cox

VIII. Meeting Adjournment

BRIEFING PAPER

CONCERNING

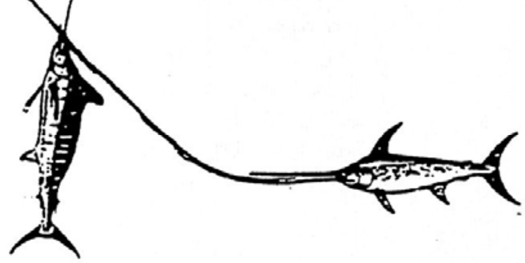
THE PELAGIC LONGLINE FISHERY

OFF SOUTH CAROLINA

A SPECIAL REPORT TO THE

MARINE ADVISORY COMMITTEE

SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES
MARINE RESOURCES DIVISION
OFFICE OF FISHERIES MANAGMENT



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MARINE ADVISORY COMMITTEE

SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES
MARINE RESOURCES DIVISION
OFFICE OF FISHERIES MANAGMENT

NOVEMBER 14, 1997

PREPARED BY

LONGLINE FISHERY COMMITTEE
CHARLES MOORE - CHAIRMAN
BOB LOW
GEORGE SEDBERRY
DON HAMMOND
JOE MORAN
GLENN ULRICH
RAY RHODES

THE PELAGIC LONGLINE FISHERY OFF SOUTH CAROLINA

A SPECIAL REPORT TO THE MARINE RESOURCES DIVISION'S MARINE ADVISORY COMMITTEE

EXECUTIVE SUMMARY

Development of the Longline Fishery

The domestic Atlantic longline fishery is a relatively new fishery. In the early 1960's, substantial catches of swordfish were made by Japanese tuna longline vessels and the Norwegian shark fishery. Exploratory fishing vessels in the northeast Atlantic using longline gear at night were also meeting with success, leading many Canadian and United States vessels to convert to longlines. The longline fished by these vessels is generally monofilament which may range from two miles long to 40 or more miles. The increasing number of large Japanese and other foreign longline vessels, which primarily targeted tuna, but also took increasing numbers of swordfish and other pelagics, was one factor in the passage of the Magnuson Fishery Conservation and Management Act of 1976.

U.S. domestic swordfish landings peaked in 1989 at 10.63 million pounds and have declined steadily to 6.3 million pounds in 1995. Draft Amendment 1 to the Fishery Management Plan for Atlantic Swordfish,(Jan.,1997)notes that," whereas the commercial harpoon and sport fishery took sustainable amounts of swordfish (mature fish only) year after year, that not only are these fisheries gone, but that if the longline fishery continues to decline at the current rate, swordfish may approach commercial extinction within the next ten years".

Associated with the increasing amount of longline fishing for tuna and swordfish during the 1980's was a considerable by-catch of sharks. From 1979 to 1989 shark landings increased over 50 fold to more than 7,000 tons annually. During 1997, the commercial allocation for large coastal sharks was reduced to 1,285 metric tons (half the 1996 level) and recreational anglers are currently limited to two dogfish and/or Atlantic sharpnose sharks plus two additional sharks per boat per trip. Atlantic longline fishermen continue to take thousands of sharks as by-catch with an associated mortality rate estimated to be in excess of 30 percent.

The changing nature of the longline fishery has been noted by the Blue Water Fishermen's Association (BWFA), the major industry group representing longliners. The BWFA considers the contemporary fishery to be multi-species with the non-swordfish component (tuna, sharks, and dolphin) a vital economic contributor. In this context, the "by-catch" now consists largely of fish that must be released (dead or alive) due to various regulations ("regulatory discards").

Longline Fishery off South Carolina:

Currently (1997) there are 1,531 permitted vessels in the U.S. Atlantic swordfish fishery; however, only about 300 land swordfish each year. In recent years, many vessel owners may have been obtaining permits in case other fisheries are depleted or in case some type of limited entry system is instituted in the future. Between the mid-1980's and 1995, the number of pelagic longline vessels off-loading in South Carolina ranged from 20-27 per year. In 1996, 40 boats were reported to have landed in South Carolina.

Most of the commercial fishermen landing fish in South Carolina fish from the Florida Straits to Cape Hatteras. Within this area, effort is most concentrated at the Charleston Mound (also known as the Charleston Hump or Bump). Since the start of the fishery, this area has been noted for an abundance of swordfish, including many small fish. The local fishery has always been characterized by some of the highest catch rates of swordfish and of undersized fish in the domestic fishery. In June 1991, a minimum size requirement for swordfish of 41 lbs dressed weight(dw)/55 lbs whole weight(ww), with a 15% allowance by number for undersized fish, was imposed by the NMFS. That year, 11% of the graded catch of swordfish landed in South Carolina was <25 lbs dw and 33% was in the 26-49 lb dw category. Average size since then has remained barely above the legal minimum. Although boats fish off South Carolina year-round, the landings here generally have been greatest during spring (April-May).

During most of the 1980's and early 1990's, estimated effort fluctuated between 90-160 trips/year which were off-loaded in South Carolina. Estimates since 1993 are unavailable. In the regional (southeast coastal) fishery, the numbers of sets and hooks fished have declined since 1989, although the average number of hooks per set have increased.

Swordfish landings in South Carolina since 1990 have been fairly stable with a slight increasing trend. Tuna (mostly yellowfin) landings have fluctuated without any directional trend since the late 1980's. Landings of dolphin and sharks have increased greatly since 1994. Species other than swordfish now represent about 55% of the aggregate weight and 25% of the ex-vessel value of South Carolina pelagic longline landings.

The discard rate of the fishery is appreciable. About 60% of the total Atlantic southeast shark catch was discarded in 1995 with an estimated 20% mortality rate. Part of the discard was due to prohibition of retention of large coastal species after the semi-annual shark quotas had been filled. Retention of billfish (marlins, sailfish, and spearfish) by commercial fishermen has been prohibited by the NMFS since September, 1988. In 1995, the total estimated southeast coastal area catch of billfish by pelagic longliners was 850 fish with 226 of these presumably dead upon release. By comparison, the average annual recreational catch in South Carolina during 1991-1994 was 270 billfish, nearly all of which were released alive. The estimated South Carolina recreational catch in 1995 was 225 billfish, 94% of which were released alive.

During 1992-94, NMFS observers sampled approximately 5.0% of the longline fishing effort in the southeast Atlantic (observing the catch of 1,348 billfish. Of these fish, 51 % (692) were dead at time of discard. A high level of mortality was observed for several other species. For example, 31.8 % of all sharks, 45.2 % of the bigeye, bluefin and yellowfin tunas and 37.1 % of the swordfish were dead or dying when the lines were retrieved.

The overall discard rate for swordfish reported by U.S. commercial fishermen as part of a mandatory logbook system (Cramer, 1996) was 43%. It is assumed that these discarded fish were below the minimum size limit. About two-thirds of the discarded fish were dead, representing 29% of the total swordfish catch. These fish constitute a major concern of both recreational and commercial fishermen, since they have no conservation value and constitute a waste of a marketable product. The South Atlantic Fishery Management Council has long expressed opposition to the minimum size limit for swordfish, due to the fact that the discard of dead, undersized fish serves no practical conservation purpose.

The high mortality of these species is of primary concern in formulating management strategies. The effectiveness of season closures, minimum length requirements and quotas on target species (i.e. swordfish) may be of limited benefit to their stock recovery if longlines are allowed to be fished for other species (i.e. tuna) in areas inhabited by the target species since a substantial proportion of these fish continue to be caught and lost.

South Carolina's total ex-vessel value of surface (pelagic) longline landings peaked in 1983 at $3.1 million and was $1.3 million in 1996. Since the 1980's, both the nominal and deflated total ex-vessel value of surface longline landings has declined while the pelagic (non-swordfish) poundage and value contribution has increased. It is estimated that 70% or more of the swordfish landed in SC are shipped out-of-state.

In 1996, pelagic longline operations represented about 26% of South Carolina's marine finfish ex-vessel value, with nearly 300 thousand pounds of swordfish landed, with a total ex-vessel value of $1 million. Of the 120 fishermen (crews and captains) associated with the 40 longline vessels that landed swordfish in this State in 1996, 8 % (10 fishermen) worked on vessels based in South Carolina. The total direct employment associated with the pelagic longline fishery in SC, primary wholesalers (estimated at 15 individuals)and pelagic longline vessels based in the State, did not exceed 30 people during 1996.

There are several types of recreational saltwater fishing trips originating from South Carolina involving anglers targeting highly pelagic species, including charter boat trips, private boat trips and tournament fishing trips. The economic impact of these trips is assumed to be a significant source of sales and employment in the coastal area but little information is available. Based on charter boat logbook data, an estimated 3,258 charter-angler trips targeting pelagic species were made in 1996 with an economic impact of approximately $1.2 million. Preliminary economic impact analysis of South Carolina billfish tournaments indicate that an estimated 10,800 person-trips generated an estimated $3.73 million during 1996.

Management Responsibilities:

The authority to manage all Atlantic tunas was given to the International Commission for the Conservation of Atlantic Tunas (ICCAT) through the Atlantic Tunas Convention Act of 1969. The United States Congress, as part of the 1976 Magnuson Fisheries Conservation and Management Act, established the Regional Fisheries Management Councils and gave these regional management councils authority for highly migratory species other than tunas. However, as part of the 1990 re-authorization of this Act, Congress transferred management authority of those highly migratory species for which fisheries management plans existed to the Secretary of Commerce and mandated that the Secretary could not establish quotas for these species that were lower than those recommended by ICCAT. Since Congress did not include dolphin in the list of highly migratory species for which management authority was transferred to the Secretary of Commerce, management authority for this species currently rests with the Fisheries Management Councils. The South Atlantic Fishery Management Council is in the process of developing a fisheries management plan for dolphin and wahoo and has requested the Secretary of Commerce to designate them as the lead Council for this plan. South Carolina's DNR is represented on the South Atlantic Fisheries Management council and is participating in the development of this plan.

In October, 1996 the Magnuson-Stevens Fishery Conservation and Management Act was passed which changed many aspects to the original Magnuson Fishery Conservation and Management Act of 1976. One provision of this Act directs NMFS to complete by January 1,1998 a comprehensive study on the feasibility of implementing a comprehensive management system for pelagic longline fishing vessels. Based on this study and working in cooperation with ICCAT and a newly created longline fishery advisory panel, the Secretary of Commerce may implement a comprehensive management system for pelagic longline vessels that participate in fisheries for Atlantic highly migratory species.

South Carolina DNR representatives are participating in this process by serving on the Longline Advisory Panel to the NMFS. Each states's DNR has an important role to play in national and international fisheries management. The National Marine Fisheries Service and U.S. representatives of ICCAT are accountable to their constituents and the various users and beneficiaries of the resource just as this State's DNR is to it's citizens. However, whereas the jurisdiction and authority to manage highly migratory species is clearly at a federal and international level, the citizens of this and other coastal states look to their respective DNR agencies to provide for the well-being of all natural resources.

Enforcement Responsibilities:

The longline fishery off the coast of South Carolina takes place well outside the state's jurisdiction (extending 3 miles off shore), in the Exclusive Economic Zone (EEZ) and in international waters (>200 miles). Enforcement of provisions and mandates of the ICCAT is the responsibility of the member countries and, since landings figures are supplied by the countries themselves, there is very little oversight. In 1996, the first provision for trade sanctions against non-member countries whose fishing practices were deemed to undermine ICCAT's conservation programs was passed. Also passed were similar possible penalties and reductions in quotas for member countries.

Enforcement of fishery laws within the EEZ is the responsibility of the National Marine Fisheries Service's (NMFS), Office of Enforcement, the U.S. Coast Guard, and those state agencies which have an enforcement agreement with NMFS. In 1994, a NMFS enforcement officer was assigned to South Carolina.

The enforcement of state, federal, and international mandates within state waters is the responsibility of the SC Department of Natural Resources' (SCDNR) Law Enforcement Division. SCDNR officers have been involved in nearly all cases involving longliners in South Carolina over the years. Most cases are originated by the SCDNR Marine Patrol with enforcement actions coordinated with the NMFS and the US Coast Guard.

Commercial Concerns

The overriding sentiment expressed by a local longline fisherman, when interviewed by SCDNR staff, was that he felt "ganged-up on" by politicians, SCDNR, NMFS, sport fishermen and the sportfishing media. He said this is primarily a result of the recent controversy over the leasing of the commercial dock at the new Charleston Maritime Center. He maintains that longliners are participants in a highly regulated and legal fishery and feels they have been unfairly branded as "crooks" with no concern for the health of the resource.

Throwing dead fish overboard is seen as a wasteful practice that serves no conservation purpose. Longline fishermen indicate that no one in the fishery intentionally targets marlin or fails to release billfish that are on the gear, but they claim it makes more sense to allow retention of at least one or two dead fish for smoking or other personal consumption.

Commercial longline fishermen believe that they have been the leaders in promoting a rebuilding schedule for Atlantic swordfish stocks and have been in the forefront in compliance with the international agreements. They believe too much energy has been expended in dealing with recreational/commercial/consumer conflict resolution, rather than dealing with the science, and accounting for all sources of take of the highly migratory pelagic species throughout their range. In response to U.S. recreational fishery concerns over the incidental take of billfish, longliners point out that the combined commercial and recreational harvest by U. S. fishermen accounts for less than 6% of the total North Atlantic billfish mortality.

Recreational Concerns

The primary issues as seen by the recreational fishing community are by-catch, shifting by longliners to other species such as dolphin (resulting in increased competition for the resource), and fishing space and an overall lack of effective management of oceanic fisheries.

Prior to the 1990's, longline fishing took place far beyond the traditional fishing grounds of offshore recreational anglers. Because of this, there was little contact between the two groups. In 1993 longline sets made during the day in 30 to 100 fathoms were observed and reported by sportfishing boats on a regular basis.

By-catch from the longline fishery, primarily of billfish (*Istiophoridae*), has been a major concern to recreational fishermen since the late 1970's; however, recreational interests now recognize that they are in direct competition with the longline fishermen for yellowfin tuna, dolphin and wahoo which

Assessment and management of dolphinfish in the Caribbean

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Dolphinfish in the Caribbean are fast growing and short-lived, living for about 12 to 18 months in the southern Caribbean and a maximum of 2-3 years in the north of the region. They are believed to be highly migratory, are seasonally abundant, and likely to have a more complex stock structure than the larger oceanic epipelagic species. Most of the information on dolphinfish in the western central Atlantic comes from studies in the waters of the USA and the eastern Caribbean, and there is a general paucity of information particularly for stock-based management of this species. No Caribbean country undertakes regular assessment of dolphinfish, or has put in place any species-specific management program. Yield-per-recruit analyses for this species in the eastern Caribbean suggest that maximisation of Y/R is likely to lead to very low levels of mature stock biomass. A stock recruitment analysis does not show any dependency of recruitment on stock size within the observed stock size range. This suggests that recruitment failure could be sudden at some threshold below the minimum observed stock size.

Given the migratory, shared nature of the dolphinfish resource, a regional approach to assessment and management is required. However, the institutional basis for this approach does not currently exist within the region in a form that is functional. The membership of the International Commission for the Conservation of Atlantic Tunas (ICCAT) does not include any of the small island states where dolphinfish is of primary importance. ICCAT would need to establish a regional presence in order to serve the needs of Caribbean states. The FAO Western Central Atlantic Fishery Commission (WECAFC) does not operate in a mode which would allow it to address this issue. The Association of Caribbean States is too new to address it within the near future. Subregional organizations with fisheries programs, such as the Caribbean Community (CARICOM) and the Organisation of Eastern Caribbean States (OECS), represent only a subset of states. However, given the ratification of UNCLOS and the recent International Agreement on Highly Migratory Stocks and Straddling Stocks, these organisations could take the initiative to establish a regional management program for dolphinfish.

WORKING PAPER PREPARED FOR: Workshop on the Biology and Fishery of Dolphin-fish and Related Species. 20-23 October. 1997. Palma de Mallorca, Spain

PRESENT STATUS: Under Review with Scientia Marina
Presented at SAFMC Workshop on Dolphin/Wahoo, 6-8 May, 1998, Charleston, SC, USA

INTRODUCTION

Despite its importance, very little effort has been expended by the countries in the western central Atlantic on dolphinfish assessment. The most comprehensive work was carried out as a graduate thesis at the University of the West Indies (Oxenford 1985). In this paper we will review, and in places, expand slightly upon, the efforts that have been made at assessment of dolphinfish. We also present a brief discussion of the need for a regional cooperative approach to dolphinfish management, based to a large extent upon Mahon (1997).

ASSESSMENT

Several studies within the Caribbean have provided information relevant to dolphinfish assessment and management (e.g. Oxenford 1985, Murray 1985, Mahon 1990, Perez and Sadovy 1991, Rivera Betancourt 1994), and a preliminary assessment was undertaken for dolphinfish in Barbados by Oxenford (1985). The results of these studies are summarised and/or used below. There is ongoing work aimed at assessing the status of dolphinfish by the CARICOM Fisheries Resource Assessment and Management Program (CFRAMP) Resource Assessment Unit in St. Vincent and the Grenadines (Dr. S. Singh-Renton, *pers com.*). Participating CARICOM countries are being assisted with the collection of catch and effort data. CFRAMP is also collecting length data for dolphinfish in selected southeastern Caribbean countries. Another CFRAMP initiative is the promotion of tagging of dolphinfish and other large pelagics by recreational fishers, and some tagging from research vessels as well. The results of these studies will become available over the next 2-4 years.

Indices of abundance

Some time-series of catch rates for dolphinfish in the western central Atlantic are presented in Figure 1. They are all characterised by marked interannual variability. The increasing trend in the Barbados fishery is due to increased fishing power in the vessels (see below). There is no apparent trend in the other time-series, except for that from Venezuela for which the declining trend over the entire period is not significant ($r = -0.364$, $p = 0.105$). However, from 1967 the decline in cpue is statistically significant ($r = -0.621$, $p = 0.013$).

The lack of ancillary information needed to apportion effort within trips among types of fishing is a serious impediment to the use of artisanal catch rates as indices of abundance of a particular species. This is because artisanal fishers often target a variety of pelagic and/or demersal species within a single trip (Mahon this volume). These catch rate data, even when available, can only provide rough estimates of seasonality and interannual variability in availability or abundance. Therefore, there are few useful time-series of fishing capacity, or of effort expended in fishing, for large pelagic fishes by domestic artisanal or small-scale fleets in the WECAFC Region.

Similarly, the fact that most medium- to large-scale commercial operations in the western central Atlantic are also targeting other species (usually large pelagics) means that the catch rates of dolphinfish from those fisheries, even if available, might also not be good indicators of abundance.

Recreational catch rates may be the best indicators of abundance. However, owing to the strong seasonal nature of dolphinfish availability, and the variability of the season (e.g., Figure

2), catch rates from tournaments will inevitably be biased according to the point in the season at which the tournament took place. Annual tournaments usually take place at about the same time each year. Furthermore, tournament data only show catch of allowable size fish (i.e. above the minimum size set by the tournament), such that the catch of small size fish goes unrecorded. Therefore, recreational catch rates from private sportfishers or from charter boats that fish throughout the season will probably provide better indices of abundance (Figure 1). However, we know of nowhere in the Caribbean where recreational vessels are required to maintain logbooks or report catches.

The time-series from the Barbados fishery is based upon 'day boats' (boats making one-day trips) operating out of Oistins, a fishing community on the south coast of the island (Oxenford 1985, Mahon *et al.* 1990, Collins and Mahon 1990). Dolphinfish are a preferred species for these vessels and comprised more than 30% of their landings in the 1980s. This is the longest available time-series in the Caribbean for a relatively large fleet of vessels that is targeting dolphinfish. Owing to its potential value for evaluating trends in abundance, and as input for a stock recruitment analysis, the characteristics of this time-series have been further examined.

Due to the fact that the dolphin season may shift by a few months from one year to the next (Figure 2), the effect of seasonality must be considered in deciding upon the best time period to use for the cpue time-series. In the eastern Caribbean the dolphinfish fishing year is best taken from September to the following August. Thus, annual cpue values are estimated for fishing seasons rather than calendar years (Figure 3). Several different estimates of annual cpue calculated from the monthly catch and effort data collected and compiled by the Fisheries Division are shown in Figure 4. The similar pattern shown by these time-series increases our confidence in the pattern shown by this time-series. The two series that appear to be most similar are: (1) the one based on the sum of the catch for the entire season (September to the following August) divided by the sum of effort for the entire season and (2) the one calculated in a similar way for the peak five months.

In view of the increasing trend in cpue for the Oistins fleet (Figure 4), Oxenford (1985) evaluated the effects of various vessel characteristics on cpue. She found that cpue was positively correlated with vessel size and duration of a fishing trip. She also found that there was a significant trend of increasing average vessel size between 1962 and 1984. This was considered to be the reason for the increasing trend in cpue. However, even after the cpue time-series was detrended using the observed relationship between vessel size and catch/trip, there remained a significant increasing trend in catch/trip. This is probably due to multplicative effects between vessel size and other vessel characteristics such as horsepower that could not be taken into account in the model. Therefore, in this paper we detrend the time-series by fitting a second order polynomial to the time-series based on a weighted mean cpue for September to August (Figure 4), and adding the series mean value to the residuals around this fitted line. The detrended series is shown in Figure 5. The cpue of dolphinfish from Barbados shows a high degree of interannual variability. The coefficient of variation for the detrended series is 27%.

Mortality

Although several studies have estimated growth for dolphinfish in the Caribbean (Oxenford this volume), only two report on mortality; both in the eastern Caribbean. Oxenford (1985) used the size composition of the commercial catch in Barbados and size-at-age estimates from daily growth rings in otoliths to construct a catch curve. The estimate of total instantaneous mortality (Z) from the catch curve was 3.9. Other methods provided similar estimates of Z (Oxenford 1985). Murray (1985) estimated Z as 3.53 from a length converted catch curve for dolphinfish sampled in St. Lucia. This value is similar to the estimate by Oxenford (1985).

Both Oxenford (1985) and Murray (1985) estimated M using Pauly's (1984) equation. As input, Oxenford (1985) used a mean water temperature T = 28°C and von Bertalanffy parameters L_∞ = 155.9 cm TL, and annual K = 3.49, to obtain M = 2.56. Murray's input was T = 27.5°C, L_∞ = 236.1 cm TL, K = 0.5322, from which he estimated M = 0.66. Given that Oxenford's growth parameters are estimated from otolith growth rings and that her estimate of L_∞ is consistent with observed maximum sizes of dolphinfish, her estimate of M is considered to be the most realistic.

Yield per-recruit

A yield per recruit (Y/R) analysis was carried out for dolphinfish in the eastern Caribbean, in order to determine the feasibility of optimising Y/R as a management objective. Owing to the uncertainties in the input parameters, in particular natural mortality, the analysis should be viewed as exploratory. However, even with the uncertainties, the analysis clearly indicates that Y/R is unlikely to be useful as a tool for providing advice to fishery managers.

Oxenford's (1985) von Bertalanffy growth parameters (L = 120.8 cm SL, K = 3.49, t_o = 0.055) were used to predict lengths for ages 1-12 months. Corresponding weights-at-age were estimated using the weight-standard length relationship provided by Oxenford (1985) for males and females combined: $W = 0.914^{3.08}$. Monthly M = 0.21 was used as input.

Two Y/R analyses were carried out by Oxenford (1985) using the method of Thompson and Bell as described by Rivard (1982): one with knife-edge recruitment occurring at age two months; the second with knife-edge recruitment occurring at age four months. Recruitment at age four months was chosen since this is the age at which dolphinfish currently become available to the fisheries in the eastern Caribbean. Recruitment at age two months was also considered since they reach marketable size at this age, and could be taken if the fleet travelled further afield to seek them out at that stage of their migratory route.

The inputs to, and results of the analyses are shown in Table 1, and Figures 6 and 7. Figure 6 shows Y/R values at different fishing mortalities (F) for recruitment at ages two and four months. The figure indicates that with recruitment at age two months, Y/R is maximized at an annual F of 3.17, whereas with recruitment at age four months it is maximized at an annual F of 8.08. Figure 7 shows the distribution of biomass-at-age for an unfished cohort, and for F_{max} and $F_{0.1}$ in each recruitment option. The age of 50% maturity is taken as 5 months based on maturity/length ogives presented by Oxenford (1985) and Perez and Sadovy (1991). The figure shows that mature biomass in an unfished cohort peaks at age six months.

In Table 1, mature biomass is taken as the sum of biomass for age groups five months and older. The sum of biomass is used because dolphinfish are multiple spawners and probably continue to spawn from the age of maturity until they die.

With recruitment at age two months, fishing at F_{max} would result in the reduction of mature biomass down to 24% of its unfished value (Table 1). With recruitment at age four months, the situation is worse when fishing at F_{max} with virtually all of the fish being caught by age seven months. Thus Y/R optimisation would lead to removal of most fish within two months of maturing. In this situation, the average mature biomass of a cohort would be about 16% of that for an unfished cohort. Such reductions in mature biomass are likely to be detrimental to recruitment (Mace 1994), but the potential effects haven not been quantified.

Using $F_{0.1}$ as a target fishing mortality the average mature biomass of a cohort would be 38% and 37% respectively, with recruitment at ages two and four months. These values are just below the recommended minimum mature stock biomass of 40% for situations where the stock recuitment relationship is not well known (Caddy and Mahon 1995).

Table 1. Comparison of cohort biomass estimates for dolphinfish (based on an initial cohort size of 100 fish) when unfished, and when fished at F0.1 and Fmax for two recruitment options.

Age (months)	Standard length (mm)	Weight (kg)	Unfished number of individuals	Cohort biomass-at-age (kg)				
				Unfished	Recruitment at age/target F			
					2 months/ F_{max}	4 months/ F_{max}	2 months/ F0.1	4 months/ F0.1
0	0	0	100	0	0	0	0	0
1	148	0.03	81	2	2	2	2	2
2	429	0.79	66	52	52	52	52	52
3	620	2.46	53	131	101	131	131	111
4	757	4.55	43	196	116	196	196	139
5	857	6.67	35	233	106	119	174	139
6	931	8.59	28	244	85	63	135	121
7	985	10.24	23	235	63	31	97	98
8	1026	11.58	19	216	44	15	67	75
9	1056	12.66	15	191	30	7	44	56
10	1078	13.51	12	165	20	3	28	41
11	1095	14.16	10	141	13	1	18	29
12	1107	14.66	8	118	8	1	11	20
Mature biomass				1544	369	240	575	579
Percent of unfished mature biomass					24%	16%	38%	37%

The conclusion from these exploratory analyses is that maximisation of Y/R is unlikely to be an appropriate management objective for dolphinfish in the eastern Caribbean. Management strategies which use Y/R as a management criterion, even through the most conservative approach used in this study (recruitment at age 2 months, $F_{0.1}$), will permit the reduction of mature biomass to levels that may result in recruitment failure, or in undesirable interannual abundance fluctuations.

Production modeling

The Caribbean Fishery Management Council (CFMC 1983) attempted to fit a surplus production model to catch and effort data for dolphinfish around Puerto Rico. They were unable to estimate MSY because cpue increased with increasing effort, suggesting that MSY was large relative to current yield. A similar problem was encountered by Oxenford (1985) when attempting to use her detrended cpue time-series as input to a production model. Furthermore, for the model to be useful it should include total catch for the entire stock.

For an annual species, there will be minimal difference between the MSY estimates from a surplus production model and that from a stock-recruitment model. Only growth variation, both due to environment and density-dependence, will cause the variation. Therefore, a stock recruitment approach may be the most appropriate for dolphinfish in the southeastern Caribbean, where they are estimated to live for only one year (Oxenford 1985).

Stock-recruitment relationships

For an annual species, catch per unit effort in a given year can be used as an index of stock for that year and as an index of recruitment from the previous year's stock. This approach was adopted by Oxenford (1985) who fitted Ricker and Beverton-Holt stock recruitment curves to the cpue time series (1962-1984) from Barbados. Neither model provided an adequate fit.

Using an additional five years of data fully detrended (Figure 5), and a Shepherd stock-recruitment curve, we re-examined the relationship between stock and recruitment for the Barbados dolphinfish. The plot of recruitment versus stock does not indicate any variation in recruitment over the range of stock sizes observed (Figure 8). This suggests that survival is strongly dependent upon density at some stage during the early (pre-recruitment) life-history. The curve, based on Shepherd's (1982) equation was fitted by eye using an iterative process that minimised the sum of squared residuals, while maintaining a fit that appeared to be reasonable. Shepherd's equation is $R = aS/[1+(S/K)^{\beta}]$, where R is recruitment, S is stock and a, K and β are constants. For the curve shown in Figure 8, $a = 8$, $K = 5.2$ and $\beta = 4.18$. Given the nature of the data, the curve is little more than a reasonable guess at the relationship. It does suggest, however, that reduced levels of recruitment might be observed below an average stock size that is about one-third of the current average.

Environmental effects on abundance and recruitment

The high degree of interannual variability in dolphinfish cpue may be due to the effects of environmental factors on availability or abundance. Oxenford (1985) looked for a correlation between cpue (1962-1984) and the discharge of the Amazon and Orinoco Rivers, which influence the southeastern Caribbean, but found no significant relationships. Mahon (1990) carried this analysis further, using a longer time-series (1962-1989) and other environmental variables, in addition to river outflow. He found significant correlations between various climatic indices and the timing of the dolphinfish season, and between dolphinfish recruitment and the Southern Oscillation Index. Most of these correlations were weak. Since they were based on atmospheric climatic variables rather than oceanic environmental variables, they were interpreted as indicating only that a more thorough examination of the effects of ocean climate on dolphinfish may be worth pursuing.

IMPLICATIONS OF ASSESSMENT FOR MANAGEMENT

The analyses presented here are based on limited data. However, they represent the best data currently available for dolphinfish, and as such can provide some indications of the likely response of dolphinfish to exploitation.

The biological characteristics of dolphinfish in the eastern Caribbean suggest that with continuation of the current trends in development of the fisheries, there could be a relatively high risk of stock depletion.

The fact that dolphinfish are frequently caught from schools aggregated under drifting objects with other large pelagics (Gomes *et al.* in press), suggests that fishing for them may remain feasible even at very low stock abundance. Thus they would be without the protective mechanism provided by a bioeconomic equilibrium.

Dolphinfish reach a marketable size long before the age of full maturity. Therefore, any shift in the fishery towards smaller fish could result in recruitment overfishing. Thus, a minimum size limit may be appropriate. This approach has already been taken for state waters of Florida and North Carolina in the USA. An alternative would be to limit fishing in areas and times where small fishes are abundant. However, the distribution of dolphinfish at various stages in its life-history is not sufficiently well known for this approach to be implemented.

Dolphinfish exhibit relatively high interannual variability in abundance. There is also a lack of information regarding the relationship between stock and recruitment at low levels of stock abundance, and a lack of information regarding environmental effects on dolphinfish recruitment. These suggest that reducing dolphinfish abundance could result in increased variability in recruitment, and could increase the risk that there may be several consecutive years of low abundance.

Mahon (1996, 1997) reports steadily increasing trends in pelagic fishing fleets and landings. He also notes the lack of reporting by many countries that most likely catch considerable quantities of dolphinfish, in particular recreational fisheries and bycatch in large-scale commercial fisheries.

Limited knowledge on landings, the lack of good indices of abundance, and the biological characteristics of the dolphinfish warrant a precautionary approach to setting any management targets (Caddy and Mahon 1995). Mace (1994) has suggested that in the absence of a known stock-recruitment relationship, a spawning stock biomass (SSB) that is 40% of the unfished SSB should be a threshold. A similar precautionary threshold could be considered for dolphinfish in the eastern Caribbean.

INSTITUTIONAL ARRANGEMENTS FOR MANAGEMENT

The management unit

Stock structure of dolphinfish in the western central Atlantic is has not been defined. However, it appears that there may be two or more stocks in the area (Oxenford and Hunte 1986). Given the seasonal, migratory nature of dolphinfish, and the large number of states within the region, it is clear that the resource will be shared among several countries (Mahon 1987) (Figure 9). Therefore, successful management of the resource will require cooperation, as defined by the United Nations Convention on the Law of the Sea (UNCLOS), and elaborated in the International Agreement on Straddling Stocks and Highly Migratory Stocks (United Nations 1995). Until the stock structure of dolphinfish in the western central Atlantic has been resolved, there should be a region-wide approach to management.

Current management

Management of fishery resources in the Caribbean region is currently carried out at the national level, by national fisheries departments. There is minimal cooperation in the management of shared resources (Chakalall *et al.* in press). The most notable is a recent effort to establish a Conch Assessment and Management Working Group for the Caribbean.

There are several regional and subregional organisations with an interest in fisheries development and management in the Caribbean region (Figure 10). However, existing institutional mechanisms are not adequate for the management of shared stocks (Mahon 1996). There is the need to strengthen one or more of the existing institutions to undertake this role, not only for dolphinfish, but for all shared, straddling and highly migratory resources.

The International Commission for the Conservation of Atlantic Tunas (ICCAT), has the mandate to manage tunas and tuna-like resources in the Atlantic. Although not specifically mentioned in the list of species in the basic texts (ICCAT 1985), dolphinfish would come under the heading of 'associated species'. Few Caribbean countries, however, are active participants in ICCAT, and there is a need for an institution that will focus on assessment and management of shared resources in the western Atlantic, some of which are not large pelagics (Mahon 1996)

Of existing regional institutions, only the Association of Caribbean States (ACS) and the Western Central Atlantic Fishery Commission (WECAFC) have the breadth of membership that would be required for a wide ranging species such as dolphinfish. The ACS is relatively new, and its role in matters such as living resource management is yet to be defined. WECAFC has been in operation since 1976, but has hitherto served only as a forum for exchange of technical information, and has suffered from a lack of commitment on the part of its member countries. Nonetheless, it is the most likely candidate for a strengthened role in assessment and management of shared, straddling and highly migratory fishery resources in the western central Atlantic.

Even if strengthened, WECAFC would probably not be able to function, in the near future, in the same mode as ICCAT regarding setting regulations which were binding to participating countries. The most likely mode of operation would be the provision of advice to regional and subregional political groupings, such as the Standing Committee of Ministers of Agriculture (SCMA) of the Caribbean Community (CARICOM)(Mahon 1997).

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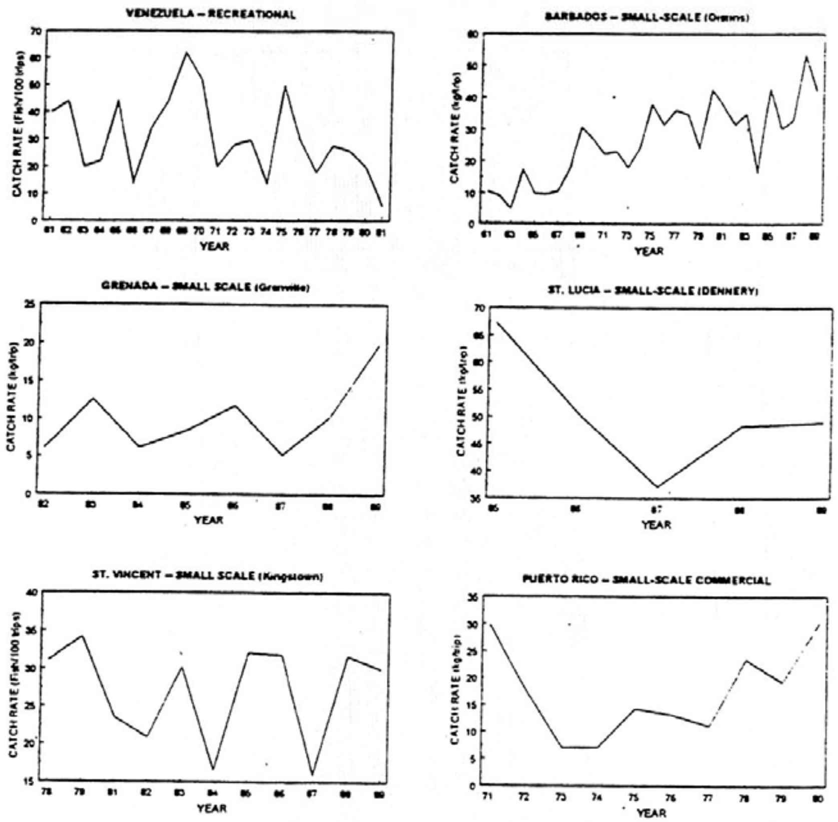

Figure 1. Some catch rate time-series for dolphinfish in the western Atlantic (Venezuela -- Machado and Jaen, 1983; Barbados -- this study; Grenada, St. Lucia, St. Vincent – Mahon *et al.* 1990; Puerto Rico -- CFMC 1983)

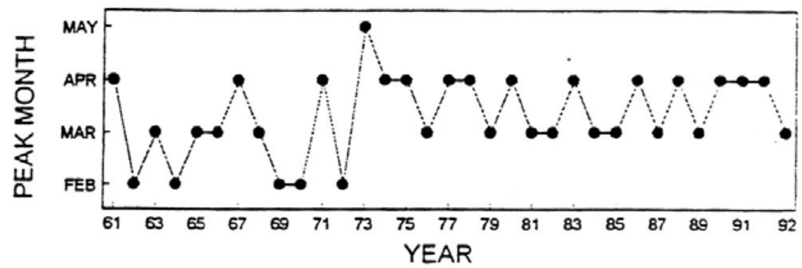

Figure 2. The months in which peak dolphinfish catch occurred in Barbados

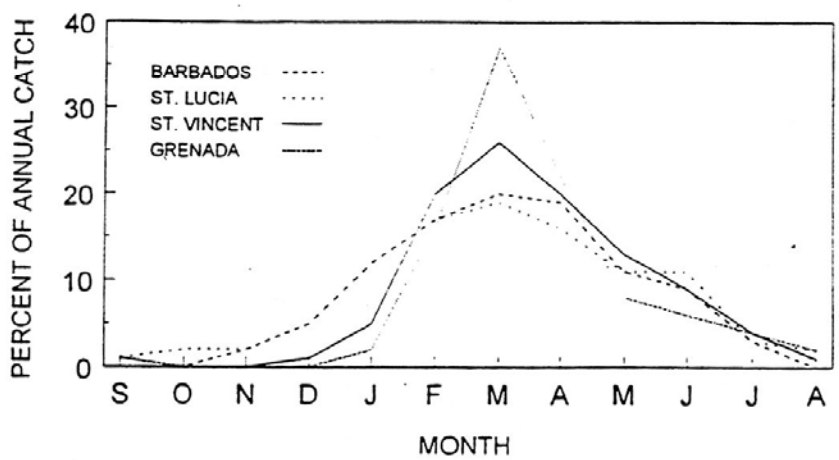

Figure 3. The dolphinfish season in four southeastern Caribbean countries, from Mahon *et al.* (1990) (Barbados, 1962-1989; St. Lucia, 1984-1989; St. Vincent, 1979-1989; Grenada, 1981-1989)

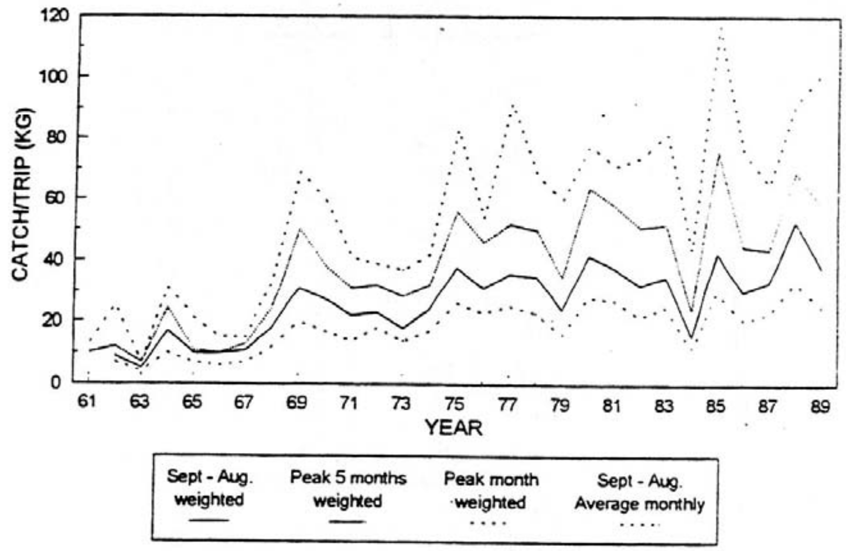

Figure 4. Five catch rate series for dolphin fish based on the same monthly catch and effort data from Barbados.

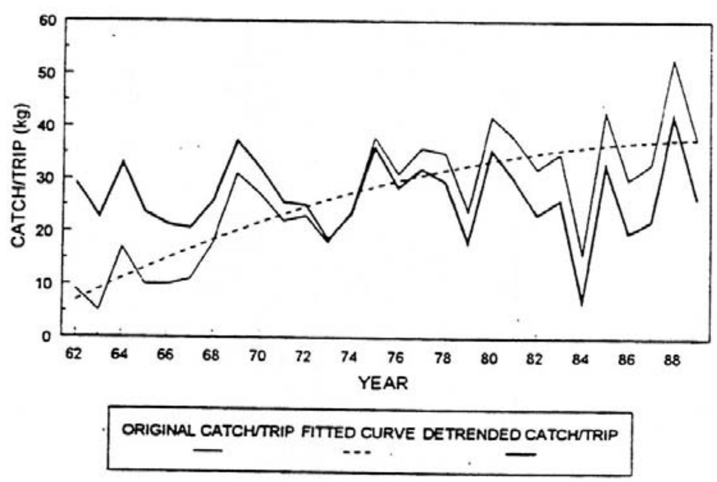

Figure 5. Original catch/trip (kg) for dolphinfish by the Barbados fleet, and the detrended catch/trip estimated as the residuals about the fitted curve.

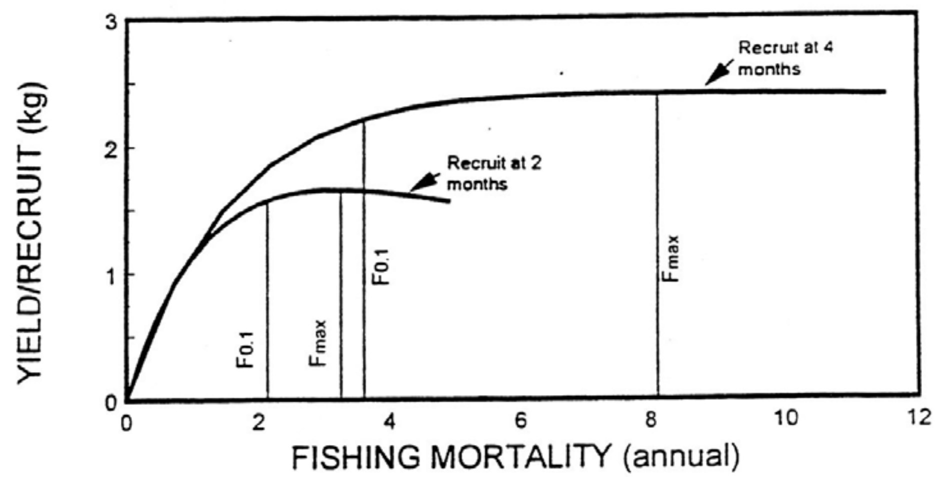

Figure 6. Yield per recruit analyses for dolphinfish using input parameters from the Barbados fishery (Oxenford 1985)

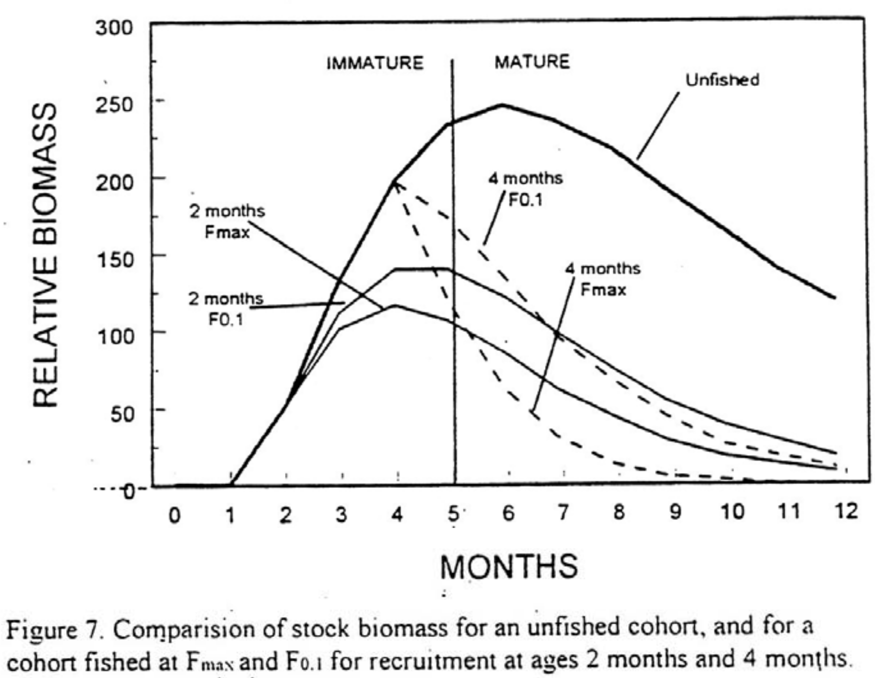

Figure 7. Comparision of stock biomass for an unfished cohort, and for a cohort fished at F_{max} and $F_{0.1}$ for recruitment at ages 2 months and 4 months.

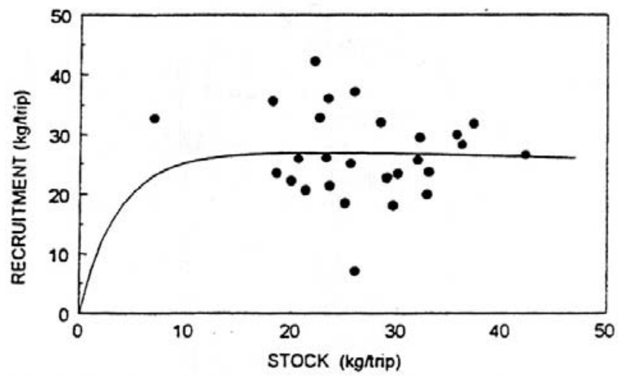

Figure 8. Recruitment versus stock for dolphinfish in the eastern Caribbean, based on a detrended catch rate time-series from Barbados. A Shepherd curve is shown.

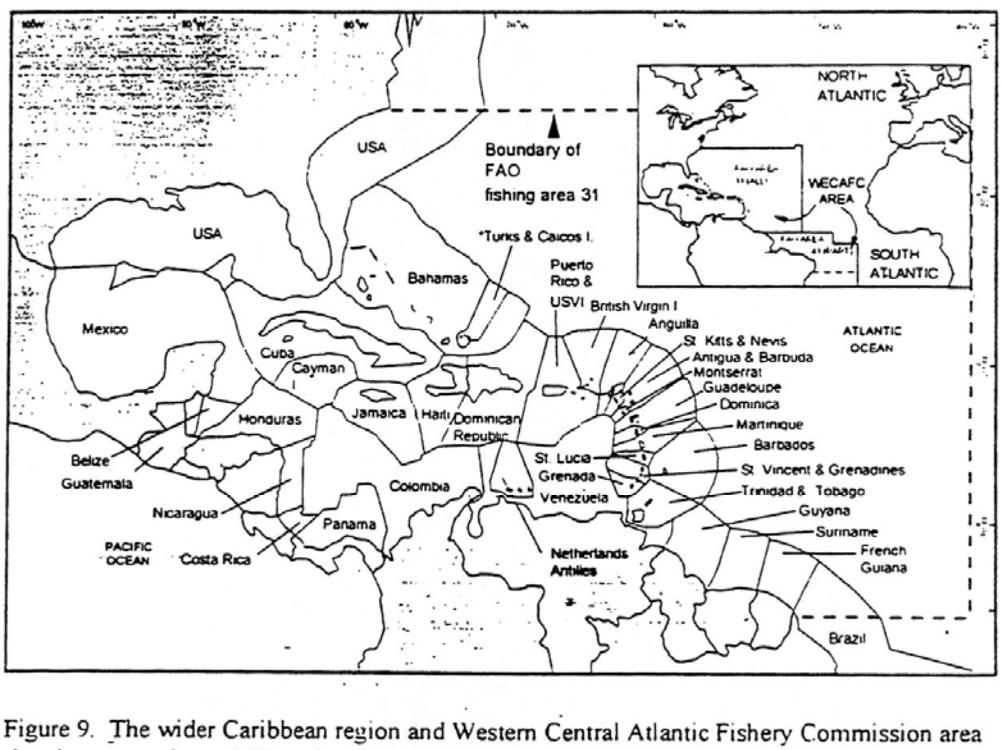

Figure 9. The wider Caribbean region and Western Central Atlantic Fishery Commission area showing approximate EEZs of countries (after Mahon 1996).

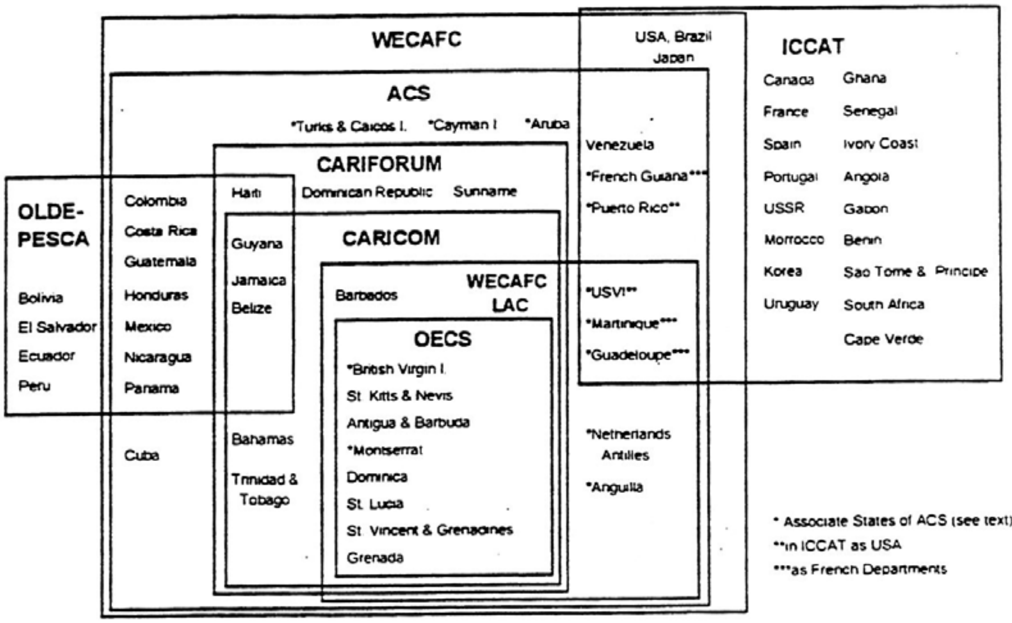

Figure 10. The membership of regional and international organisations with responsibility for fisheries management and development in the wider Caribbean (WECAFC = FAO West Central Atlantic Fishery Commission, ACS = Association of Caribbean States, CARICOM = Caribbean Community and Common Market, OECS = Organisation of Eastern Caribbean States, LAC = Lesser Antilles Committee, OLDEPESCA = Latin American Organization for Fishery DevelopmentICCAT = International Commission for the Conservation of Atlantic Tunas).

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Appendix G. Investigations into the Growth, Maturity, Mortality Rates and Occurrence of the Dolphin (*Coryphaena hippurus*, Linnaeus) in the Gulf of Mexico

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Investigations into the growth, maturity, mortality rates and occurrence of the dolphin (Coryphaena hippurus, Linnaeus) in the Gulf of Mexico

A dissertation presented in partial fulfilment of the requirements for the degree of Magister in Scientia in Fisheries Biology and Management at the University of Wales, Bangor

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INTRODUCTION

Taxonomy

Dolphin-fish can be divided into two separate species, Coryphaena hippurus, (Linnaeus 1758), the common dolphin and Coryphaena equiselis, (Linnaeus 1758), the pompano dolphin. According to the Committee on Names of Fishes of the American Fisheries Society the official names of the two species are dolphin (Coryphaena hippurus) and pompano dolphin (Coryphaena equiselis) but to avoid confusion the family Coryphaenidae will be called dolphin-fish with C. hippurus the dolphin and C. equiselis the pompano dolphin. The family Coryphaenidae is monogeneric and its affinities within the percoid fishes is still unclear (Palko et al, 1982).

Distribution

Dolphin-fish are primarily oceanic fishes with some representatives of the dolphin found occasionally in harbors and estuaries. They are predominantly found below the 41 N latitude lines (Tibbo 1962) and are generally restricted to the 18 C isotherm (Gibbs and Collette 1959). The latitude of the Gulf of Mexico falls well below the northerly limits. The most northern point in the gulf occurs at the Mississippi coast, approximately 30.5 N latitude.

Dolphin-fish adults are generally year-round residents of the tropics, however, pronounced seasonal variation in abundance and distribution are evident in most areas primarily due to changes in water temperature or migrational patterns

(Wheeler and Ommanney 1953; Mather and Day 1954; Kojima 1955; Erdman 1956; Williams and Newell 1957; Springer and Pirson 1958; Gibbs and Collette 1959; Kojima 1960; Galea 1961; Beardsley 1964; Rose and Hassler 1969; Wang 1979). The occurrence of dolphin-fish in the Gulf of Mexico has been documented. In the gulf, dolphin are caught almost exclusively during the summer months and catches show very sharp peaks during August (Springer and Pirson 1958). These peaks, however, may indicate migrations where fish are present in large numbers for short periods of time while they pass through a given area (Palko et al, 1982).

Larvae of both species occur in the tropical regions of all the oceans (Clemens 1957; Gibbs and Collette 1959; Kojima 1964; Jensen 1967; Shcherbachev 1973). Larvae and young dolphin-fish appear to be abundant globally at most times of the year (Meek and Hidebrand 1925; Anderson and Gehringer 1957; Pew 1957; Springer and Pirson 1958; Gibbs and Collette 1959; Potthoff 1971; Shcherbachev 1973; Fahay 1975; Takehashi and Mori 1975). Pew (1957) reported captures of juvenile dolphin in sizes from 32 to 73 mm TL off Rockport, Texas during the summer of 1954-56 while Springer and Pirson (1958) collected juveniles in sargassum off Port Aransas, Texas in July. Gibbs and Collette (1959) found young dolphin were not as easily obtained from the Gulf of Mexico as either adults or juveniles of pompano dolphin. Kelley et al. (1983) found few dolphin larvae (<.65 mm SL) were captured in bongo tows and more were caught in neuston nets, indicating their predominant occurrence at the sea surface. The larvae are distributed in the northern Gulf of Mexico shelf waters and above all deep water where Kelley et al sampled in 1983. Most dolphin larvae were captured in May and June, but a few captures were in September and October. Only a few pompano dolphin larvae (< 35 mm SL) were caught in 1983 in bongo and neuston net tows in the northern Gulf of Mexico, both over shallow shelf and deep oceanic waters. Almost all pompano dolphin larvae were caught in April, May and June (Kelley et al 1983).

Stocks Within the Population

In the Pacific, Kojima (1966) stated that due to the reverse tendencies of migration patterns of the Northern and Southern Hemisphere dolphin populations, there were apparently two stocks of dolphin separated by the equator. Oxenford and Hunte (1983, 1986a, 1986b) examined the populations of *C. hippurus* of the western Atlantic Ocean and proposed two distinct populations, one in the Atlantic coast of the United States (the northern population) and the other in the Caribbean (the southern population) each with very distinct life histories. These differences in life histories could theoretically be environmental. However, a single-stock hypothesis was not supported by the results of the electrophoretic survey of Oxenford and Hunte (1986a). Genetic similarities between populations may be coincidental, but differences strongly suggest population segregation. They found significant differences at the IDH-2 locus in heart extracts and at the IDH-2,3 loci in liver extracts. This is inconsistent with the assertion that there is a single dolphin stock.

Sexuality

Dolphin-fish are heterosexual. Sexual dimorphism is expressed as a steepening of the forehead in male dolphin compared to a more gentle streamlining in females and pompano dolphin. The sexual dimorphism becomes notable between 35 and 40 cm FL (Beardsley 1964; Shcherbachev 1973).

Maturity

Maturity in dolphin-fish is complete within the first year of life (Beardsley 1964; Shcherbachev 1973). Beardsley (1967) found female dolphin, in the Straits of Florida, begin to mature at about 35 cm FL and at 55 cm FL 100% were mature. The smallest male with milt present in the testes was 42.7 cm FL and Beardsley inferred that female dolphin began to mature at a slightly smaller size than males. Williams and Newell (1957) stated that dolphin reached maturity at < 53.3 cm FL in East African waters. Dolphin-fish have extended spawning seasons and multiple spawning is common among both males and females (Fahay 1975). Oxenford and Hunte (1986a) determined that the male C. hippurus of the northern stock begin to mature at 39.3 cm FL and at 32.4 cm FL for females. This corresponds to an age of 6-7 months. Males of the southern stock begin to mature at 73.5 cm FL and females at 61 cm FL, corresponding to an age of 4 months.

Longevity and Mortality

Dolphin-fish are highly cannibalistic and also serve as prey to a wide range of ocean predators at all stages of their life histories. They form close-knit schools and are easily caught by both commercial and sport fishing gear. These characteristics are not conducive to longevity (Palko et al 1982).

Based on age and growth studies by Beardsley (1967) and Rose and Hassler (1968), dolphin, on the Atlantic side of the United States, have a very high mortality and the maximum life span is probably around 4 yrs. Observations of specimens in artificial enclosures also indicated that the life span may be < 5 years (Hinton 1962). But Oxenford and Hunte (1983, and personal communication 1988) found that the populations off the coast of Barbados (southern population) lived to be little over 1 year old and 100%, of sampled fish, were less than two years old. Rose and Hassler (1968) found 96% of the Northern population caught of N. Carolina to be less than 2 years old and Beardsley (1967) found 98% caught off of the Atlantic coast of Florida (northern population) to be less than 2 years old.

Food

Dolphin-fish are top level carnivores capable of preying upon fast moving fishes. It is well known for its associations with floating objects and in the Atlantic they take much of their food from fishes and crustaceans associated with sargassum windows (Gibbs and Collette 1959; Beardsley 1964). Dolphin-fish do not appear to be very selective in prey capture (Ronquillo 1953; Gibbs and Collette 1959). Their diet alters in the course of growth from predominantely crustaceans as juveniles (Shchercachev 1975), to an adult diet of fishes of the families

Exocetidae, Scombridae, Carangidae, Monocanthidae, Balistidae and other Coryphaenidae to invertebrates such as crabs, shrimp and cephalopods (Gibbs and Collette 1959; Rose 1966; Shcherbachev 1973; Rose and Hassler 1974).

Age and Growth

Age and growth of fishes is very important in determining other life history parameters. The age of fishes tells their longevity, age at maturity, and age when they are recruited to the fishery. Carefully determined fish age data is essential for the calculation of growth (Summerfelt 1987).

Age studies have been carried out on many different parts of fishes. Scales (Beardsley 1967; Beamish and Chilton, 1977; Han-Lin Lai and Shea-Ya Yeh, 1983), otoliths (Pannella, 1980; Radtke and Dean, 1981; Han-Lin Lai and Shea-Ya Yeh, 1983; Oxenford and Hunte 1983; Essig and Cole, 1986 Uchiyama et al 1986), fin-rays, dorsal and pectoral (Beamish and Chilton, 1977; Beamish, 1981; Han-Lin Lai and Shea-Ya Yeh, 1983) and vertebrae (Sharp and Bernard 1988) have all been examined in the past as possible sources to determine the age of fish.

The interpretation of age and growth from any bony structure of fish is based on the assumption that periodic features are formed at a constant frequency, and that the distance between consecutive features such as scale circuli or annuli is proportional to fish growth. But the findings of Blacker (1974) indicated that both age and genetic factors may influence the rate of production of structures commonly referred to as annuli. In addition, environmental variables such as

1985).

The influence of photoperiod on increment formation has been documented although the results are seemingly contradictory (Taubert and Coble 1977; Takana et al. 1981; Radtke and Dean 1982). However, disruption of daily increment production through an abnormal photoperiod has never resulted in a 1:1 correspondence between increment formation and the light cycle (Taubert and Coble 1977, Campana and Neilson 1982, Geffen 1982).

Temperature is another environmental variable that may influence the production of growth increments. There is no evidence that daily increment formation is inhibited under constant temperature conditions high enough to promote growth (Taubert and Coble 1977; Campana and Neilson 1982, Neilson and Geen 1982 and 1984; Radtke and Dean 1982; Campana 1984). Nor does increment number vary between temperature levels (Neilson and Geen 1982, Radtke and Dean 1982) except where low temperature has resulted in cessation of fish growth. However, Neilson and Geen (1984) found that a temperature cycle with a 12-hour period resulted in the formation of 2 increments/24 hours. Temperature therefore has the potential to influence the otolith microstructure of fishes in the wild.

The effect of feeding cues on otolith deposition is more equivocal than is the response to temperature. Increment number appears to be unaffected by food deprivation, at least when body energy reserves are sufficient to enable limited skeletal growth to occur (Marshall and Parker 1982, Campana 1983, Neilson and Geen 1984, Volk et al. 1984). Neilson and Geen feeding frequency, photoperiod and temperature may affect both the rate of formation and distance between successive scale annuli (Bilton 1974), thus complicating or invalidating age and growth inferences (Campana and Neilson, 1985).

The relatively new finding by Pannella (1971) and subsequent workers that many teleost fishes deposit otolith growth increments with a 24-hour periodicity appears to offer a method of assessing age and growth with greater accuracy and precision than was previously possible (Campana and Neilson, 1985). It also offers a means of age determination for species or life histories where scale, fin ray and vertebrae banding was not detectable, as in most tropical species such as the dolphin-fish.

Otoliths have been shown to grow bands, rings, lamellae, or growth increments (terminology used here) usually on a 24 hour cycle consisting of incremental and discontinuous zones. When viewed under a light microscope, the incremental zone appears as a broad, translucent band, while the discontinuous zone is relatively narrow and opaque. The incremental growth occurs through differential deposition of calcium carbonate and protein over a 24-hour period (Campana and Neilson, 1985).

Growth increments vary in width from ring to ring and knowledge of the factors that may affect the production of the increments is important since the assumption is that they occur on a daily cycle. Environmental and physiological variables such as photoperiod, temperature, feeding, growth and endogenous circadian rhythm may all fluctuate cyclically and all have the potential to influence otolith deposition (Campana and Neilson, (1982, 1984) found that feeding young chinook salmon (O. tshawytscha) more than once per day produced significantly more increments than did feeding once daily, although increment number was not proportional to feeding frequency. The opposite was also found, that daily increment number was unaffected by multiple daily feedings (Taubert and Coble 1977, Campana 1983).

Despite the number of variables that have been suggested as influencing otolith deposition, a cohesive theory can still be presented that is consistent with much of the published work to date. Campana and Neilson (1985) surmised that daily increment formation was linked to an endocrine-driven, endogenous circadian rhythm. This circadian rhythm is entrained at an early age by photoperiod, but certain environmental variables can "mask" the rhythm. Endocrine secretion displays a circadian periodicity in many animals and through the intermediary of metabolic rate, ultimately controls most physiological processes including skeletal growth (Simpson 1978). Circadian rhythms in general have been documented at several system levels in fishes (Gibson et al. 1978, Eriksson and van Veen 1980, Godin 1981). Since the basic features of endogenous circadian rhythms differ little among taxa, expected features of a piscine rhythm would include free-run capability (continuation of a circadian rhythm in the absence of periodic stimuli) and entrainment to a daily environmental cue (zeitgeber) such as the light-dark cycle or a diel temperature fluctuation (Jacklet 1981, Takahashi and Zatz 1982). The entrainment to a cue with a periodicity differing by more than 2-4 hours from 24h is generally impossible (Campana and Neilson 1985). Further evidence of the appearance of structures similar to daily increments have been observed in Arctic (Townsend and Shaw 1982) Antarctic (Townsend 1980), and deepsea fishes (Rannou and Thiriot-Quievreux 1975). The absence of diel light and/or temperature cues in these environments is consistent with the presence of an endogenous circadian rhythm in the resident fishes (Campana and Neilson 1985). Thus, from all the evidence accumulated, it would still appear that daily increments are formed in most environments and the habitat of dolphin-fish, with the presence of day-night regimes, would strongly support the theory of daily increment growth.

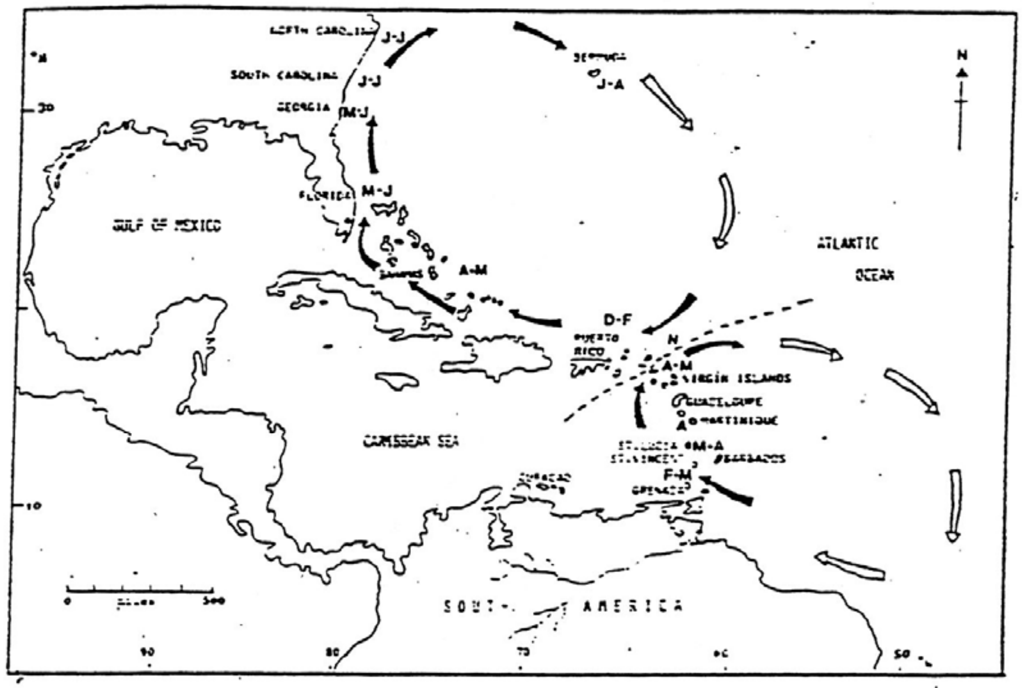
Many studies have been done estimating the growth rates of dolphin-fish. Methods varied from knowing the number of days in captivity and the size increase over the time period (Herald 1961; Hagood et al 1981; Schekter 1981), to estimations by using scale annuli (Beardsley 1967), to progression of size frequency (Wang 1979), to otolith counts (Oxenford and Hunte 1983, otolith banding was assumed to be daily). However, none of these methods have been justified through marking and recapturing fish or through the raising of fish from eggs to known ages and then examining calcified structures for any correlation of banding to known days.

Uchiyama et al (1984) were the first to validate otolith counts in C. hippurus. They conducted experiments with captive C. hippurus and C. equiselis. Eggs were collected, hatched and grown to as large a size as possible in aquaria.

Frequent specimens were sacrificed and their otoliths examined. In this manner the exact number of days since hatching were known and could be correlated to the number of sagittal rings counted. Their findings revealed that the relationship of mean increment counts to known age for C. hippurus (up to 161 days) was Y = -0.5297 + 1.0035X (r=0.999, P<0.01) and for C. equiselis (up to 63 days) Y=-0.6986 + 1.0164X (r=0.997, P,0.01). These results demonstrated that growth increments were formed daily and validated their use for aging wild fish up to 191 days for C. hippurus and 63 days for C. equiselis.

Studies on the population biology of the dolphin Coryphaena hippurus, from the Western Atlantic Ocean have established that there are two distinct populations, a northern and a southern (Fig.1) each with very distinct life histories (Oxenford and Hunte 1986a). By contrast there is a distinct lack of information on the basic population biology of the abundant stocks of dolphin, C. hippurus and pompano dolphin, C. equiselis from the Gulf of Mexico (Baugham 1941; Springer and Bullis 1956; Pew 1957; Springer and Pirson 1958). Therefore the objectives of the project were to determine some of the basic population parameters of the stocks of the two species in the Gulf. The program of work involved the identification of species by meristic and morphometric measurements, age determination, using otolith microbanding and the determination of growth rate, maturity rate, and mortality.

Figure 1. Months of peak catch of the dolphin, Coryphaena hippurus, and proposed migration circuits for northern and southern dolphin stocks in the western central Atlantic. Letter symbols (e.g. A-M) indicate months of peak catch. ➡ indicate proposed migration. ⇨ indicate proposed migration where catch data were not available. (Taken from Oxenford and Hunte, 1986a)



MATERIALS AND METHODS:

Acquisition of Fishes

The dolphin fish were collected in 1988 during the months of June - October from the Gulf of Mexico, in the offshore regions of Alabama, Mississippi, and northwestern Florida. Fishing tournaments (rodeos) were attended and most of the large fish, which are rather rare, were collected from these events. Contact with some of the local fishermen and numerous personal trips on the boats from the Dauphin Island Sea Lab brought in the remainder of the fishes.

The usual method of obtaining information was to first talk with the fisherman who caught the fish and make sure the necessary data could be collected. Since the dolphin-fish makes excellent eating, the whole fish was usually not donated and the data had to be collected as quickly as possible. From each fish, the fork length and standard length were taken to the nearest millimeter. The fish was gutted for the fisherman and the state of the gonads recorded when possible. A scale sample was collected and the head was removed and taken the lab for extraction of otoliths. When time permitted, the dorsal rays and vertebrae were counted.

Species Identification

The two species are very difficult to differentiate at the juvenile stage. Although dolphin larger than 50 cm FL are, for the most part, of the species Coryphaena hippurus, morphological and meristic features were checked on all specimens. The two species can be distinguished in a number of ways: 1) dorsal fin ray count; C. hippurus has 58 - 66 rays (mean of 61.3) whereas C. equiselis has 52 - 59 rays (mean 55.0). 2) number of vertebrae (when possible); C. hippurus has 31 and C. equiselis 33. 3) general shape; C. hippurus has a concave anal fin and the pectoral fin is more than half the length of the head. The tooth patch on the tongue is small and oval and, in the juveniles only, the tips of the caudal fin are white and the pelvic fins are black. C equiselis has a convex anal fin and the pectoral fin is about half the length of the head. The tooth patch on the tongue is broad and square and in the juveniles the entire margin of the caudal fin is white and the pelvic fins are not pigmented (Palko et al 1982).

Gonadal Assessment

Stage of maturity of each fish was determined by examination of the gonads. Beardsley's (1967) gonadal assessment scheme was followed for both ovaries and testes. For ovaries:

I Immature. Ovaries long, thin, hollow tubes: diameter 3-4mm; eggs microscopic; ovary wine-red to pink.

II Early maturing. Ovary slightly enlarged; diameter 10-15mm; eggs visible to the naked eye through the ovary wall, but no distinct size groups distinguishable; pale yellow.

III Late maturing. Ovary much enlarged; at least two distinct size groups of eggs easily visible to the naked eye; bright yellow to orange.

IV Ripe. Ovary distended, half filling the body cavity; lumen full of large, clear eggs which give the ovary a speckled appearance.

V Spent. Ovaries flaccid, hollow tubes; a few remnants of ripe ova may remain in the lumen or folds of the ovary, usually visible by microscopic examination; dull red and discolored, particularly at the posterior end; numerous blood clots.

For testes only two stages were recognized:

I Immature or resting. Testes small, firm to the touch; no milt extruded after cutting and squeezing.

II Mature. Testes enlarged; milt extruded after cutting and squeezing.

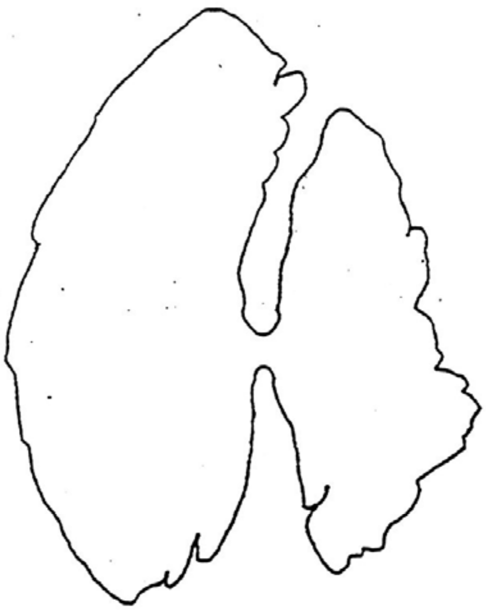
These guidelines were easy to follow and wherever possible the state of maturity of the gonads were determined.

Otolith Preparation and Counts

In extracting the otolith a hack saw was used to make an incision, vertically through the cranium, therefore exposing the brain. Fine tweezers were used to extract the optic lobes and expose the region of the otoliths. The sacculi were removed, containing the sagittal and lapillar otoliths and immersed in water. Great care was taken to remove the sagittal otoliths and clean them (Figure 2).

A variety of techniques were tested for the preparation of the otoliths for counting. Simple cleaning and immersion in epoxy resin (Evercoat shipyard resin) yielded smoky slides that could not be read easily. Next, a staining technique (Bouain and Siau 1988) of 12 - 14 hours submersion in 1% acid fuchsin followed by 1-3 minutes in 5% Amido-Schwartz was tested. These otoliths were mounted in Crazy glue. The last and currently adopted method was to clear the otoliths in glycerine for up to a week, then rinse in water, dry and mount with Crazy glue. This method was conveyed, through a personal communication by Dr. Oxenford (July, 1988). Whole prepared otoliths were viewed under a Wild M20 microscope at 100 and 400 times magnification with

FIGURE 2. Right and left sagittal otoliths from the same <u>*Coryphaena hippurus*</u>.



LEFT SAGITTAL OTOLITH

RIGHT SAGITTAL OTOLITH

transmitted light to count the growth increments of the otoliths.

Linear measurements of all the whole otoliths were also carried out, employing a Wild dissecting microscope with an occular micrometer. Each otolith is shaped like a pair of butterfly wings, the ventral wing always being the larger one (Figure 3). Therefore in the terminology of this thesis, the two components of the otolith will be called henceforth "wings", a ventral "big wing" and a dorsal "small wing" (Right big/small wing, Left big/small wing). The cranial tip of the big wing is called the "rostrum" and the small wing "antirostrum" (see Figure 4 for orientation and terminology of otoliths). Measurements were taken from the rostrum to the most distant posterior point, wherever located, of the big wing (this point varies in location from otolith to otolith) and from the antirostrum to the most distant posterior point of the small wing. Thus, if both sagittal otoliths were intact, four measurements were made for each fish. Figure 5 is a photo of a right sagittal otolith from C. hippurus. The growth increments can be clearly seen originating at the primordium and continuing to the outer edge. In Figure 6, a different right sagittal otolith shows that, although the rings are present throughout the whole otolith, they can be most easily counted from the primordium to the posterior edge of the small wing. Most readings were carried out in this region.

Since the otolith is a three dimensional bone, the growth increments are set down like layers of paint completely covering the previous bands. They appear similar to the rings in

FIGURE 3. Orientation and terminology of the right sagittal otolith of C. hippurus.

R = Rostrum
A = Antirostrum
P = Primordium
E = Excisural Notch

RIGHT SAGITTAL OTOLITH

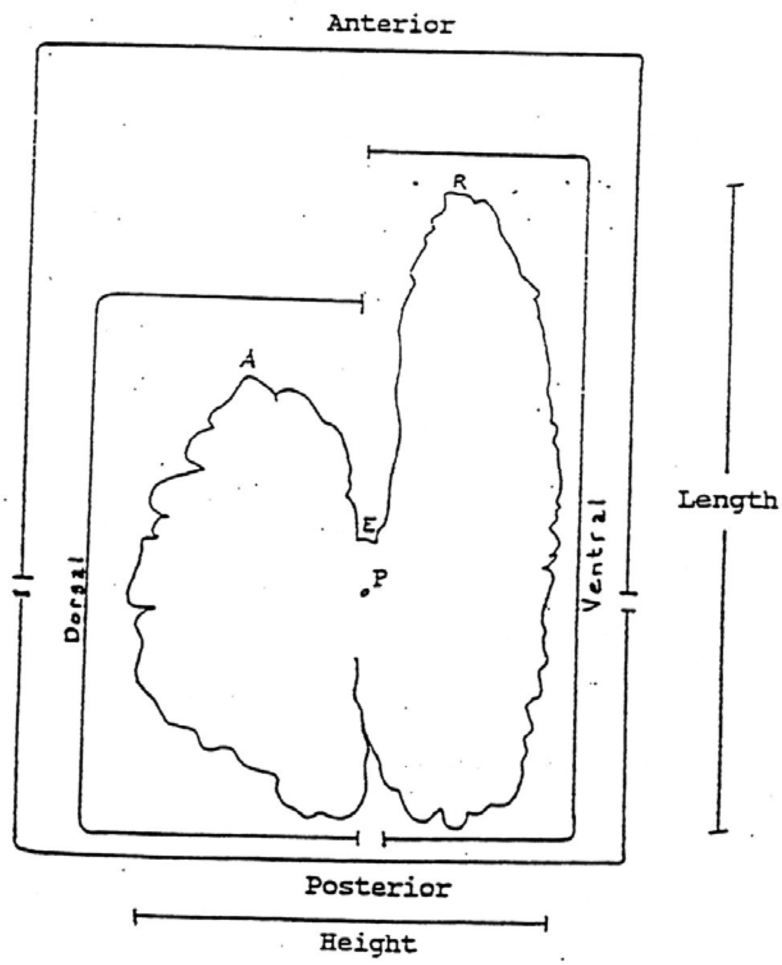


FIGURE 4. Measurements taken of right and left sagittal otoliths of <u>Coryphaena hippurus</u>.

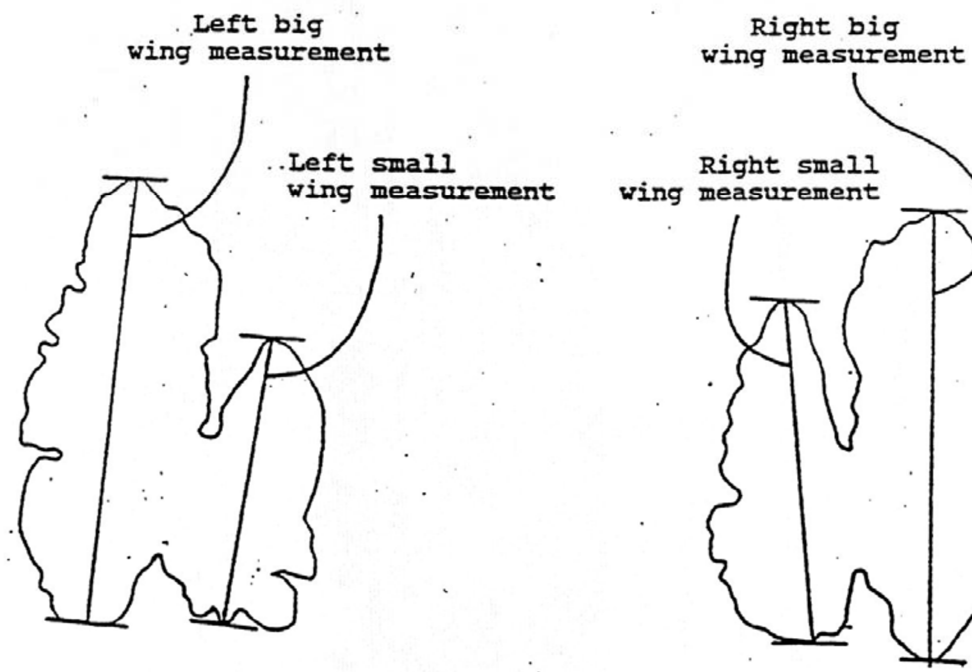


Figure 5. Right sagittal otolith of Coryphaena hippurus showing the growth increments observed and counted from all fishes collected.

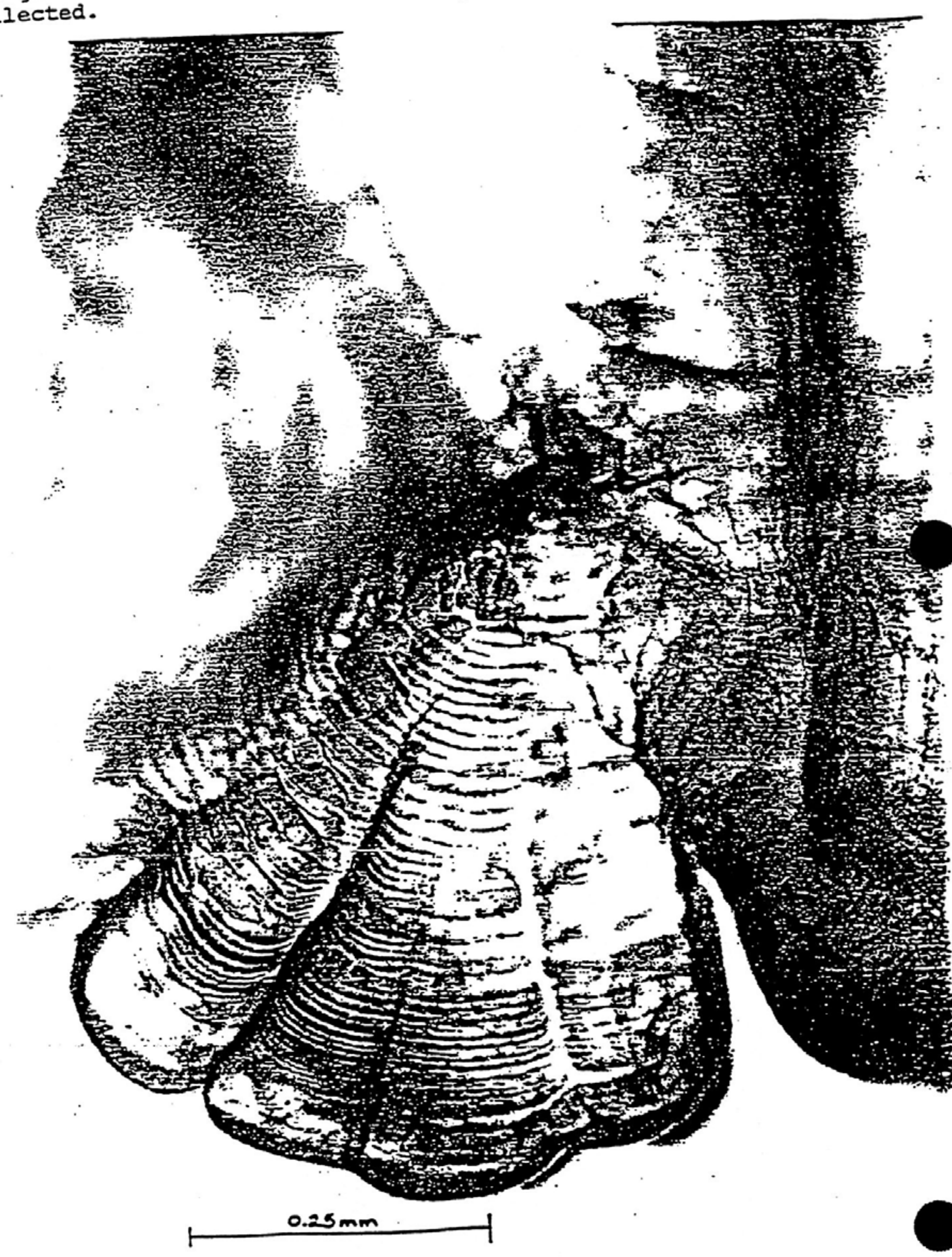
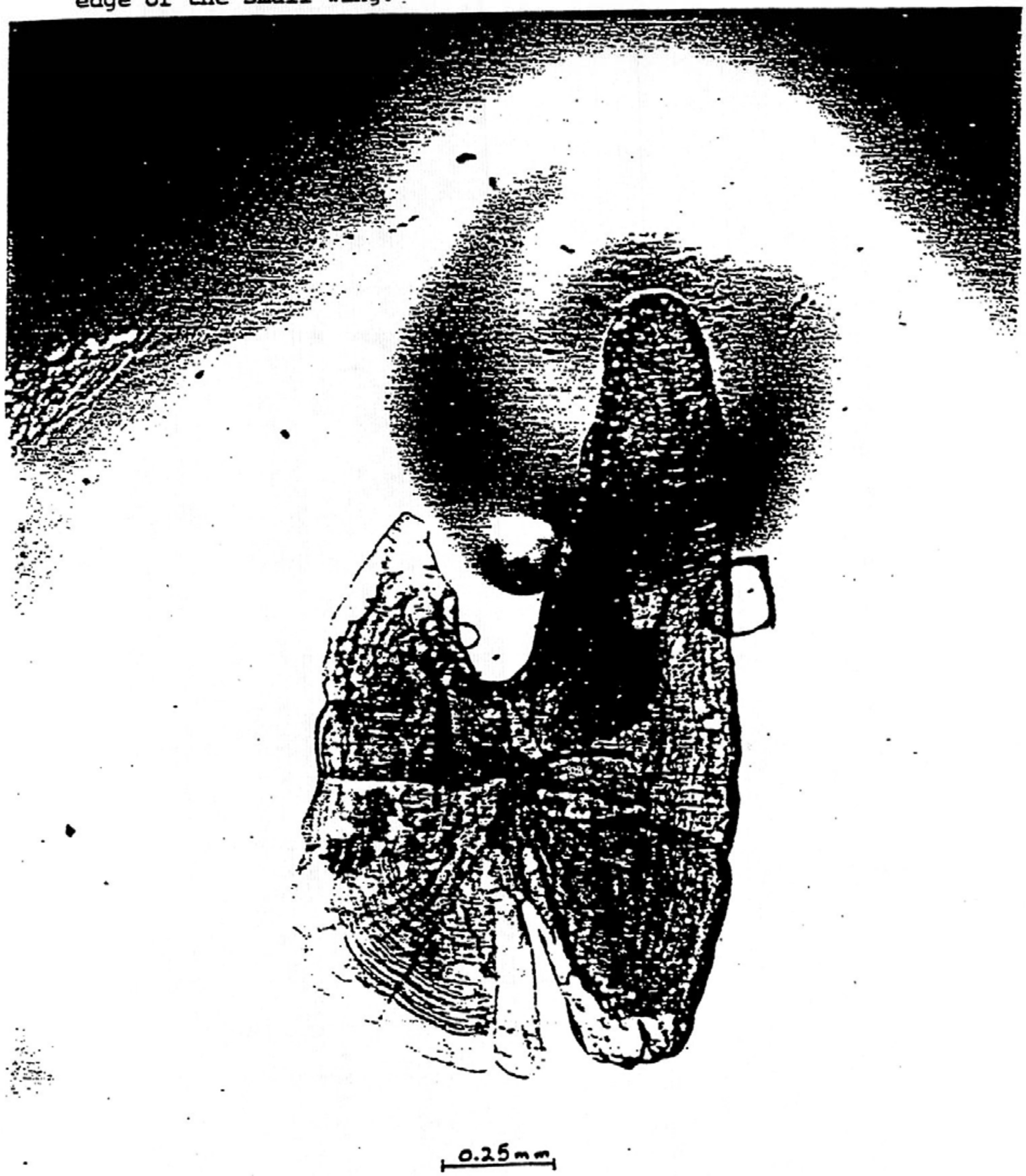


Figure 6. Photo of whole right sagittal otolith of Coryphaena hippurus showing growth increments around most of the otolith but most evident from the primordium to the posterior edge of the small wing.



trees. As the fishes grow, the growth increments become closer and closer so that, in fishes > 90 cm FL, they are not generally resolvable through light microscopy. Because of this difficulty, a different technique was used (see Figure 7). The Crazy glue was dissolved with xylene and the otoliths were reimbedded perpendicular to the slide with their posterior edge touching it. The rostrum and antirostrum were ground away with 400 grit sand paper on a Buehler Ecomet III Polisher-Grinder until the primordium was nearly reached: then Buehler Metade II, 9 micron diamond polishing compound was used to polish this surface. The otolith (about half remaining) was them removed and remounted, anterior side down, for grinding away the remainder of the otolith until finally a thin anterior/posterior section (about 0.1mm thick) was obtained that ran through the primordium (see also Figure 8 for photo of otolith cross-section). From this slide all the bandings could theoretically be counted. This method of sectioning has been used extensively on slow growing fishes to distinguish yearly intervals, but it is also widely used for determining daily growth intervals (Demory 1972; Beamish 1973; Brothers 1976).

Right and left otoliths, when both available, or only one when the other was missing, were read at least 3 times in random order and the size of the fish was concealed so as not to bias any readings. There was a close correlation between successive readings of otoliths smaller than 90 cm SL. For these otoliths, a margin of error < or = 10% between successive readings of the number of growth rings was considered acceptable.

FIGURE 7. Sanding technique used on sagittal otoliths from C. hippurus greater that 90cm FL.

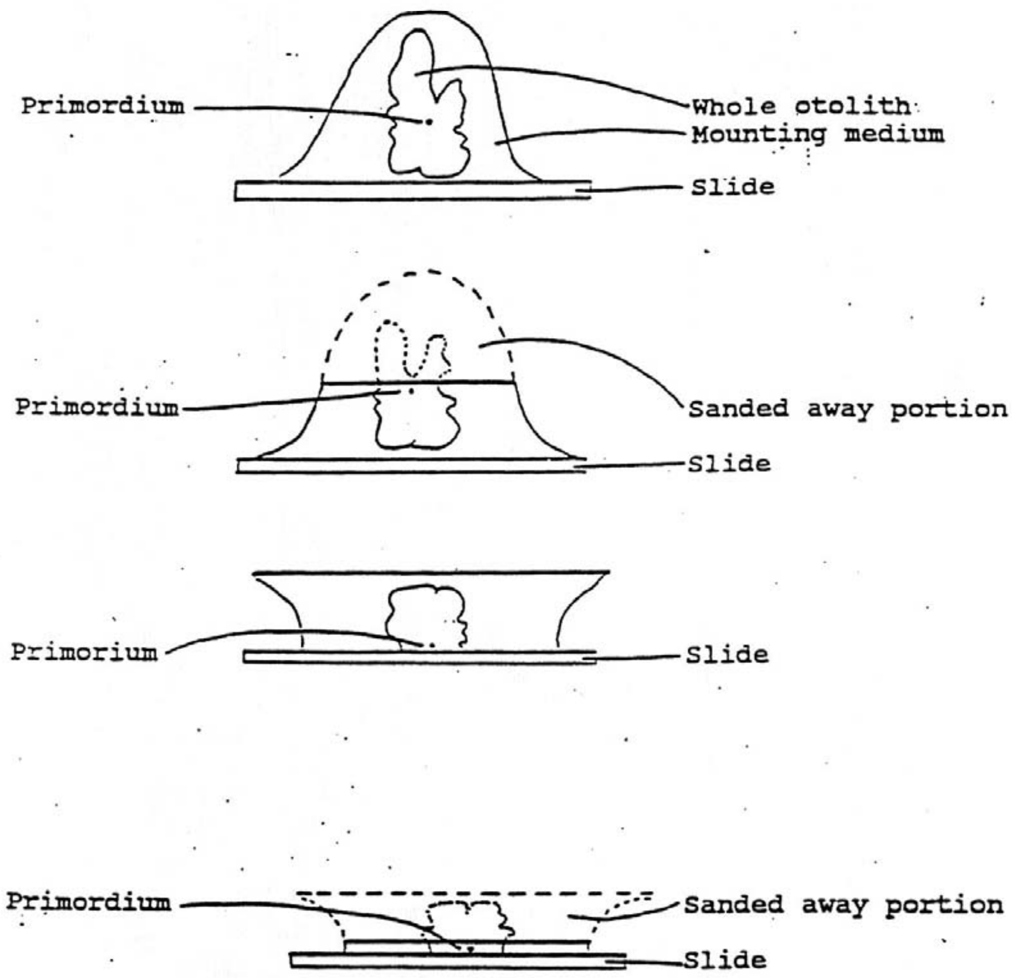
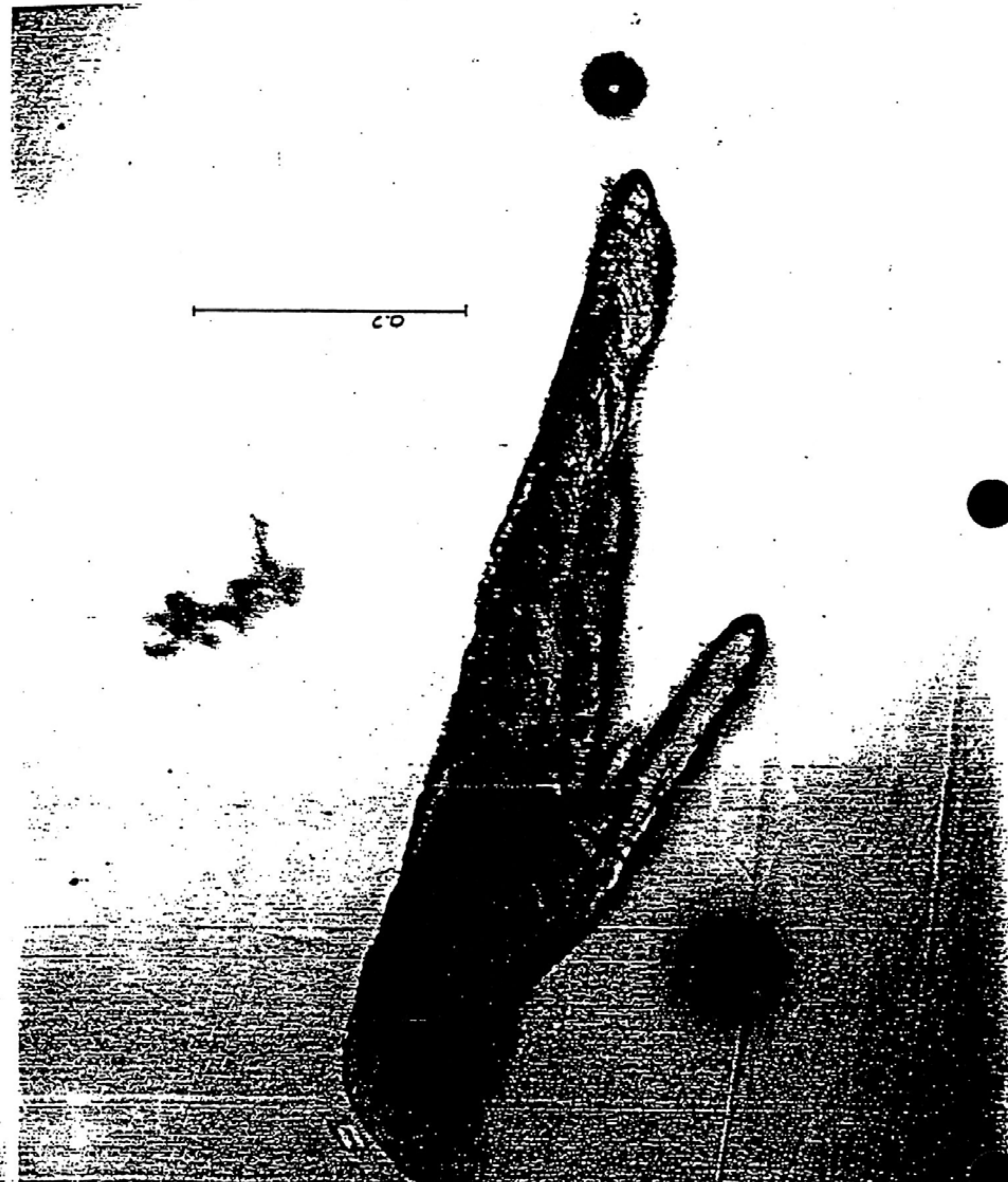


Figure 8. Anterior-posterior cross section of the large wing of the right sagittal otolith of Coryphaena hippurus, after grinding, to approximately 0.1 mm thick and estimated to have 147 growth increments.



If there was greater than 10% deviation, then counting was repeated until the last 3 readings correlated. If both otoliths were obtained, all six readings had to correlate to within 10%. The readings of the larger otoliths usually did not correlate to within 10% of each other. In this case the two closest readings were used. All readings were carried out by the author; however, a sampling of 10 otoliths was sent to Dr. Oxenford who independently read them.

Preparations of pectoral and dorsal spines were also made. The cleaned bones were embedded in resin until hard, then thinly sectioned (about 0.05mm thick) using a Buehler Isomet low speed saw. The sections were glued to a slide and viewed under the Wild microscope.

Scales were taken from the dorsal side above the lateral line posterior to the beginning of the dorsal fin. The scales were cleaned with water and viewed under a Wild dissecting microscope.

RESULTS

Species Identification

The morphological characteristics, dorsal fin ray and vertebral counts, to determine the differences between the two species are summed up in Appendix 1. This study showed that all the fish collected were of the species Coryphaena hippurus and no representatives of the species C. equiselis were caught. The vertebral counts only varied in two of the fishes with an average of 31 vertebrae.

The dorsal fin ray counts varied as expected. The low count was 52 and the high was 66 with and average of 58.45, the confidence limits ranging from 56.26 < DFR <_60.64.

Age Determination

The results from the sectioning and microscopic examination of the spines from the pectoral and dorsal fins showed that there were no visible bands laid down in these bones. The scales showed bands but these could not be correlated with any of the obvious environmental periodicities, such as daily, lunar or annual cycles. They were hard to read and varied from scale to scale in the same fish. For these reasons they were not used for aging of the fish.

Examination of the otoliths showed very clear microbanding. Appendix 1 gives the growth increment counts, fish length measurements, sex, stage of maturity, dorsal fin ray and vertebral counts, and the otolith measurements of all the fishes collected. A sample of 10 otoliths were sent to Dr. Oxenford, who read them independently. Her readings fell within the 10% criteria for acceptable variation between counts in the small fishes otoliths (< 90 cm FL). Dr. Oxenford's readings were 100 and 99 compared to the authors 110 and 107 respectively. However the readings of the larger fishes otoliths (> 90 cm FL) did not fall within the 10% acceptable variation limit with Dr. Oxenfords readings of 163 and 210 compared to the authors 277 and 240. The remaining 6 otoliths were small and the preparations were poor so increments could not be counted.

In all otoliths growth increments were found that appeared to occur according to a daily periodicity. Figures 9-12 show different relationships between the growth increments (GI), fork length (FL), standard length (SL) and four otolith measurements. The best correlations occured between the fork length and GI ($r2 = 0.9041$), the standard length and GI ($r2 = 0.9040$), and the left big otolith regressed against SL ($r2=0.9295$) and FL ($r2 = 0.9311$).

Figures 13-15 show a right sagittal otolith of _C. hippurus_ with an estimated 57 growth increments. Figure 13 is focused on the primordium (P) and 28 growth increments can be counted. Figure 14 is focused on the middle section of the otolith. Here 27 more GI's can be counted. Finally, Figure 15 shows the outer edge where there are 2 more GI's. In this instance the number of counted growth increments from the photos correlates exactly with the number counted using the light microscope.

Maturity

The size and age at which dolphin begin to mature (Table 1) do not obviously differ between the sexes, at least not in the small sample collected. From Table 1, if the chronological sequence of samples is scanned, the July 23rd females which are all stage I, seem anomalously large and old compared with the stage II females caught one month later. However maturity was reached by all fish greater than 52.1 cm FL or older than 88d save one fish of 97d, stage III. There were no size anomalies with the males and all were mature by 52.8 cm FL or 95 days. Table 1 appears to be contradictory in the size and age of first

Figure 9. The regression line of the fork length against the number of daily growth increments, $Y=0.415(X) + 11.29$, $r=0.951$.

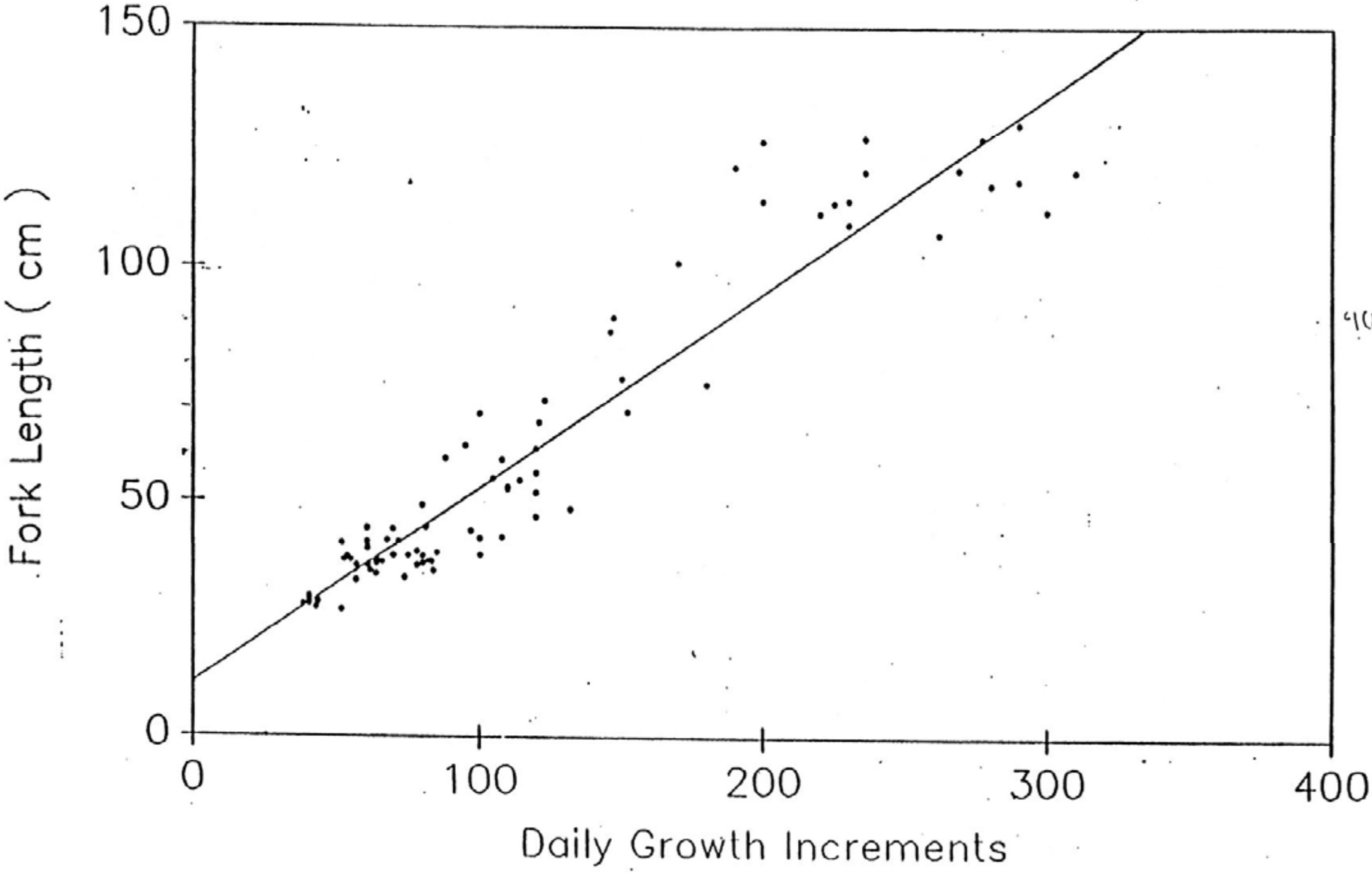


Figure 10. The regression line of the standard length against the nu
daily growth increments, Y=0.388(X) + 10.65, r=0.951

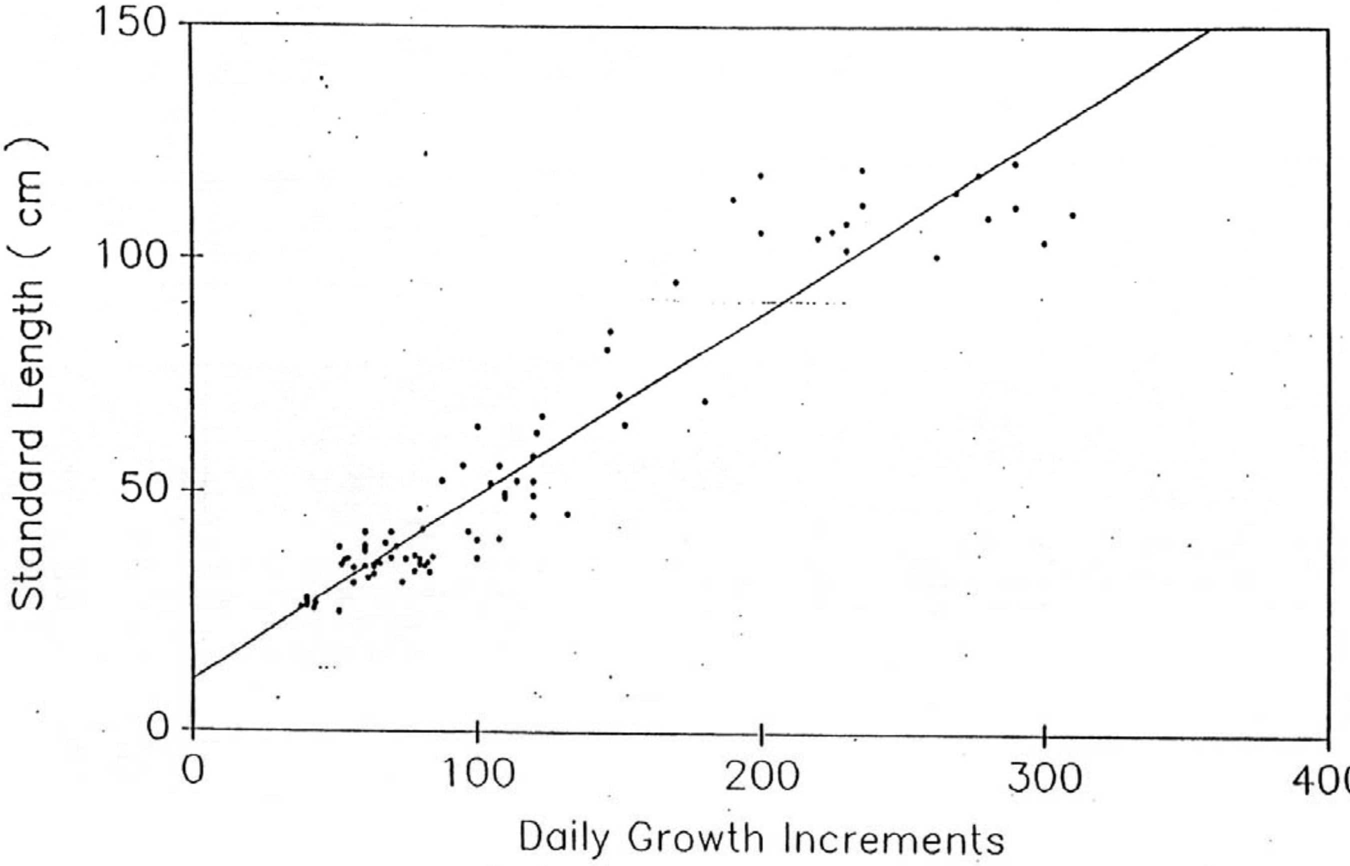


Figure 11. The regression line of the fork length against the lengt
the big wing of the left otolith, Y=9.70(X) – 43.27, r=(

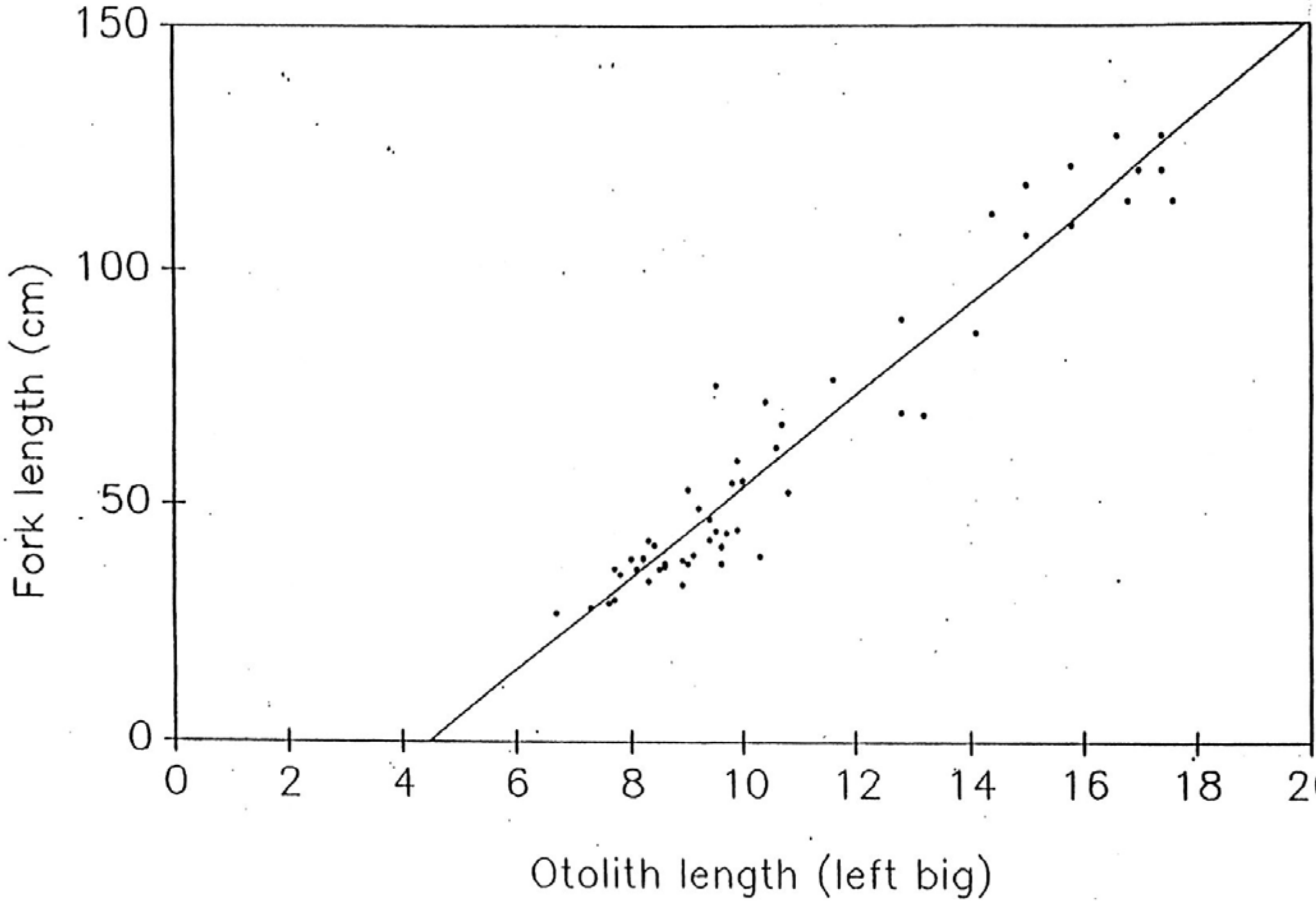


Figure 12. The regression line of the standard length against the le
of the big wing of the left otolith, Y=9.05(X) − 40.24,

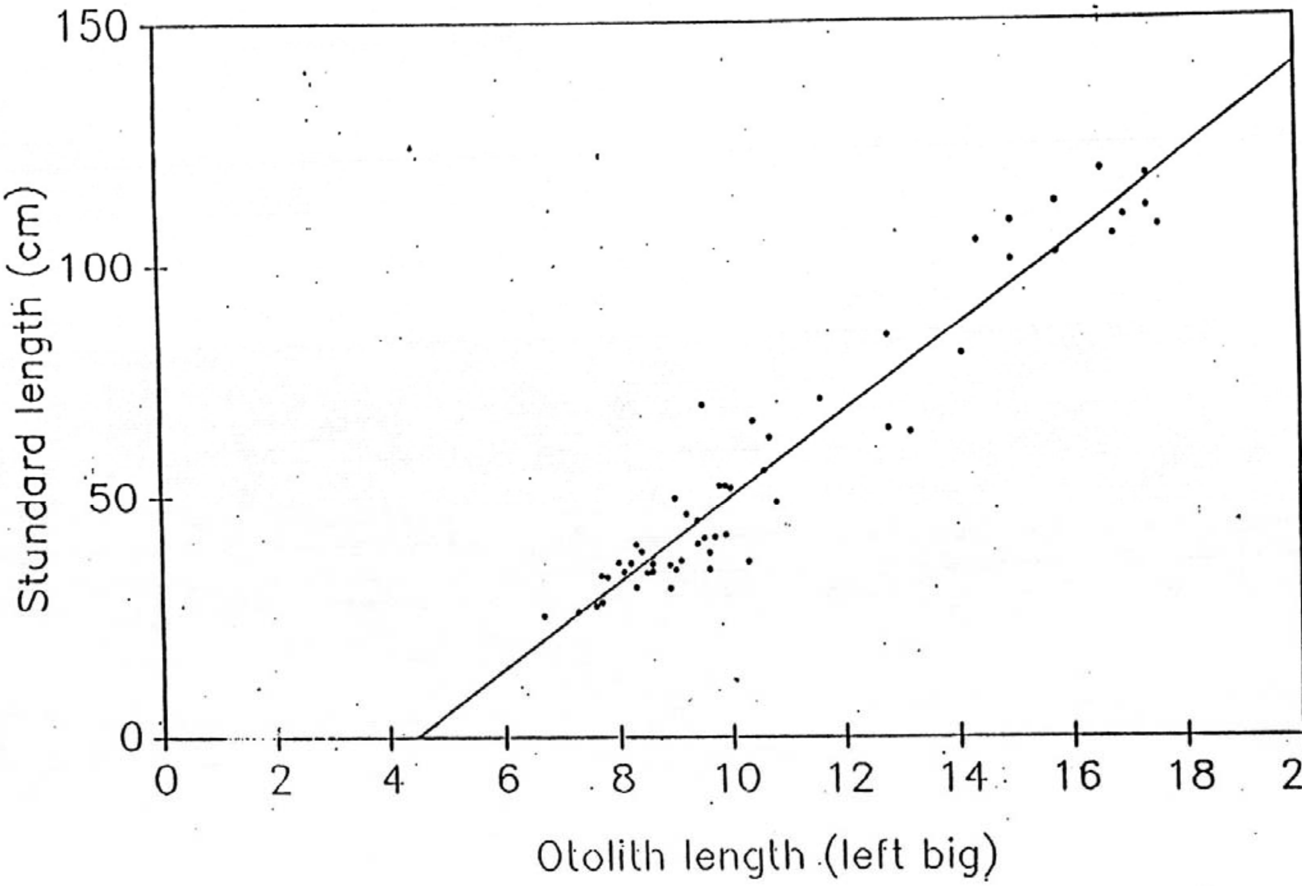


Figure 13. Right sagittal otolith of Coryphaena hippurus, focused on the primordium where 28 growth increments can be counted, out of a total of 57 growth increments.

Figure 14. The same otolith as in Fig. 13, focused on the middle section showing 27 growth increments in focus out of a total count of 57.

Figure 15. The same otolith as in Fig. 13 focussed on the outer section with 2 growth increments visible out of a total count of 57.

Table 1. Maturity stages (Stage) of selected small male and female common dolphin-fish, Coryphaena hippurus, according to Beardsley 1967, their size (in centimeters total fork length), the number of growth increments counted and the date collected.

IMMATURE MALES

Size(cm) FL		Growth Incr.	Stage	Date Collected
29.0		41	I	Aug. 24
33.0		57	I	Jul. 23
33.8		74	I	Jul. 23
37.0		66	I	Sep. 1
37.5		55	I	Sep. 14
38.0		54	I	Jul. 23

MATURE MALES

Size(cm) FL		Growth Incr.	Stage	Date Collected
52.8	3.6	110	II	Jul. 15
62.0	3.2	95	II	Sep. 14
68.8	3.3	100	II	Sep. 14
69.3	5	152	II	Sep. 14
76.3	5	150	II	Sep. 14

IMMATURE FEMALES

Size(cm) FL		Growth Incr.	Stage	Date Coll.
36.2		61	I	Jul.23
36.3		57	I	Jul.23
36.8		64	I	Jul.23
37.1		82	I	Jul.23
37.4		53	I	Jul.23
38.4		75	I	Jul.23
39.2		78	I	Jul.23

MATURING FEMALES

Size(cm) FL		Growth Incr.	Stage	Date Coll.
27.5		43	II	Aug.24
28.0		39	II	Aug.24
28.6		44	II	Aug.24
29.7		41	II	Aug.24
38.4		70	II	Sep.14
41.3		61	II	Sep.14
41.9		68	II	Sep.14
41.2	1.7	52	III	Sep.14
44.0	3.2	97	III	Oct. 1
44.2	2.3	70	III	Sep.14
44.3	2.0	61	III	Sep.14
49.2	2.6	80	III	Sep.14

Considered 1st maturity

MATURE FEMALES

Size(cm) FL	mo	Growth Incr.	Stage	Date Coll.
52.1	3.9	120	IV	Oct.15
54.7	3.75	114	IV	Oct.15
59.4	2.9	88	IV	Oct.15
67.0	4.0	121	IV	Jul.15
70.2		-	IV	Jul.23
71.6	4.0	123	IV	Oct.15

maturity of the females. The July 23rd fishes ranged from 36.2cm to 39.2 cm and were all immature (stage I), while Aug. 24th fishes showed a later stage of maturity (stage II) yet were smaller in size (27.5cm - 29.7cmFL). On the other hand the Sept. 14 fishes were both larger and more mature, all stage III.

Growth Rate

Actual growth rates were calculated from the regression equations of Figures 9 and 10. From Figure 9, the growth rate was 4.15 mm SL per day for all lengths of fish, and from Fig. 10 a growth rate of 3.88 mm SL per day. The r values were both 0.951. These growth rates were then divided into two groups; one group for fishes less than 90 cm FL and the other for fish greater than 90 cm FL. Their growth rates were; for the fish less than 90 cm FL, 3.92 mm FL/day (r=0.865) and 3.67 mm SL/d (r=0.871). For fish greater than 90 cm FL the growth rates were 0.61 mm FL/d (r=0.324) and 0.49 mm SL/d (r=0.286).

The von Bertalanffy growth rate (k) was estimated by drawing six different Ford-Walford plots with time intervals (t) of one to six weeks (the equation for the linear regression is $L_{(t+1)} = a + bL_t$). From these graphs, Figures 16-21, the proposed maximum length L is estimated from the intersection of the 45 line and the regression line, or by the equation L = a / (1-b). The K value is calculated from the equation K = -lnb. The six calculated K and L values were; for t=1 week, K = 0.0006 and L = 5600cm, for t=2 weeks, K = -0.196 and L = 39.55cm, for t=3 weeks, k = 0.02 and L = 435cm, t=4 weeks, K =

20

Figure 16. Ford—Walford plot with a time interval of one week, length
Y=1.0006X + 1.22, r=0.96, K=0.0006/wk or 0.031/yr
L =5680cm.

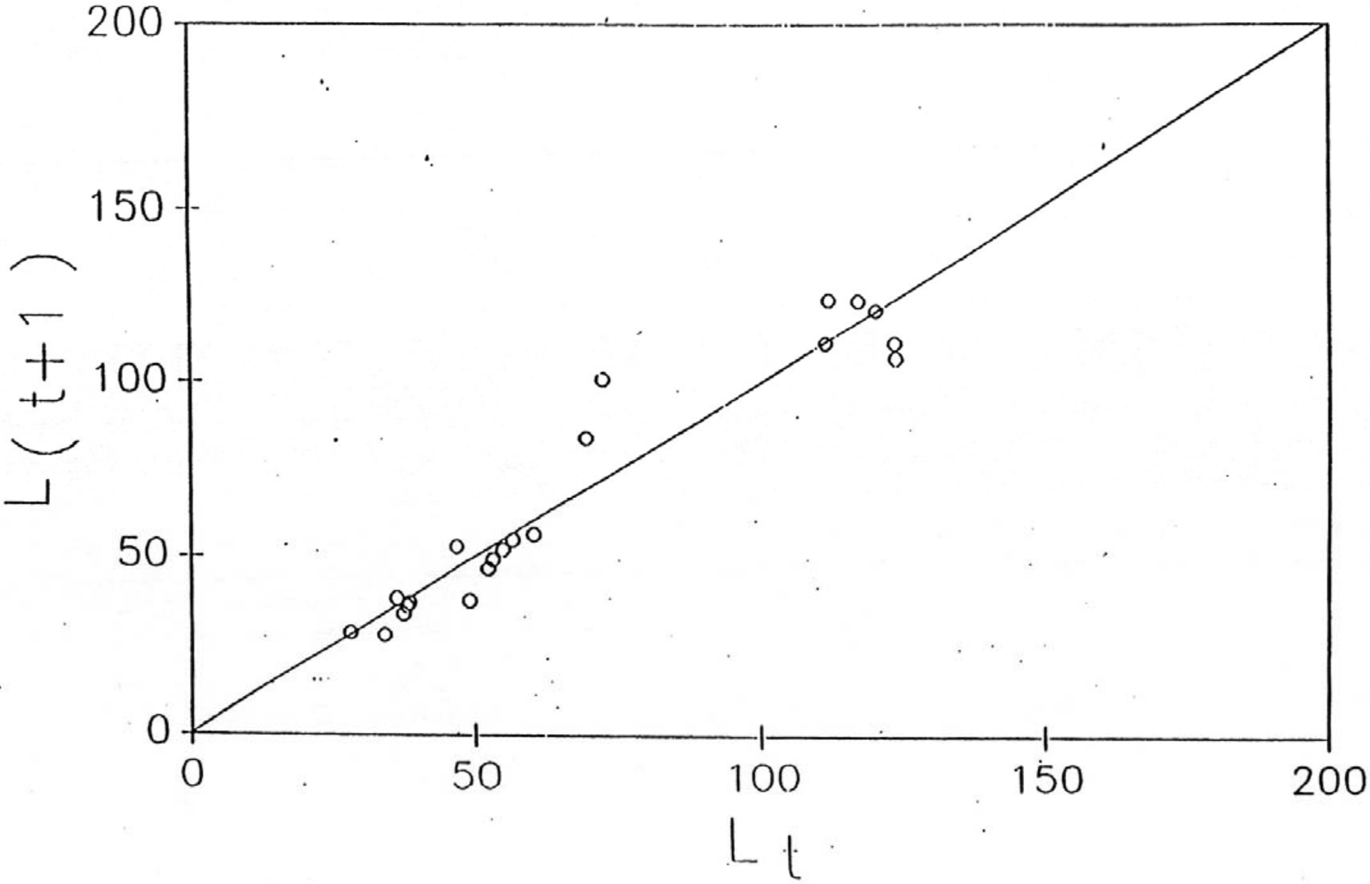


Figure 17. Ford–Walford plot with a time interval of two weeks, leng
Y=0.822X + 6.96, r=0.85, K=–0.196/2wks or –5.096/
L =39.55cm

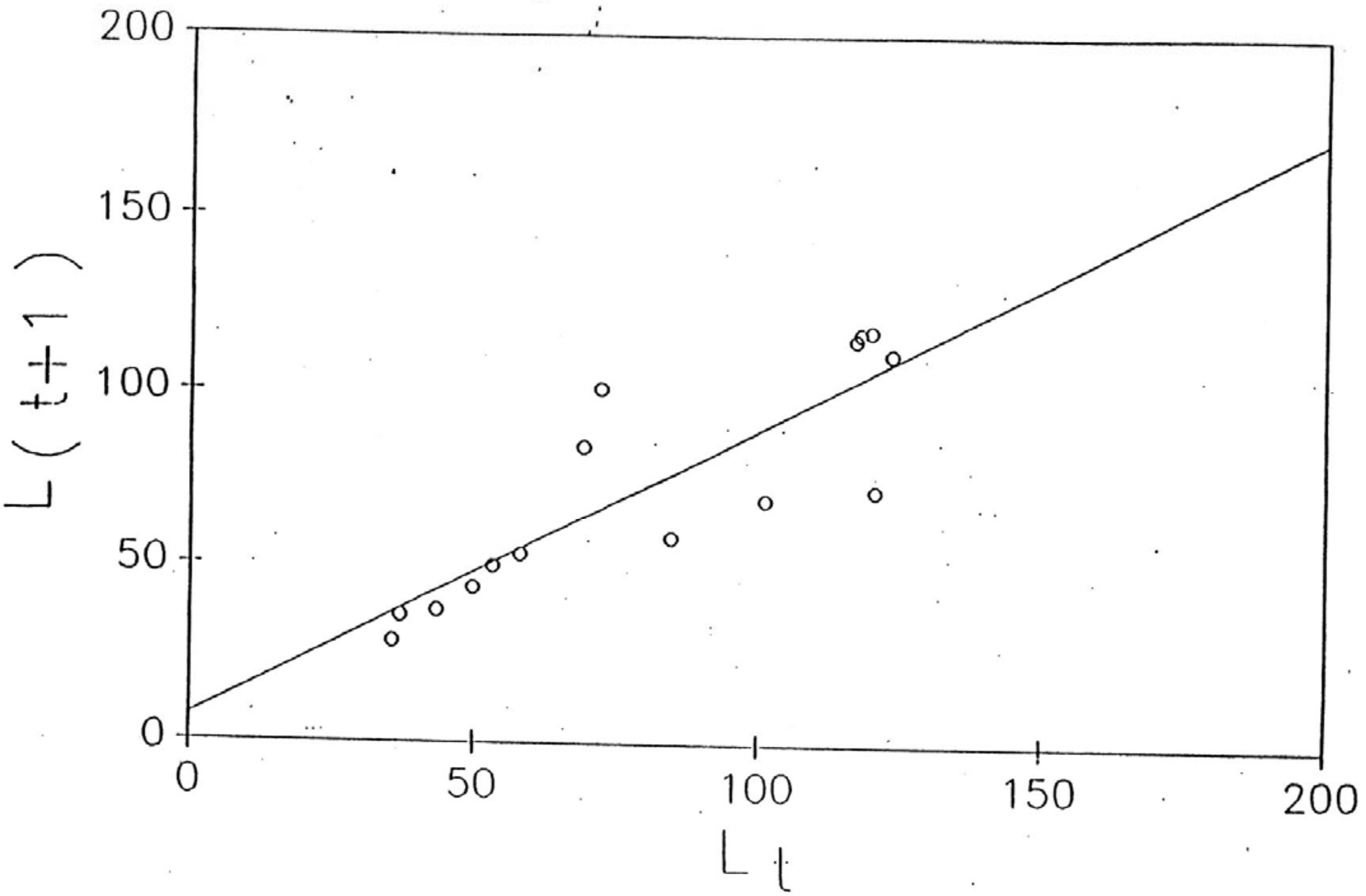
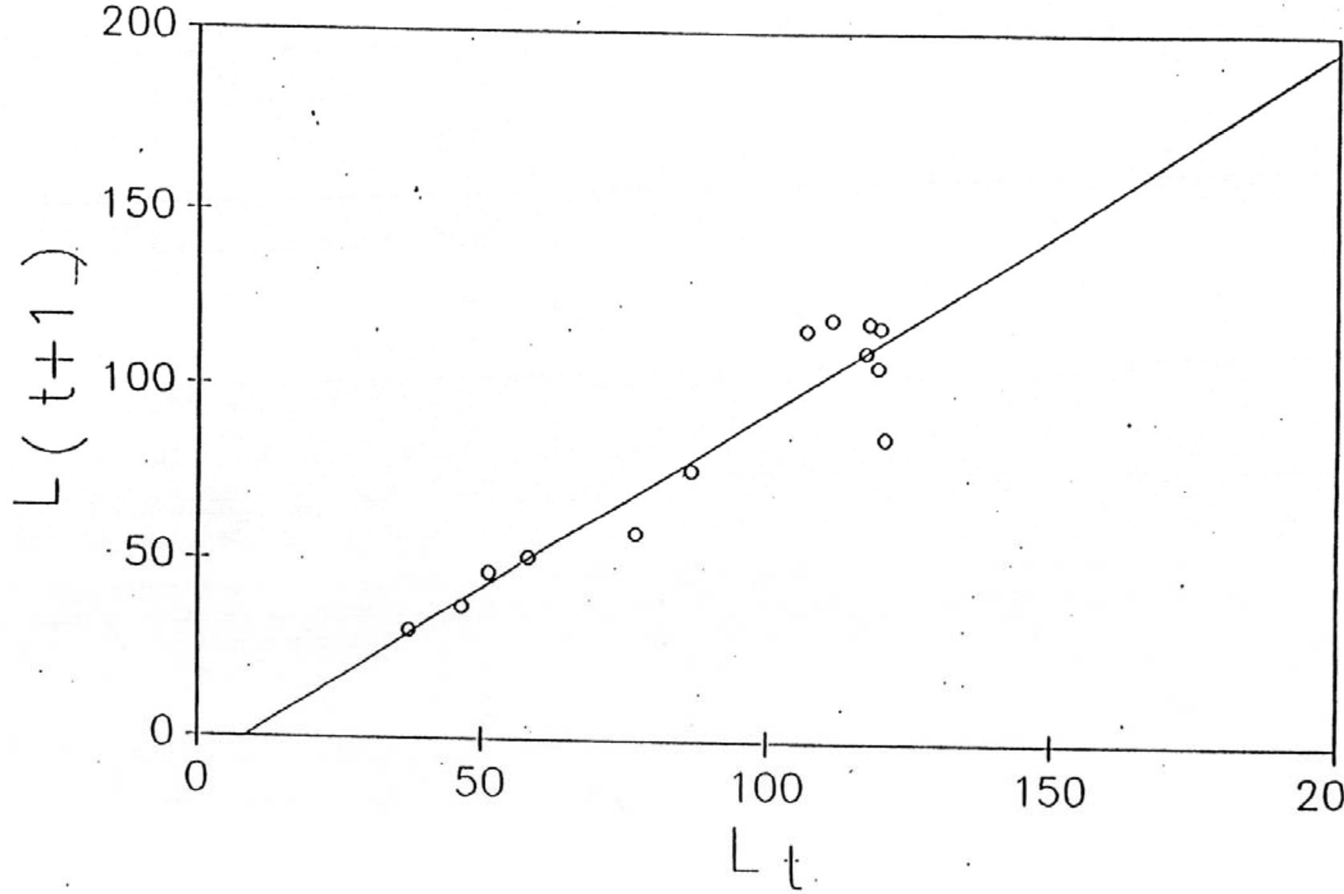


Figure 18. Ford–Walford plot with a time interval of three weeks, l
is in cm. Y=1.02X − 8.70, r=0.943, K=0.02/3 wks or
L =435cm.



9. Ford–Walford plot with a time interval of four weeks, length is in cm. Y=1.086X – 17.46, r=0.976, K=0.086/4wks or 1.118/yr, L =194cm.

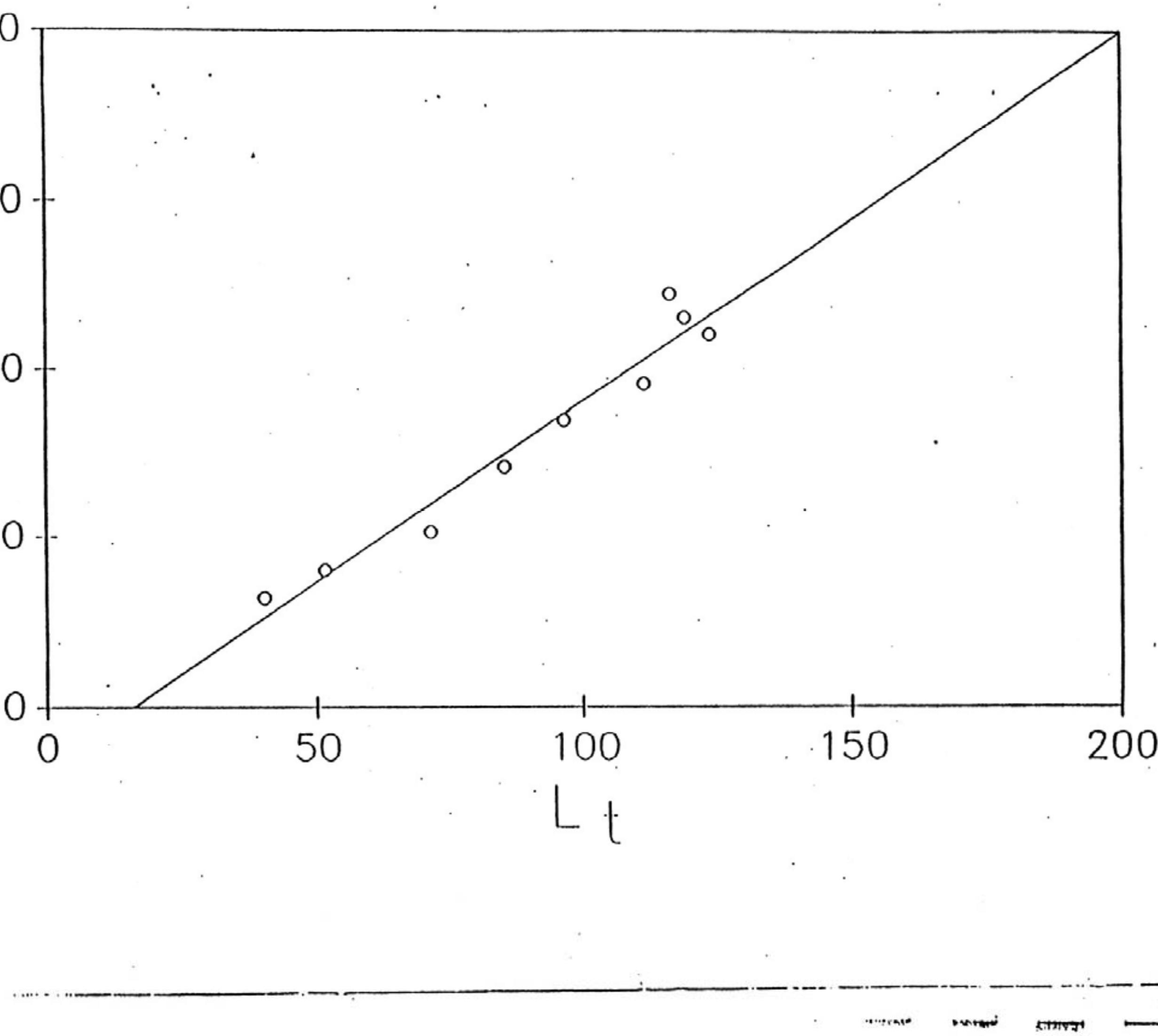
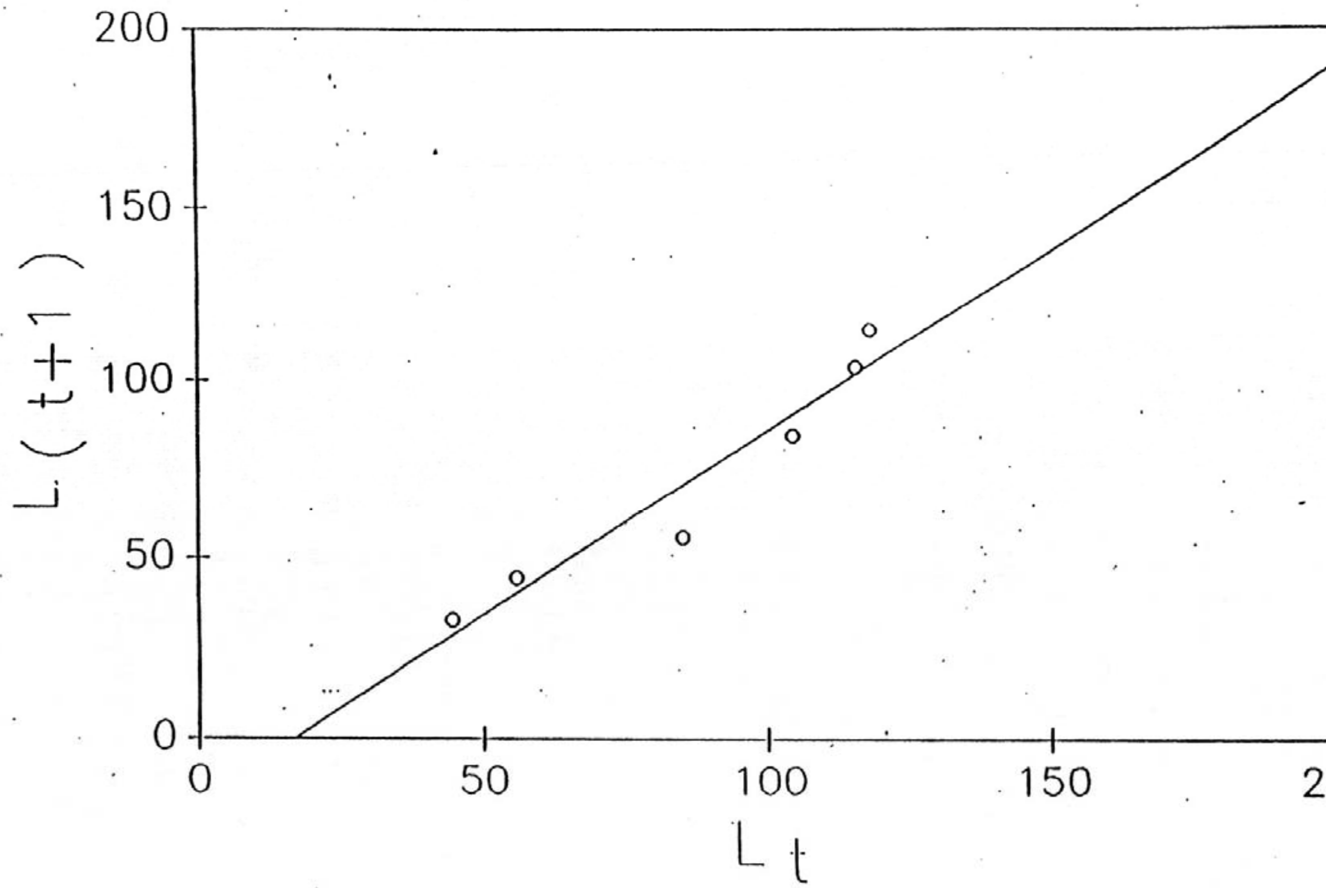


Figure 20. Ford–Walford plot with a time interval of five weeks, le
is in cm. Y=1.04X − 17.84, r=0.96, K=0.039/5wks or
0.406/yr, L =446cm.



0.086 and L_∞ = 194cm, for t=5 weeks, K = 0.039, and L_∞ = 446cm, and finally for t=6 weeks, K = 0.129, and L_∞ = 199cm.

These last values of K and L_∞ were used to calculate t_o from the equation $t_o = t + 1/K [\ln(L_\infty - L_t/(L))]$, resulting in a value of 0.033 yrs or 12 days (see Table 2).

Table 2. The von Bertalanffy parameters calculated from all *Coryphaena hippurus* collected and using a time interval of four weeks to calculate K and L_∞.

Number of Fish	Parameter	Estimate
80	t_o	0.033yrs
	K	1.121/yr
	L_∞	194 cm FL

Mortality Rate

Three estimates were made of the mortality rate using the Robson and Chapman (1961) least squares method. Two using 20 days as the time interval (they were offset by 10 days) and one using a 10 day interval. The calculations are found in Table 3. The mortality rates (Z) were (for the 20 day intervals) 0.451 with Confidence Limits (CL) between 0.37 < Z < 0.53 and 0.475 with the CL between 0.39 < Z < 0.56. For the ten day interval the mortality rate was 0.224 with CL between 0.18 < Z < 0.27. If these values are to be expanded to cover a year then the corresponding mortality rates are 8.231, 8.669 and 8.176. From the rough growth increments of fishes larger than 90 cm FL none appeared to be older than one year of age.

Table 3. Three estimated mortality rates (Z) of Coryphaena hippurus for 10 and 20 day time intervals.

T = Summation of the product of age calss and number of fish that age class.
N = Total number of fish over the entire experimental period
S.V.= Survival Variable
i = The age class, in this case at 10 and 20 day intervals

MORTALITY RATES

10 day intervals

$T = SUM\ i\ (n_i)$
= 207

$N = SUM\ n_i$
= 53

S.V.(s) = T / [N + T - 1]
= 0.894

Z = ln [S.V.(s)]
= -0.224 per 10 days
For one year the Z value is 8.176

20 day intervals beginning at day 10

T = 100
N = 58
S.V.(s) = 0.637
Z = -0.451 per 20 days
For one year the Z value is 8.231

20 day intervals beginning at day 0

T = 84
N = 52
S.V.(s) = 0.622
Z = -0.475 per 20 days
For one year the Z value is 8.669

DISCUSSION

Distribution

Despite the repeated documentation of C. equselis occuring in the Gulf of Mexico (Springer and Pirson 1958; Kelley et al 1983) no representatives of this species were collected over the four month period. One of the main reasons for this may be that most of the dolphin collected were obtained at rodeos where prizes are awarded for the biggest fishes. Since C. equiselis do not usually grow to be larger than 70 cm FL, they clearly would not rank with the larger C. hippurus which can attain 150 cm FL.

It has not been determined exclusively whether the two species school together. Beardsley (1964) found dolphin and pompano dolphin schooling, whereas, Shcherbachev (1973) felt that pompano dolphin shun dolphin based on his observations during a cruise aboard the Baikal.

The fishes collected in this study were usually a few representatives of larger schools. Fifteen dolphin caught on July 23 were the most representatives collected from the same school, at the same time. Clearly a few dolphin from a large school does not indicate that the school is comprised entirely of dolphin and no pompano dolphin are present. Whatever their affinities towards each other, this study was not comprehensive enough to influence either view-piont.

For these reasons it is assumed that C. equiselis still migrates through the gulf and that C. hippurus is an annual visitor with occurrences during the summer warmer months.

Species Identification

Vertebrae numbers correlated with those found by Palko et al (1982), with almost all fish having 31 vertebrae except 2 (30 and 32). Collette (1969) found one dolphin in the western Atlantic, with 30 vertebrae but none with 32, and one pompano dolphin with 32 vertebrae. There were no overlaps in the 221 fishes he examined. The number of vertebrae is still one of the most useful features for differentiating the two species.

The number of dorsal fin rays, 52-62 mean 58.45, was substantially lower than the 58-66 mean 61.3 found by Palko et al (1982) for C. hippurus and higher than those for C. equiselis, 52-59 mean 55.0. This finding could indicate that the fishes sampled were in fact a mixture of the two species. This hypothesis can be dismissed due to the consistancy of the vertebral counts and the positive identification of each specimen as C. hippurus by overall body shape at time of catch.

The abberation in dorsal fin ray counts between established ranges and the ranges found in this study could very easily have been due to the rushed environment of the rodeos. The author is sure that all fishes examined were C. hippurus.

Age Determination

Uchiyama et al (1984) verified growth increments to a daily periodicity from lab reared C. hippurus in the Pacific. Their relationship of mean increment counts (Y) to known age (X) was $Y= -0.529 + 1.0035X$ ($r=0.999$ $P<0.01$) for fish up to 191 days old. Daily growth increments formation started at day 1 (D-1), therefore no adjustment was required to the increment counts of the wild fish to estimate age.

Further evidence for daily formation came from the close correlation of Dr. Oxenfords readings of the 4 otoliths sent to her. Oxenford and Hunte (1983) assumed daily growth increments due to two factors. Firstly the close correlation between the number of sagittal rings and fish standard length (SL = 58.608 + 4.709N, r=0.95) and secondly the similarity in growth rates obtained for the same population using length frequency distribution and the otolith rings. A similar correlation of SL to growth increments was carried out yielding a similar r value of 0.95.

It was assumed that the growth increments found by this study were daily in nature due to four factors. 1) Verification of GI's to be daily by Uchiyama et al 1984 and the close similarities in the life history patterns between the Pacific and this studies dolphin populations. 2) Dr. Oxenford's close correlation between sagittal rings and the SL of fishes. 3) Close correlation between Dr. Oxenford's readings and this authors, for fish smaller than 90 cm FL. 4) Good correlation between growth counts and SL.

Maturity

The present study shows that dolphin, in the gulf, grow rapidly and mature in their first year, as do neighbouring stocks (Beardsley 1967; Shcherbachev 1973; Oxenford and Hunte 1986a). From the small sample it is only possibe to draw tentative conclusions about the size and age at which fishes begin to mature. Females begin to mature at approximately 49 to 52 cm FL, whereas the corresponding sizes for neighbouring stocks are 32.4 cm FL (Northern stock from the W. Atlantic; Oxenford and Hunte 1986b), 35 cm FL (Straits of Florida; Beardsley 1967) and 61 cm FL (Southern stock from the W. Atlantic; Oxenford and Hunte 1986b). The age at which gulf females begin to mature is 3-4 months which compares with 4 months for the Southern stock and 6-7 months for the Northern stock from the Western Atlantic (Oxenford and Hunte 1986b). From this limited information it is suggested that the gulf population resembles more closely the Southern stock of the Western Atlantic dolphin in the size and age at which they begin to mature. From the even more limited data available from the Gulf males it may also be tentatively suggested that they resemble more closely the Southern Western Atlantic stock.

From Table 1, there would seem to be an anomaly in the size/maturity relationship of the July 23rd females when compared with the later August sample. The former, although larger and older than the latter, are less mature. This anomaly may be explained if the lower temperatures experienced earlier in the season between spawning in April - May and catching on July 23rd differentially inhibit maturation.

Growth

Growth rates of fishes show a slowing tendency as the fish approaches $L\infty$. The artificial cut off point of 90 cm FL was chosen to separate growth into two segments. The placement at

90 cm FL was due to the observed lack of data points between 89.2 and 101 cm FL and the fact that there was much greater accuracy in counting the daily growth increments of small fishes than larger fishes. Therefore, the varied results from the growth data are not surprising. The overall growth rate of 3.67 mm SL/d for fishes less than 90 cm FL most closely resembles that of Hagood et al (1981), 3.56 mm SL/d, working with lab reared fish in Hawaii, Uchiyama et al (1984), also working in Hawaii, who found a growth rate of 4.03 mm SL/d (value determined through personal extrapolation of fishes smaller than 90 cm FL) and a very rough extrapolation of Oxenford and Huntes (1983) growth rate for fishes smaller than 70 cm FL giving a value of 3.8 cm SL/d.

However, from Table 4, a wide range of growth rates for C. hippurus are observed. From a low value of 1.07 to a high of 5.88 mm SL/d. Hassler and Hogarth's (1977) rate of 5.88mm SL/d was for fish raised in captivity in a North Carolina estuary (salinity ranged from 16 to 26 ppt) and fed twice to three times daily to satiation. This is obviously a highly removed situation but may represent an upper limit for the stock. Hassler and Rainville (1978) also conducted experiments in N. Carolina waters and their growth rates were low at 1.07 mm SL/d.

If parts of the growth curves are examined then very low growth rates can be observed. As predicted by the von Bertalanffy curve, growth will theoretically approach zero. This was seen in the growth rates of the fishes over 90 cm FL, with a growth rate of 0.49 mm SL/d and by Oxenford and Hunte's (1983)

Table 4. Estimated growth rates of Coryphaena hippurus found by other researchers.

Location	No. of fish	Aging method	1st year growth rate (mmSL/d)	References
Gulf of Mexico	**81**	**otolith counts**	**0.49**	**Author 1988 for fishes > 90 cm FL**
Lab reared	26	days known	1.07	Hassler & Rainville 1975
Barbados	>1000	otolith counts	1.43	Oxenford and Hunte 1983 for fishes 70-110 cm SL
North Carolina	593	scale annuli	1.64	Rose and Hassler 1968
Straits of Florida	121	scale annuli	1.82	Beardsley 1967
Waters adjacent to Taiwan	?	progression of size frequency	2.96	Wang 1979
Lab reared	?	days known	3.03	Schekter [1]
Lab reared	94	days known	3.56	Hagood et al 1981
Gulf of Mexico	**81**	**otolith counts**	**3.88**	**Author 1988 all fishes**
Hawaii	18	days known	4.03	Uchiyama et al 1984
Barbados	>1000	otolith counts	4.17	Oxenford and Hunte 1983
Florida Marineland	2	days known	4.80	Herald 1961
Miami Seaquarium	1	days known	5.28	Beardsley 1971
Lab reared	30	days known	5.88	Hassler and Hogarth 1977

Richard Schekter, cited in: Oxenford, H.A. and W. Hunte. 1983. Age and growth of dolphin, Coryphaena hippurus, as determined by growth rings in otoliths. Fish. Bull. 84: 906 - 909.

growth rates for fish between 70 and 110 cm SL of 1.43 cm SL/d.

This wide range in growth rates could therefore be explained by differential growth with age. A linear correlation of an increase in length to an estimated age will therefore depend entirely on the fraction of the growth curve the data are coming from. Young fish will yield very high growth rates whereas older fishes, very low growth rates.

For these reasons the growth rate, K, according to the von Bertalanffy equation was determined. Six Ford-Walford plots, with differing t values were drawn. Due to the few data points and the scattered length distribution of larger fishes, a 4 week t value was deemed the most representative time interval for the population. This graph gave the most plausable L value (194cm FL). The other parameters, K=1.121/yr and a t_o value of -0.033yrs were relatively close to those found by Uchiyama et al (1984) with males having t_o = 0.079yrs, K = 1.1871 and L = 189.93 cm Fl and for females t_o = 0.0731 yrs, K = 1.41/yr and L = 153.26 cm Fl.

All growth studies giving results in length increase per day or year must therefore be examined with care. These calculations give linear relationships that are nor realistic to fish growth over extended periods of time. If taken over entire life cycles of fishes the measurements represent an average from birth to death. If a fraction of the entire life is examined then the value is an average for a portion and not representative of the fishes life cycle. In either case, the growth values are constant over time which has been found not to be the case with fishes (Pitcher and Hart 1982, Cushing 1975).

Contrarily, von Bertalanffy parameters give good estimations of a fishes life history. These values, K, L_∞, and t_o, must be calculated for a better representation of growth for all ages and lengths. From all growth studies done in the Atlantic, the Gulf of Mexico dolphin population would seem to resemble the southern population as determined by Oxenford and Hunte (1986a). The similar K value of Uchiyama et al (1984) adds confidence to the estimate of the growth rate by the gulf population.

Mortality

Mortality rates influence life tables by varying the maximum age that a population will reach. Low Z values indicate a long lived species whereas a high Z value indicates a short lived species.

The three estimates of Z concur, leading one to believe that a mortality value of about 8 represents the dolphin population collected in the gulf. However a number of conditions must be met before the Robson and Chapman method of estimating Z can be accepted. These are: a) the survival rate is uniform with age, over the range of age-groups in question, b) since survival rate is the complement of mortality rate and the latter is compounded of fishing and natural mortality, this will usually mean that each of these individually is uniform, c) there has been no change in mortality rate with time, d) the sample is taken randomly from the age-group involved and e) the age-groups in question were equal in number at the time each was being recruited to the fishery (Ricker 1978).

From these restrictions the most glaring possibility for misrepresentation comes from the sampling method used. Obviously a random sample was not taken of the gulf population, since most fish were collected from rodeos. A heavy biased was placed towards older fishes with young fishes not targeted by rodeo fishermen. Such a biased sampling of fishes would however tend to lower the mortality value. This, of course, could be compensated for, to some degree, by heavy commercial and sport fishing reducing the numbers of older, larger fishes.

The complicating factors of the five conditions have not been examined in the gulf. Despite this, the very high growth rate and the short life span found by this study would indicate that the dolphin, in the Gulf of Mexico, is a very short lived species, with a very high mortality rate and few living to be older than 1 - 2 years.

CONCLUSION

Dolphin are incredibly fast growing, early maturing, high mortality, delicious fishes that are found circumtropically. Their distribution includes the Gulf of Mexico where they can be found in abundance during the summer. They mature at a very young age, corresponding to a short length and most do not live longer than 1 year.

They appear to form daily growth increments in the sagittal otoliths that can be seen and counted quite easily without extensive preparation. Recent discoveries, through

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electrophoresis, have propossed different populations occuring in the western Atlantic Ocean and the Caribbean Sea. This study proposses the affinities of the Gulf of Mexico dolphin population to the south Caribbean Sea dolphin population and raises the potential for electrophoretic studies to be carried out on this population and other populations for potential discovery of different stocks. With such a phenomenal life history pattern, the dolphin in the Gulf of Mexico appears to be a prime candidate for more study for potential aquaculture usage and population monitoring to insure its continued survival.

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APPENDIX A

Data collected from all Coryphaena hippurus during the period from July to Octo

FL = Fork length
SL = Standard length
Mat = State of maturity according to Beardsley 1967
DFR = Dorsal fin ray counts
RB = Big wing of the right otolith
RS = Small wing of the right otolith
LB = Big wing of the left otolith
LS = Small wing of the left otolith

Date Collected	Growth Increments	FL	SL	Sex	Mat	DFR	Vertebral Count	Otolith M RB	RS
July1	170	101.0	95.3	m	II	-	-		
Pensacola "	230	114.0	108.0	m	II	-	-	-	-
FLA "	269	120.6	114.4	m	II	-	-	-	10.5
"	310	120.0	110.0	m	II	-	-	16.0	-
								17.4	11.4
July 8	132	48.6	45.5	f	-	56	31	11.5	8.2
" Dauphin	85	39.0	36.5	m	-	-	-	-	-
" Island	100	38.5	36.3	f	-	52	31	8.6	6.5
" ALA	108	42.6	40.3	f	-	57	31	9.4	7.6
"	100	36.0	33.8	f	-	-	-	8.3	6.3
"	120	42.3	40.0	m	-	57	31	9.4	7.0
"	83	37.3	35.3	f	-	60	30	8.1	6.0
"	84	35.0	33.3	f	-	57	31	8.4	6.4
"	80	36.8	34.8	m	-	56	31	9.7	6.7
July 15	121	67.0	62.8	f	IV	57	31	-	-
" Dauphin	110	52.8	49.0	m	II	61	-	10.4	7.2
" Island	110	53.3	50.0	f	-	57	-	9.6	-
" ALA	120	56.3	52.5	m	-	-	-	-	5.7
"	120	61.5	58.0	f	-	57	31	8.1	-
"	180	75.2	69.8	m	-	58	-	-	-
"	146	86.2	80.6	f	-	58	31	-	-
"	108	59.0	55.7	f	-	60	-	-	-
"	220	111.4	104.8	m	-	57	-	14.2	11.0
"	61	39.9	37.7	m	-	59	31	-	-

Date Collected	Growth Increments	FL	SL	Sex	Mat	DFR	Vertebral Count	Otolith Meas RB	RS
"	64	37.5	34.9	m	–	61	31	9.2	6.5
"	80	38.3	36.0	f	–	–	–	–	–
"	225	113.6	106.2	m	–	58	32	–	–
"	105	55.0	52.0	f	–	–	–	10.0	7.5
July 16	190	121.0	113.0	m	–	60	31	–	–
"	52	27.0	25.0	f	–	59	31	6.7	5.2
" Dauphin	290	118.2	111.4	m	–	62	31	15.0	11.2
" Island	277	127.0	118.5	m	–	61		18.2	13.0
"	290	130.0	121.0	m	–	58	–	–	–
" ALA	230	109.2	102.3	f	–	62	31	14.8	–
"	147	89.2	84.6	m	–	–	–	13.2	10.2
"	200	114.0	104.0	m	–	–	–	16.4	–
"	300	112.0	104.0	m	–	–	–	16.4	12.2
"	236	120.0	112.0	m	–	58	31	15.4	13.0
"	200	126.4	118.4	m	–	61	31	17.0	10.2
"	73	36.2	33.5	f	–	54	31	7.3	–
July 23	–	70.2	65.4	f	IV	57	–	–	–
"	–	57.0	53.2	m	–	58	–	–	–
"	82	37.1	34.6	f	I	60	–	9.6	7.0
" ALABABA	64	36.8	34.3	f	I	–	–	–	7.1
"	75	38.4	36.1	f	I	–	–	–	–
"	54	38.0	35.7	m	I	58	–	9.0	6.5
"	74	33.8	31.2	m	I	–	–	8.5	–
"	–	38.7	36.2	f	I	56	–	–	–
"	57	36.3	34.2	f	I	–	–	8.3	6.2
"	53	37.4	34.9	f	I	–	–	9.2	6.8
"	62	35.1	32.0	–	–	–	–	–	–
"	57	33.0	31.0	m	I	57	–	8.2	4.7
"	78	39.2	36.8	f	I	57	–	8.9	6.7
"	61	36.2	34.4	f	I	–	–	–	–
"	64	34.4	32.7	f	I	60	–	–	6.2
Aug.13-14	262	107.0	101.0	f	IV	56	31	14.6	10.4
FLA " Orange Beach	236	127.0	119.5	m	II	59	31	16.4	11.2
Aug.24	41	28.0	26.2	–	–	58	31	–	–
"	41	29.0	27.2	m	I	57	31	7.3	5.5
LA " Destin	43	27.5	25.7	f	II	58	31	–	–

Date Collected	Growth Increments	FL	SL	Sex	Mat	DFR	Vertebral Count	Otolith Mea RB	RS
" Destin	44	28.6	26.7	f	II	61	31	-	5.0
FLA "	39	28.0	26.0	f	II	60	31	7.0	-
"	41	29.7	27.9	f	II	55	31	7.9	6.0
Sept. 1 ALA	66	37.0	35.1	m	I	59	31	8.9	6.7
Sept. 14	114	54.7	52.5	f	IV	60	31	-	-
"	120	52.1	49.5	f	IV	62	31	10.2	7.9
"	152	69.3	64.7	m	II	62	31	-	-
FLA " Destin	150	76.3	70.9	m	II	58	31	11.8	7.3
"	72	41.5	38.5	-	-	66	31	9.7	7.3
"	70	44.2	41.4	f	III	58	31	8.3	7.4
"	61	44.3	41.3	f	III	58	31	-	-
"	68	41.9	39.2	f	II	57	31	-	7.6
"	70	38.4	36.2	f	II	57	31	7.9	6.7
"	81	44.6	42.0	-	-	59	31	9.8	7.7
"	88	59.4	52.6	f	IV	58	31	10.4	-
"	95	62.0	55.8	m	II	58	31	11.0	9.0
"	100	68.8	64.0	m	II	59	31	-	-
"	123	71.6	66.2	f	IV	58	31	10.6	7.4
"	61	41.3	38.6	f	II	57	31	9.0	6.4
"	52	41.2	38.4	f	III	58	31	9.2	6.6
"	55	37.5	36.0	m	I	60	31	8.6	6.2
"	80	49.2	46.6	f	III	58	31	9.4	7.0
Oct. 1	97	44.0	-	f	III	-	-	9.8	7.3
" ALA	280	117.2	109.0	m	II	62	31	15.8	11.2

43 females
36 males
79

Plot SL / days separa[te] male[s]

Plot SL / FL for all miss[ing]

Dear Barbara Palko,

Enclosed is my thesis pertaining to C. hippurus. The appendix has all my data along with where they were caught. I hope you find it useful and that you eventually find the otoliths.

I am presently moving to California but hope to pursue work on dolphin so I would like to keep in touch. Information on dorsal spines or scales would be helpful as well as any electrophoretic data of local dolphin. As of yet I have no address in California but will let the lab here know what it is as soon as I find a place. They will foreward any material.

If I can be of any further help just let me know.

Sincerely

Antonio Bentivoglio

Address: DISL
P.O. Box 369
Dauphin Island, AL 36528

Appendix H. Trends in Dolphin and Wahoo Commercial and Recreational Catch Rates: A Study for the South Atlantic Fishery Management Council

Trends in Dolphin and Wahoo Commercial and Recreational Catch Rates:
A Study for The South Atlantic Fishery Management Council

C. Phillip Goodyear
415 Ridgewood Road
Key Biscayne, FL 33149
Phil_Goodyear@email.msn.com

March 2, 1999

Data Sources Available for the Analyses

Data Source	Requested	Have	Imported	Extracted	Processed
Recreational					
MRFSS catch	X	X	X	X	X
MRFSS size	X	X	X	X	X
MRFSS cpue	X	X	X	X	X
TPWD catch	X	X	X	X	X
TPWD length	X	X	X	X	X
TPWD trips	X	X	X	X	X
TPWD fish	X	X	X	X	X
TPWD party	X	X	X	X	X
Headboat catch	X	X	X	X	X
Headboat bioprofile	X	X	X	X	X
Headboat effort	X	X	X	X	X
Headboat vessel	X	X	X	X	X
Large Pelagic catch	X	X	X	X	X
Large Pelagic size	X	X	X	X	X
Large Pelagic cpue	X	X	X	X	X
NMFS Charterboat Master	X	X	X	X	X
NMFS Charterboat Vessels	X	X	X	X	X
SC Charterboat survey	X	X	X	X	X
AL Charterboat size	X	X	X	X	X
NC Survey	X (Data incorporated into MRFSS intercept files)				
Commercial					
NMFS Commercial Catches	X	X	X	X	X
FL Commercial Catches	X	X	X	X	X
GOM Reef fish logbook	X	X	X	X	X
SA Reef fish logbook	X	X	X	X	X
Pelagic longline logbook	X	X	X	X	X
Pelagic longline weigh out	X	X	X	X	X
Pelagic longline observers	X	X	X	X	X
Trip Interview Program	X	X	X	X	X

Dolphin Recreational Landings

Dolphin Annual Totals

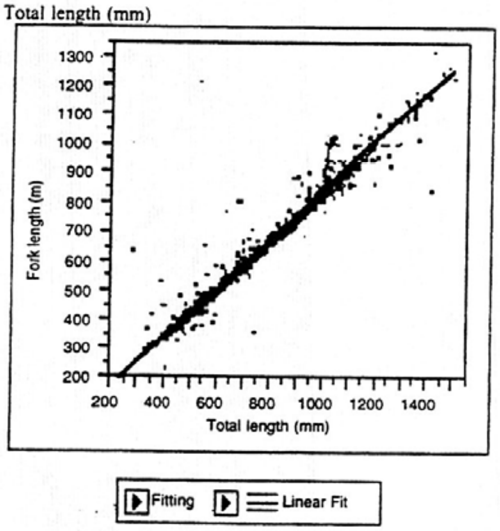
	Headboat		Charter		Private/Rental		Total	
YR	Number	Pounds	Number	Pounds	Number	Pounds	Number	Pounds
81	23,056	76,103	228,038	1,606,560	408,715	2,969,019	659,809	4,651,681
82	39,977	95,021	467,180	2,526,861	816,955	4,456,811	1,324,112	7,060,691
83	13,714	53,692	146,907	847,827	1,009,223	6,072,043	1,169,844	6,973,563
84	18,896	55,842	135,424	861,529	833,706	3,576,840	988,025	4,494,210
85	5,348	33,686	149,895	927,970	1,008,560	6,038,049	1,163,803	6,999,705
86	18,396	70,347	424,240	3,195,089	1,014,289	6,620,998	1,495,367	10,088,250
87	17,797	63,876	537,243	3,006,939	917,785	4,205,998	1,472,825	7,278,815
88	12,191	45,540	448,513	1,672,217	1,054,986	5,932,472	1,522,362	7,670,456
89	19,369	63,501	769,175	3,925,113	1,899,695	9,566,182	2,693,550	13,592,950
90	30,387	141,218	376,658	2,202,994	1,099,335	7,767,084	1,761,093	12,904,230
91	18,508	93,120	673,100	4,466,616	1,966,721	12,801,070	2,658,329	17,360,800
92	8,601	45,619	475,690	4,062,992	834,232	5,814,866	1,330,661	9,976,774
93	14,234	63,656	1,142,284	6,493,442	831,451	4,825,101	2,019,027	11,460,040
94	10,897	39,113	1,158,643	6,310,622	1,036,197	6,428,897	2,206,731	12,787,150
95	12,720	70,943	1,254,486	10,873,300	1,003,538	8,974,380	2,272,314	19,920,700
96	14,668	54,172	800,878	6,699,763	891,306	6,069,741	1,706,852	12,823,680
97	11,639	48,348	1,273,035	13,765,780	931,847	8,743,603	2,216,521	22,557,710

Dolphin Recreational Size Limits

Dolphin All Areas

	Headboat				Party/Charter				Private/Rental					
	Number		Weight		Number		Weight		Number		Weight		Number	
Size Mm Fl.	Int %	Cum %	Int %	Cum %	Int %	Cum %	Int %	Cum %	Int %	Cum %	Int %	Cum %	Int %	Cu
< 300	1.5	1.5	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	
301-350	2.1	3.6	0.4	0.5	0.1	0.1	0.0	0.0	0.4	0.5	0.0	0.1	0.1	
351-400	8.2	11.8	2.1	2.6	0.9	0.9	0.2	0.2	3.3	3.8	0.5	0.6	1.3	
401-450	12.0	23.8	4.2	6.9	2.5	3.5	0.6	0.8	6.1	9.9	1.3	1.8	3.2	
451-500	14.6	38.4	7.0	13.9	10.8	14.3	3.5	4.3	9.0	18.9	2.5	4.4	10.5	
501-550	17.3	55.7	10.7	24.6	21.8	36.1	9.1	13.4	11.4	30.3	4.2	8.6	20.0	
551-600	11.5	67.2	9.1	33.7	14.1	50.2	7.5	20.9	10.8	41.1	5.1	13.8	13.5	
601-650	6.1	73.3	6.1	39.8	9.2	59.5	6.1	27.0	9.9	50.9	5.9	19.6	9.3	
651-700	4.8	78.0	5.9	45.8	5.7	65.1	4.7	31.7	7.0	57.9	5.1	24.7	5.9	
701-750	4.9	83.0	7.4	53.2	3.8	68.9	3.8	35.4	6.5	64.4	5.8	30.6	4.2	
751-800	2.7	85.7	4.8	58.0	4.6	73.4	5.6	41.0	3.9	68.3	4.1	34.7	4.4	
801-850	4.4	90.1	9.4	67.4	4.6	78.0	6.6	47.6	4.6	72.9	5.7	40.4	4.6	
851-900	2.5	92.6	6.3	73.7	5.3	83.3	8.9	56.5	5.5	78.3	8.2	48.6	5.3	
901-1000	4.0	96.6	12.1	85.7	8.9	92.2	18.4	74.9	12.8	91.1	24.7	73.3	9.6	

Dolphin Fork Length (mm) By Total length (mm)



Linear Fit

Fork length (m) = 1.59779 + 0.83677 Total length (mm)

Summary of Fit

RSquare	0.980438
RSquare Adj	0.980431
Root Mean Square Error	24.51826
Mean of Response	541.8344
Observations (or Sum Wgts)	2899

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	87284973	87284973	145197.8
Error	2897	1741518	601.1452	Prob>F
C Total	2898	89026491		0.0000

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	1.5977865	1.4891	1.07	0.2834
Total length (mm)	0.8367711	0.002196	381.05	0.0000

Nonlinear Fitting Control Panel

_ Second Deriv. Method
_ Continuous Update
_ Iteration Log
_ Loss is -LogLikelihood
PLCI iter=1 Converged g=0.00469
Converged in the Gradient

	Current	Limit	Alpha
Iteration	1	60	0.050
Shortening	0	15	
O Criterion	2.458692e-12	0.0000001	
D Criterion	8.934562e-11	0.0000001	
G Criterion	2.576568e-16	0.000001	
CL Criterion	?	0.00001	

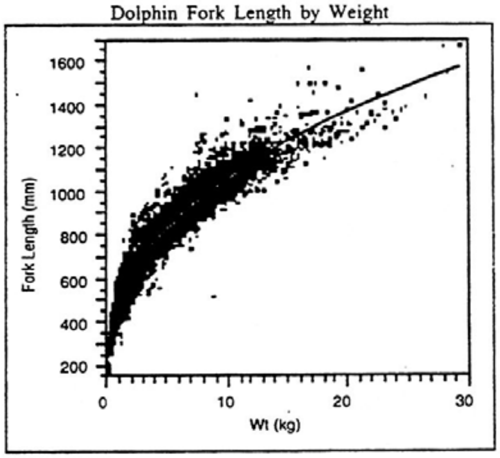
Parameter	Current Value	Lock	SSE
p1	470.40733804	_	48728678.461
p2	0.3563859561	_	48733983.89

Solution

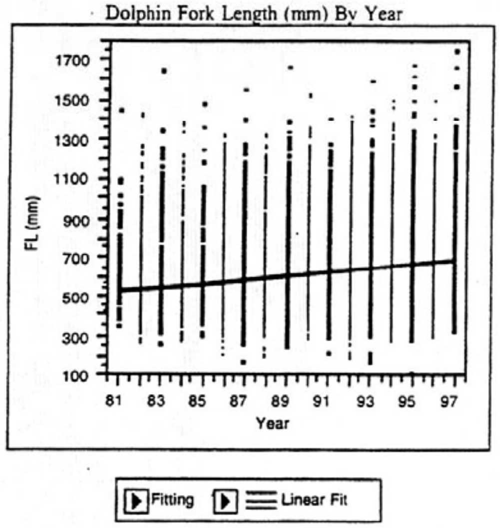
SSE	DFE	MSE	RMSE
48728678.461	35285	1381.0026	37.161844

Parameter	Estimate	ApproxStdErr	Lower CL	Upper CL
p1	470.40733804	0.24986684	469.917591	470.897085
p2	0.3563859561	0.00036833	0.35566401	0.3571079

Dolphin Fork Length by Weight



Dolphin Fork Length (mm) By Year



Linear Fit

FL (mm) = -284.82 + 10.0443 Year

Summary of Fit

RSquare	0.036284
RSquare Adj	0.036258
Root Mean Square Error	187.8641
Mean of Response	643.1458
Observations (or Sum Wgts)	37645

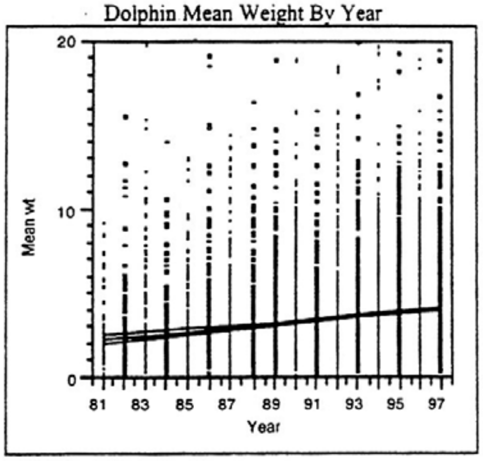
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	50019232.3	50019232	1417.259
Error	37643	1328531947	35292.93	Prob>F
C Total	37644	1378551180		<.0001

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-284.8169	24.66839	-11.55	<.0001
Year	10.044267	0.266805	37.65	<.0001

Dolphin Mean Weight By Year



Linear Fit

Mean wt = -6.9656 + 0.1152 Year

Summary of Fit

RSquare	0.025844
RSquare Adj	0.025715
Root Mean Square Error	2.82595
Mean of Response	3.584954
Observations (or Sum Wgts)	7591

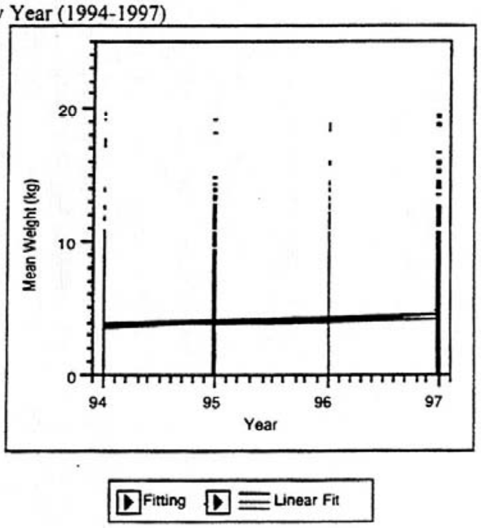
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	1607.835	1607.84	201.3319
Error	7589	60605.714	7.99	Prob>F
C Total	7590	62213.550		<.0001

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-6.965575	0.74427	-9.36	<.0001
Year	0.1151981	0.008119	14.19	<.0001

Dolphin Mean Weight (kg) By Year (1994-1997)



Linear Fit

Mean Weight (kg) = -18.338 + 0.2355 Year

Summary of Fit

RSquare	0.008351
RSquare Adj	0.00803
Root Mean Square Error	2.913549
Mean of Response	4.137488
Observations (or Sum Wgts)	3093

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	220.954	220.954	26.0290
Error	3091	26238.783	8.489	Prob>F
C Total	3092	26459.736		<.0001

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-18.33767	4.4056	-4.16	<.0001
Year	0.2355042	0.04616	5.10	<.0001

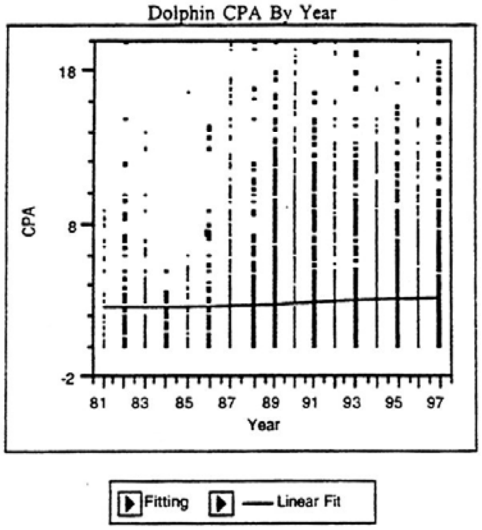
Dolphin Recreational Bag and Trip Limits

Dolphin Bag Limit All Areas

Bag Limit	Headboat				Party/Charter				Private/Rental				To	
	Number		Weight		Number		Weight		Number		Weight		Number	
	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red
0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0
1	59.8	40.2	69.1	30.9	21.2	78.8	25.0	75.0	43.7	56.3	49.6	50.4	26.8	73.2
2	13.2	27.0	11.4	19.6	14.7	64.0	15.6	59.4	20.1	36.2	20.5	29.9	15.7	57.5
3	7.7	19.3	6.2	13.4	11.8	52.2	11.9	47.5	10.6	25.5	10.0	19.8	11.5	46.0
4	5.2	14.1	3.9	9.5	9.9	42.3	9.6	37.9	6.2	19.3	5.5	14.3	9.0	37.0
5	3.6	10.5	2.6	6.9	8.5	33.8	8.1	29.8	4.2	15.2	3.5	10.7	7.5	29.5
6	2.6	7.9	1.8	5.0	7.2	26.6	6.7	23.1	2.9	12.3	2.4	8.4	6.2	23.2
7	1.9	6.0	1.3	3.7	6.2	20.4	5.7	17.4	2.2	10.1	1.7	6.6	5.3	17.9
8	1.4	4.6	1.0	2.7	5.2	15.2	4.7	12.7	1.7	8.4	1.3	5.3	4.4	13.5
9	1.0	3.6	0.6	2.1	4.3	10.9	3.8	8.9	1.4	7.0	1.0	4.3	3.6	9.9
10	0.7	2.8	0.5	1.6	3.5	7.4	3.1	5.8	1.2	5.9	0.9	3.4	3.0	6.9
11	0.5	2.3	0.3	1.3	1.7	5.6	1.5	4.4	0.6	5.3	0.4	3.0	1.5	5.4
12	0.5	1.8	0.3	1.0	1.4	4.2	1.2	3.2	0.6	4.7	0.4	2.6	1.2	4.2
13	0.4	1.4	0.2	0.8	0.8	3.3	0.7	2.5	0.5	4.2	0.3	2.3	0.8	3.4
14	0.3	1.2	0.2	0.6	0.7	2.6	0.6	1.9	0.4	3.8	0.3	2.0	0.6	2.8
15	0.2	1.0	0.1	0.5	0.6	2.1	0.5	1.5	0.3	3.5	0.2	1.8	0.5	2.3
20	0.5	0.5	0.3	0.2	1.2	0.9	0.9	0.6	1.2	2.2	0.8	1.0	1.2	1.1
25	0.2	0.3	0.1	0.1	0.4	0.4	0.3	0.3	0.5	1.7	0.3	0.7	0.4	0.7

Dolphin Trip Limit All Areas

	Headboat				Party/Charter				Private/Rental				Total		
	Number		Weight		Number		Weight		Number		Weight		Number		
Trip Limit	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red	In
0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	
5	36.1	63.9	45.2	54.8	21.6	78.4	25.0	75.0	65.3	34.7	71.4	28.6	30.1	69.9	
10	12.9	51.0	13.4	41.4	14.3	64.1	14.9	60.1	13.8	20.9	12.4	16.2	14.2	55.7	
20	13.7	37.2	13.0	28.5	21.0	43.1	20.6	39.4	10.7	10.2	8.9	7.4	18.8	36.9	
30	8.1	29.1	7.1	21.4	15.6	27.4	14.8	24.7	4.4	5.8	3.3	4.0	13.3	23.6	
40	5.6	23.6	4.6	16.8	11.6	15.9	10.6	14.1	2.4	3.4	1.7	2.3	9.7	13.9	
50	4.2	19.4	3.3	13.5	8.3	7.5	7.5	6.6	1.4	2.0	1.0	1.3	6.9	7.0	
60	3.4	16.0	2.6	10.9	5.6	1.9	5.0	1.6	1.0	1.0	0.7	0.6	4.7	2.3	
70	2.6	13.3	2.0	8.9	0.9	1.1	0.7	0.9	0.3	0.7	0.2	0.4	0.9	1.5	
80	2.1	11.2	1.5	7.3	0.4	0.6	0.4	0.5	0.2	0.4	0.1	0.3	0.5	1.0	
90	1.7	9.6	1.2	6.1	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.3	0.7	
100	1.4	8.2	1.0	5.2	0.2	0.1	0.2	0.1	0.1	0.2	0.0	0.1	0.2	0.5	



Linear Fit

CPA = -0.1354 + 0.03366 Year

Summary of Fit

RSquare	0.001128
RSquare Adj	0.000996
Root Mean Square Error	4.002495
Mean of Response	2.947139
Observations (or Sum Wgts)	7591

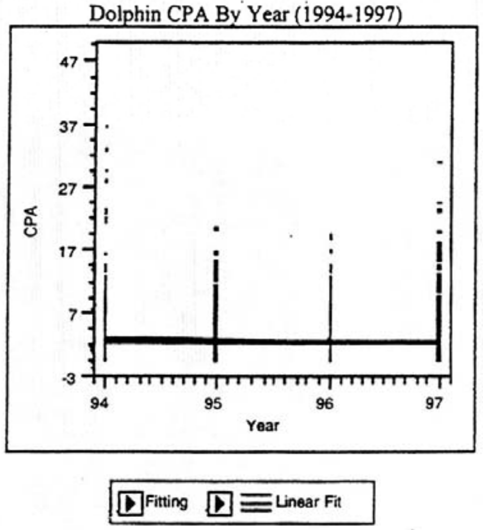
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	137.25	137.254	8.5677
Error	7589	121575.54	16.020	Prob>F
C Total	7590	121712.79		0.0034

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-0.13545	1.054137	-0.13	0.8978
Year	0.0336579	0.011499	2.93	0.0034

Dolphin CPA By Year (1994-1997)



Linear Fit

CPA = 11.8375 0.09327 Year

Summary of Fit

RSquare	0.000705
RSquare Adj	0.000382
Root Mean Square Error	3.985751
Mean of Response	2.935976
Observations (or Sum Wgts)	3093

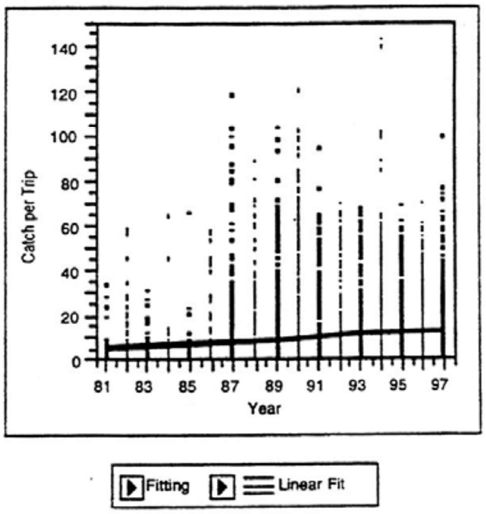
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	34.659	34.6593	2.1817
Error	3091	49104.275	15.8862	Prob>F
C Total	3092	49138.934		0.1398

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	11.83745	6.026884	1.96	0.0496
Year	-0.093273	0.063148	-1.48	0.1398

Catch per Trip By Year



Linear Fit

Catch per Trip = -34.32 + 0.49285 Year

Summary of Fit

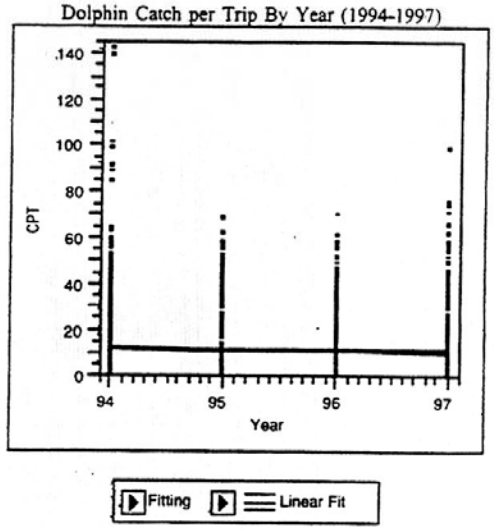
RSquare	0.012755
RSquare Adj	0.012624
Root Mean Square Error	17.3252
Mean of Response	10.81821
Observations (or Sum Wgts)	7591

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	29429.4	29429.4	98.0449
Error	7589	2277933.7	300.2	Prob>F
C Total	7590	2307363.1		<.0001

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-34.31998	4.562937	-7.52	<.0001
Year	0.4928505	0.049774	9.90	<.0001



Linear Fit

CPT = 55.591 0.45859 Year

Summary of Fit

RSquare	0.000933
RSquare Adj	0.00061
Root Mean Square Error	17.03551
Mean of Response	11.82574
Observations (or Sum Wgts)	3093

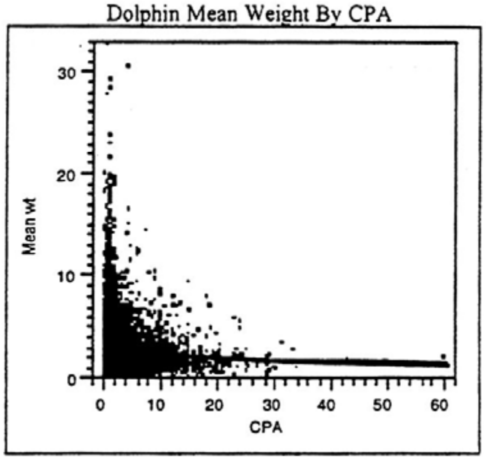
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	837.83	837.829	2.8870
Error	3091	897035.24	290.209	Prob>F
C Total	3092	897873.07		0.0894

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	55.591004	25.75953	2.16	0.0310
Year	-0.458591	0.2699	-1.70	0.0894

Dolphin Mean Weight By CPA



Fitting | Transformed Fit to Log

Transformed Fit to Log

Mean wt = 3.86429 0.58417 Log(CPA)

Summary of Fit

RSquare	0.048237
RSquare Adj	0.048111
Root Mean Square Error	2.793282
Mean of Response	3.584954
Observations (or Sum Wgts)	7591

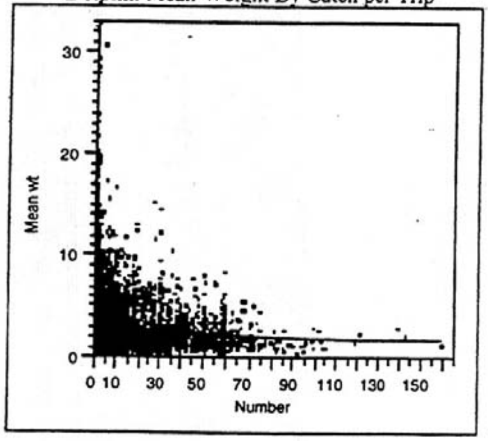
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	3000.971	3000.97	384.6205
Error	7589	59212.578	7.80	Prob>F
C Total	7590	62213.550		<.0001

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	3.8642881	0.035082	110.15	0.0000
Log(CPA)	-0.58417	0.029787	-19.61	<.0001

Dolphin Mean Weight By Catch per Trip



Fitting — Transformed Fit to Log

Transformed Fit to Log

Mean wt = 4.19247 0.45221 Log(Number)

Summary of Fit

RSquare	0.047877
RSquare Adj	0.047751
Root Mean Square Error	2.79381
Mean of Response	3.584954
Observations (or Sum Wgts)	7591

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	2978.584	2978.58	381.6069
Error	7589	59234.966	7.81	Prob>F
C Total	7590	62213.550		<.0001

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	4.1924652	0.04467	93.85	0.0000
Log(Number)	-0.452208	0.023149	-19.53	<.0001

Dolphin Commercial Landings

Dolphin Commercial Totals by Gear (1950-1997)

Gear	N Rows	Pounds	% total
Combined Gears	50	11844787	56.30
Lines Long Set With Hooks	124	3117906	14.82
Lines Troll Other	98	2611375	12.41
Lines Hand Other	152	2104716	10.00
Not Coded	7	1070966	5.09
Rod and Reel	16	97571	0.46
Lines Long Reef Fish	11	61710	0.29
Reel Electric or Hydraulic	7	49047	0.23
Lines Troll Salmon	2	20600	0.10
Trawl Midwater Paired	6	15730	0.07
Troll & Hand Lines Cmb	3	10424	0.05
Otter Trawl Bottom Fish	21	8952	0.04
Lines Troll Tuna	9	4626	0.02
Lines Long Shark	3	4487	0.02
Gill Nets Drift Runaround	3	3600	0.02
Haul Seines Beach	2	3417	0.02
Gill Nets Other	3	1850	0.01
Gill Nets Drift Other	5	1824	0.01
Gill Nets Drift Large Pelagic	5	1084	0.01
Pots And Traps Eel	1	1004	0.00
Gill Nets Sink/Anchor Other	3	592	0.00
Floating Traps (Shallow)	2	500	0.00
Stop Seines	1	400	0.00
Dredge Scallop Sea	2	221	0.00
Harpoons Other	1	152	0.00
Pots And Traps Fish	1	102	0.00
Lines Power Troll Tuna	1	85	0.00
Harpoons Swordfish	2	66	0.00
Pots And Traps Lobster Ofshore	1	15	0.00
Pots And Traps Lobster Inshore	1	10	0.00

Dolphin Commercial Totals by State All Years

State	N Rows	Pounds	Percent
Florida West Coast	47	9376129	44.36
Florida East Coast	48	4229386	20.01
Louisiana	14	2862699	13.55
North Carolina	19	1786685	8.45
South Carolina	21	1360478	6.44
New Jersey	15	489272	2.32
New York	17	317928	1.50
Texas	9	300314	1.42
Georgia	16	149593	0.71
Rhode Island	18	90605	0.43
Maryland	16	68537	0.32
Virginia	15	39601	0.19
Massachusetts	11	35908	0.17
Maine	9	10966	0.05
Alabama	5	9439	0.04
Connecticut	6	6648	0.03
Florida	4	3.9	0.00

Dolphin Commercial Totals by State 94-97

State	N Rows	Pounds	Percent
Florida West Coast	4	2911777	38.51
Florida East Coast	4	1445035	19.11
Louisiana	4	919431	12.16
North Carolina	4	873023	11.55
South Carolina	4	822176	10.87
New Jersey	4	277579	3.67
New York	4	128784	1.70
Texas	4	48356	0.64
Georgia	3	44954	0.59
Maryland	4	36561	0.48
Rhode Island	4	21171	0.28
Massachusetts	4	17436	0.23
Maine	4	8202	0.11
Virginia	1	6087	0.08
Connecticut	2	584	0.01
Alabama	1	219	0.00

Dolphin All Areas

Gear	1994	1995	1996	1997
Hook & Line	929,351	1,493,093	988,692	1,104,947
Longline	453,232	1,025,654	507,506	812,059
Other	16,545	24,314	15,284	14,752
Unknown	129,922	284,210	304,326	270,856
Total	1,528,768	2,826,985	1,815,520	2,202,323

Dolphin Commercial Size Limits

Dolphin All Areas

	Hand Line				Long Line				Other				Total		
	Number		Weight		Number		Weight		Number		Weight		Number		
Size Mm FL	Int %	Cum %	Int %	Cum %	Int %	Cum %	Int %	Cum %	Int %	Cum %	Int %	Cum %	Int %	Cum %	Int
< 500	7.3	7.3	0.8	0.8	2.3	2.3	0.2	0.2	-	-	-	-	7.3	7.3	
501-600	3.0	10.3	0.6	1.4	2.8	5.1	0.5	0.7	-	-	-	-	3.0	10.3	
601-650	1.3	11.6	0.4	1.7	1.0	6.1	0.2	0.9	-	-	-	-	1.3	11.6	
651-700	2.5	14.1	0.9	2.6	1.0	7.1	0.3	1.2	-	-	-	-	2.5	14.1	
701-750	1.7	15.8	0.7	3.3	1.2	8.3	0.4	1.7	-	-	-	-	1.7	15.8	
751-800	3.3	19.1	1.7	5.0	5.3	13.6	2.3	4.0	-	-	-	-	3.3	19.1	
801-850	4.2	23.2	2.5	7.5	0.6	14.2	0.3	4.3	-	-	-	-	4.2	23.2	
851-900	2.7	26.0	1.9	9.5	0.4	14.6	0.2	4.5	-	-	-	-	2.7	26.0	
901-950	4.4	30.3	3.6	13.1	10.5	25.1	7.6	12.1	-	-	-	-	4.4	30.3	
951-1000	8.1	38.4	7.7	20.9	6.6	31.7	5.1	17.2	-	-	-	-	8.1	38.4	
1001-1050	21.3	59.7	23.3	44.2	14.2	45.9	13.0	30.3	-	-	-	-	21.3	59.7	2
1051-1100	19.6	79.3	24.5	68.7	16.6	62.5	17.6	47.8	-	-	-	-	19.6	79.3	2
1101-1150	13.0	92.4	18.2	86.9	6.5	69.0	7.6	55.4	-	-	-	-	13.0	92.3	1
1151-1200	3.5	95.9	5.6	92.5	20.4	89.5	27.7	83.1	-	-	-	-	3.5	95.9	
1201-1250	3.5	99.4	6.3	98.8	5.2	94.7	7.6	90.7	-	-	-	-	3.5	99.4	
1251-1300	0.6	100.0	1.2	100.0	5.0	99.7	8.6	99.3	-	-	-	-	0.6	100.0	
1301-1350	-	100.0	-	100.0	0.2	99.8	0.3	99.6	-	-	-	-	0.0	100.0	
1351-1400	-	100.0	-	100.0	-	99.8	-	99.6	-	-	-	-	-	100.0	
1401-1450	-	100.0	-	100.0	0.1	99.9	0.2	99.8	-	-	-	-	0.0	100.0	
1451-1500	-	100.0	-	100.0	-	99.9	-	99.8	-	-	-	-	-	100.0	

Dolphin Commercial Trip Limits

Dolphin All Areas

	Hand Line/R&R				Long Line				Other				Total			
	Trips		Weight		Trips		Weight		Trips		Weight		Trips		Weight	
Trip Limit	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red
0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0
100	80.5	19.5	59.5	40.5	49.3	50.7	20.8	79.2	91.6	8.4	37.0	63.0	73.2	26.8	36.9	63.1
200	10.9	8.6	17.7	22.8	14.6	36.1	12.5	66.7	1.3	7.0	11.8	51.2	11.8	15.0	14.7	48.4
300	4.6	4.0	8.0	14.9	6.8	29.3	9.6	57.1	3.5	3.6	5.9	45.3	5.1	9.9	8.9	39.5
400	1.5	2.5	4.4	10.5	5.5	23.8	7.8	49.3	-	3.6	5.2	40.0	2.4	7.5	6.4	33.1
500	0.8	1.7	2.9	7.6	5.0	18.8	6.3	43.1	0.3	3.3	5.0	35.0	1.8	5.7	4.8	28.3
600	0.5	1.2	2.0	5.6	4.4	14.5	4.9	38.1	-	3.3	4.8	30.2	1.4	4.3	3.7	24.6
700	0.3	0.9	1.4	4.2	3.4	11.0	3.7	34.4	0.1	3.1	4.7	25.5	1.0	3.3	2.8	21.8
800	0.3	0.6	1.1	3.1	3.2	7.8	3.0	31.5	-	3.1	4.6	20.9	1.0	2.3	2.2	19.6
900	0.3	0.4	0.7	2.4	0.7	7.1	2.2	29.3	-	3.1	4.6	16.2	0.3	2.0	1.6	18.1
1000	0.1	0.3	0.4	2.0	0.5	6.6	2.0	27.3	-	3.1	4.6	11.6	0.2	1.8	1.3	16.7
1500	0.2	0.1	1.3	0.7	2.2	4.4	8.1	19.2	3.1	0.0	11.6	0.0	0.7	1.1	5.2	11.5
2000	0.1	0.0	0.5	0.3	1.6	2.8	5.1	14.2	-	0.0	-	0.0	0.4	0.7	3.1	8.4
3000	0.0	0.0	0.2	0.1	1.1	1.7	6.3	7.8	-	0.0	-	0.0	0.3	0.4	3.8	4.6
3500	0.0	0.0	0.0	0.0	0.5	1.3	2.3	5.6	-	0.0	-	0.0	0.1	0.3	1.3	3.3
4000	0.0	0.0	0.0	0.0	0.4	0.9	1.5	4.0	-	0.0	-	0.0	0.1	0.2	0.9	2.4

Wahoo Recreational Harvest

Wahoo Annual Totals

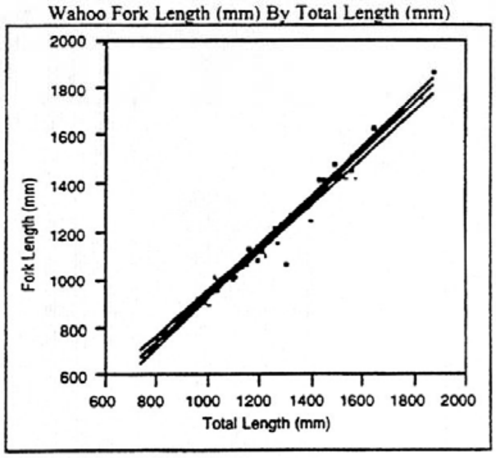
YR	Headboat		Charter		Private/Rental		Total	
	Number	Pounds	Number	Pounds	Number	Pounds	Number	Pounds
81	110	3,716	106,022	1,615,215	14,386	213,540	120,518	1,832,471
82	130	4,815	627	8,741	21,113	300,914	21,870	314,470
83	161	3,314	10,561	314,696	34,126	749,487	44,848	1,067,497
84	119	3,676	3,347	94,929	16,911	335,281	20,377	433,886
85	96	3,175	3,350	112,214	12,392	443,292	15,838	558,680
86	23,912	900,775	18,370	569,890	36,326	1,254,674	78,608	2,725,338
87	115	4,068	32,202	711,809	23,220	467,049	55,537	1,182,926
88	618	20,173	23,140	513,462	30,707	737,052	54,465	1,270,686
89	95	3,521	8,013	209,285	16,048	586,909	24,156	799,715
90	4,335	142,615	10,021	208,078	11,465	228,561	25,821	579,254
91	125	3,989	20,984	426,385	24,212	560,891	45,321	991,266
92	181	6,643	17,913	390,873	32,753	594,113	50,847	991,629
93	153	4,689	24,789	505,692	28,608	694,614	53,550	1,204,994
94	219	5,385	28,041	550,670	19,822	392,952	48,082	949,007
95	278	8,901	45,669	847,456	30,170	520,836	77,210	1,393,745
96	149	4,366	23,371	564,068	23,875	619,467	47,394	1,187,901
97	258	3,394	52,022	1,068,091	15,669	288,341	67,949	1,359,826

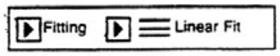
Wahoo Recreational Size Limits

Wahoo All Areas

Size Mm FL	Headboat Number %	Headboat Number Cum %	Headboat Weight %	Headboat Weight Cum %	Party/Charter Number %	Party/Charter Number Cum %	Party/Charter Weight %	Party/Charter Weight Cum %	Private/Rental Number %	Private/Rental Number Cum %	Private/Rental Weight %	Private/Rental Weight Cum %	Number %	Number Cum
< 601	-	-	-	-	0.4	0.4	0.0	0.0	0.4	0.4	0.1	0.1	0.4	0
601-800	26.8	26.8	12.6	12.6	3.2	3.7	0.8	0.9	1.7	2.2	0.5	0.5	3.2	3
801-900	9.1	35.9	6.9	19.5	5.6	9.2	2.3	3.2	3.7	5.9	1.3	1.8	5.5	9
901-1000	36.0	71.9	37.2	56.7	8.9	18.2	4.8	8.0	15.6	21.5	8.0	9.9	9.4	18
1001-1050	18.2	90.1	23.7	80.5	8.9	27.0	6.0	14.0	8.2	29.7	5.0	14.9	8.8	27
1051-1100	0.1	90.2	0.2	80.7	10.4	37.4	8.0	22.0	11.6	41.3	8.3	23.2	10.5	37
1101-1150	0.3	90.5	0.5	81.2	10.4	47.8	9.1	31.0	9.9	51.2	8.0	31.2	10.3	48
1151-1200	9.1	99.6	17.2	98.5	12.1	59.9	12.0	43.0	6.6	57.9	6.1	37.2	11.7	59
1201-1250	0.1	99.7	0.3	98.7	10.8	70.7	12.0	55.0	6.7	64.6	6.9	44.1	10.5	70
1251-1300	-	99.7	-	98.7	10.5	81.2	13.1	68.1	10.4	75.0	11.9	56.0	10.5	80
1301-1350	-	99.7	-	98.7	5.5	86.7	7.6	75.7	3.7	78.6	4.8	60.8	5.3	86
1351-1400	-	99.7	-	98.7	3.6	90.3	5.6	81.3	4.3	82.9	6.2	67.0	3.6	89
> 1400	0.3	100.0	1.3	100.0	9.7	100.0	18.7	100.0	17.1	100.0	33.0	100.0	10.2	100

Wahoo Fork Length (mm) By Total Length (mm)





Linear Fit

Fork Length (mm) = -54.153 + 0.99104 Total Length (mm)

Summary of Fit

RSquare	0.971017
RSquare Adj	0.970413
Root Mean Square Error	42.61702
Mean of Response	1163.64
Observations (or Sum Wgts)	50

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	2920681.4	2920681	1608.118
Error	48	87178.1	1816	Prob>F
C Total	49	3007859.5		<.0001

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-54.15281	30.96017	-1.75	0.0867
Total Length (mm)	0.9910423	0.024713	40.10	<.0001

Nonlinear Fitting Control Panel

_ Second Deriv. Method
_ Continuous Update
_ Iteration Log
_ Loss is -LogLikelihood
PLCI iter=2 Converged g=9.47e-6
Converged in the Gradient

	Current	Limit	Alpha
Iteration	2	60	0.050
Shortening	0	15	
O Criterion	5.587935e-14	0.0000001	
D Criterion	0.0000029098	0.0000001	
G Criterion	0.0000000036	0.000001	
CL Criterion	?	0.00001	

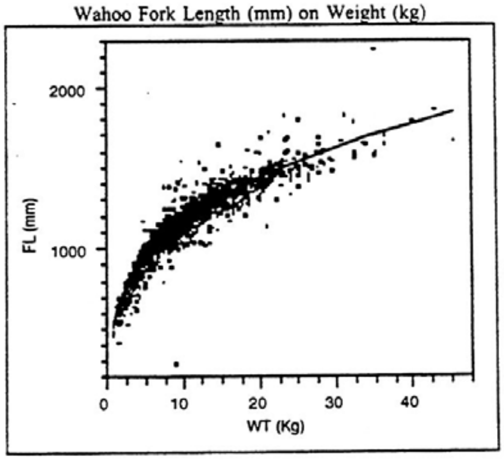
Parameter	Current Value	Lock	SSE
p1	589.06590181	_	9744995.5861
p2	0.3004449317	_	9761113.438

Solution

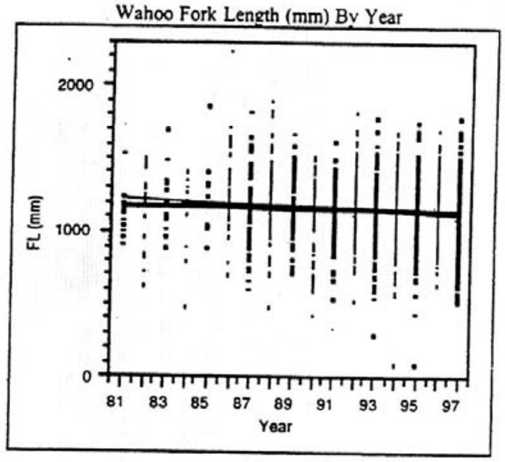
SSE	DFE	MSE	RMSE
9744995.5861	2325	4191.396	64.740991

Parameter	Estimate	ApproxStdErr	Lower CL	Upper CL
p1	589.06590181	3.22517103	582.809605	595.390413
p2	0.3004449317	0.00228632	0.29599309	0.30489937

Wahoo Fork Length (mm) on Weight (kg)



Wahoo Fork Length (mm) By Year



Fitting Linear Fit

Linear Fit

FL (mm) = 1449.64 3.12172 Year

Summary of Fit

RSquare	0.003002
RSquare Adj	0.002636
Root Mean Square Error	199.036
Mean of Response	1159.642
Observations (or Sum Wgts)	2728

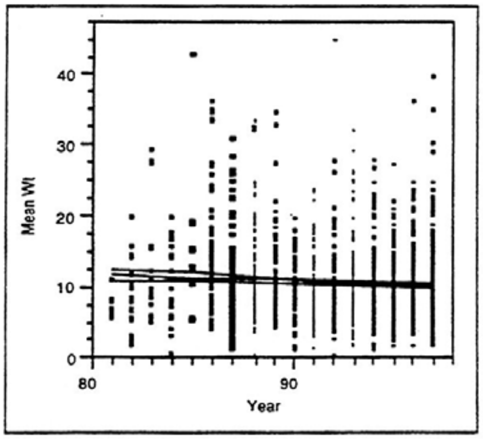
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	325141	325141	8.2075
Error	2726	107991389	39615	Prob>F
C Total	2727	108316530		0.0042

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	1449.6371	101.2964	14.31	<.0001
Year	-3.12172	1.089657	-2.86	0.0042

Wahoo Mean Weight By Year



Fitting Linear Fit

Linear Fit

Mean Wt = 19.2759 0.09255 Year

Summary of Fit

RSquare	0.003729
RSquare Adj	0.003078
Root Mean Square Error	5.579437
Mean of Response	10.71417
Observations (or Sum Wgts)	1532

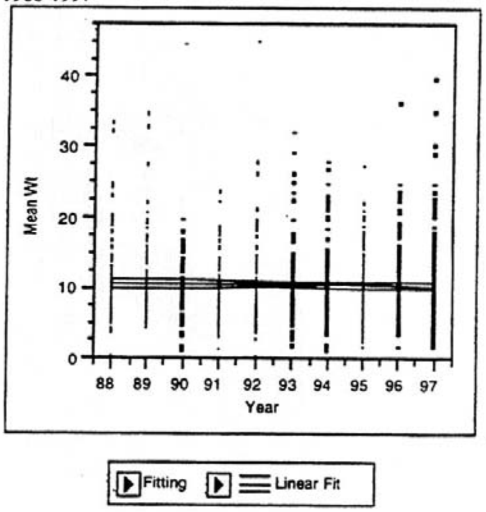
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	178.274	178.274	5.7267
Error	1530	47629.080	31.130	Prob>F
C Total	1531	47807.354		0.0168

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	19.275858	3.580554	5.38	<.0001
Year	-0.09255	0.038674	-2.39	0.0168

Wahoo Mean Weight By Year 1988-1997



Linear Fit

Mean Wt = 13.1362 0.02778 Year

Summary of Fit

RSquare	0.000205
RSquare Adj	-0.00054
Root Mean Square Error	5.281206
Mean of Response	10.53934
Observations (or Sum Wgts)	1344

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	7.677	7.6773	0.2753
Error	1342	37429.912	27.8911	Prob>F
C Total	1343	37437.590		0.5999

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	13.136238	4.951842	2.65	0.0081
Year	-0.027781	0.052952	-0.52	0.5999

Wahoo Recreational Bag and Trip Limits

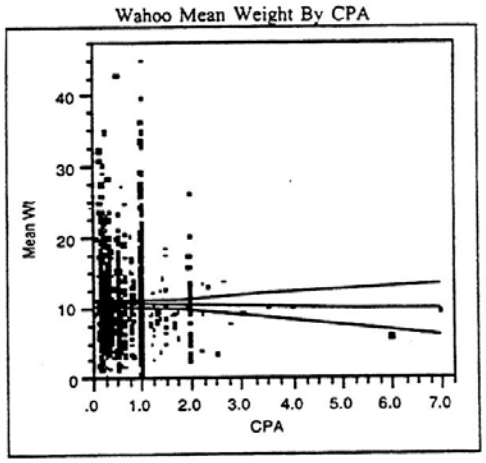
Wahoo Bag Limitr\ All Areas

Bag	Headboat				Party/Charter				Private/Rental				Total			
	Number		Weight		Number		Weight		Number		Weight		Number		Weight	
Limit	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red
0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0
1	43.8	56.2	51.5	48.5	80.4	19.6	85.3	14.7	80.0	20.0	84.8	15.2	65.9	34.1	73.4	26.6
2	21.7	34.5	21.8	26.7	10.4	9.2	9.0	5.7	8.8	11.2	7.8	7.3	14.8	19.3	13.4	13.2
3	10.8	23.7	10.1	16.7	2.4	6.8	1.8	3.8	2.7	8.5	2.1	5.2	5.7	13.6	4.7	8.4
4	6.5	17.2	5.7	10.9	0.8	6.0	0.5	3.3	0.9	7.6	0.6	4.6	3.1	10.5	2.4	6.1
5	4.2	13.0	3.6	7.4	0.6	5.4	0.3	3.0	0.8	6.8	0.5	4.1	2.0	8.5	1.5	4.6
6	2.9	10.2	2.4	5.0	0.5	5.0	0.3	2.7	0.7	6.1	0.4	3.6	1.4	7.1	1.0	3.6
7	1.9	8.2	1.6	3.4	0.4	4.6	0.2	2.5	0.7	5.4	0.4	3.2	1.0	6.1	0.7	2.9
8	0.9	7.3	0.7	2.7	0.4	4.2	0.2	2.3	0.6	4.8	0.4	2.9	0.6	5.5	0.4	2.5
9	0.2	7.1	0.1	2.6	0.4	3.9	0.2	2.1	0.6	4.2	0.4	2.5	0.3	5.2	0.2	2.3
10	0.2	7.0	0.1	2.5	0.4	3.5	0.2	1.9	0.6	3.6	0.3	2.2	0.3	4.9	0.2	2.1
11	0.1	6.9	0.0	2.5	0.4	3.1	0.2	1.7	0.6	3.1	0.3	1.8	0.3	4.6	0.1	2.0
12	0.1	6.8	0.0	2.5	0.4	2.8	0.2	1.5	0.6	2.5	0.3	1.5	0.3	4.3	0.1	1.8
13	0.1	6.7	0.0	2.4	0.4	2.4	0.2	1.3	0.6	1.9	0.3	1.1	0.3	4.1	0.1	1.7
14	0.1	6.6	0.0	2.4	0.4	2.0	0.2	1.1	0.6	1.3	0.3	0.8	0.3	3.8	0.1	1.5
15	0.1	6.6	0.0	2.4	0.4	1.7	0.2	0.9	0.6	0.8	0.3	0.5	0.3	3.6	0.1	1.4
20	0.4	6.2	0.1	2.2	1.7	0.0	0.9	0.0	0.8	0.0	0.5	0.0	1.1	2.4	0.6	0.8
25	0.4	5.8	0.1	2.1	-	0.0	-	0.0	-	0.0	-	0.0	0.2	2.3	0.0	0.7

Wahoo Trip Limit All Areas

Trip Limit	Headboat Number Int %	Headboat Number % Red	Headboat Weight Int %	Headboat Weight % Red	Party/Charter Number Int %	Party/Charter Number % Red	Party/Charter Weight Int %	Party/Charter Weight % Red	Private/Rental Number Int %	Private/Rental Number % Red	Private/Rental Weight Int %	Private/Rental Weight % Red	Total Number Int %	Total Number % Red	Total Weight Int %	Total Weight % Red
0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0
1	6.4	93.6	11.2	88.8	41.7	58.3	46.4	53.6	60.1	39.9	65.9	34.1	28.9	71.1	37.8	62.2
2	1.9	91.7	2.5	86.3	18.0	40.3	18.5	35.2	12.7	27.2	12.6	21.5	11.3	59.8	13.5	48.7
3	1.7	90.0	2.1	84.2	10.3	30.0	10.1	25.1	6.2	20.9	5.9	15.6	6.7	53.2	7.5	41.1
5	3.1	86.8	3.8	80.4	11.1	18.9	10.4	14.6	6.5	14.4	5.8	9.8	7.7	45.5	8.2	32.9
10	7.0	79.9	8.1	72.3	9.8	9.1	8.6	6.0	5.3	9.1	4.4	5.4	8.4	37.0	8.2	24.8
15	6.0	73.9	6.7	65.6	2.5	6.6	2.0	4.0	1.1	8.0	0.8	4.6	3.8	33.2	3.3	21.5
20	5.3	68.5	5.8	59.8	0.8	5.8	0.6	3.4	0.6	7.5	0.3	4.3	2.6	30.6	2.0	19.5
25	4.6	63.9	4.9	54.9	0.4	5.3	0.3	3.2	0.5	7.0	0.3	4.0	2.1	28.6	1.6	17.9
30	4.2	59.6	4.4	50.6	0.4	5.0	0.2	3.0	0.5	6.5	0.3	3.7	1.9	26.6	1.4	16.5
40	7.8	51.8	7.9	42.6	0.7	4.2	0.4	2.5	1.0	5.5	0.6	3.2	3.5	23.1	2.6	13.9
50	6.6	45.2	6.5	36.2	0.7	3.5	0.4	2.1	1.0	4.6	0.5	2.6	3.1	20.0	2.2	11.8
75	12.7	32.6	12.0	24.1	1.8	1.7	1.1	1.0	2.4	2.2	1.4	1.3	6.1	13.9	4.2	7.6
100	7.8	24.8	7.0	17.2	1.7	0.0	1.0	0.0	2.2	0.0	1.3	0.0	4.1	9.8	2.7	4.9

31



Fitting Linear Fit

Linear Fit

Mean Wt = 10.7859 0.12574 CPA

Summary of Fit

RSquare	0.000121
RSquare Adj	-0.00053
Root Mean Square Error	5.58953
Mean of Response	10.71417
Observations (or Sum Wgts)	1532

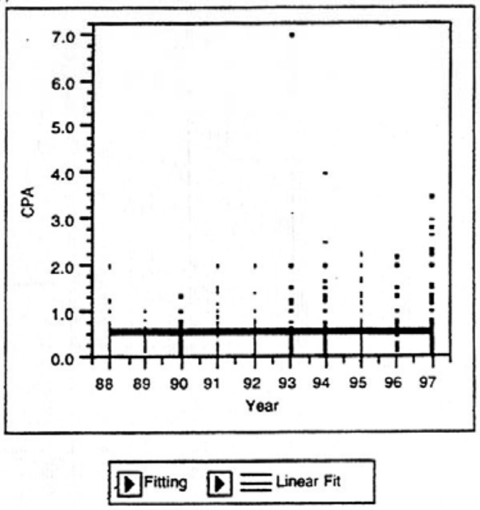
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	5.808	5.8084	0.1859
Error	1530	47801.546	31.2428	Prob>F
C Total	1531	47807.354		0.6664

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	10.785931	0.219302	49.18	0.0000
CPA	-0.125743	0.291631	-0.43	0.6664

Wahoo CPA By Year 1988-1997



Linear Fit

CPA = 0.77166 0.00236 Year

Summary of Fit

RSquare	0.000181
RSquare Adj	-0.00056
Root Mean Square Error	0.478131
Mean of Response	0.550983
Observations (or Sum Wgts)	1344

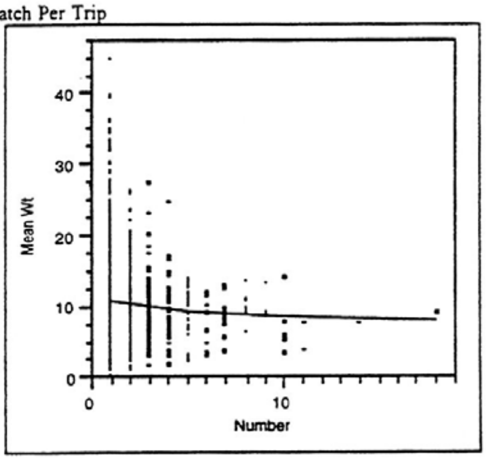
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.05544	0.055441	0.2425
Error	1342	306.79337	0.228609	Prob>F
C Total	1343	306.84881		0.6225

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	0.7716632	0.448312	1.72	0.0854
Year	-0.002361	0.004794	-0.49	0.6225

Wahoo Mean Weight (kg) By Catch Per Trip



Fitting — Transformed Fit to Log

Transformed Fit to Log

Mean Wt = 10.8536 0.94241 Log(Number)

Summary of Fit

RSquare	0.009649
RSquare Adj	0.008911
Root Mean Square Error	5.256204
Mean of Response	10.53934
Observations (or Sum Wgts)	1344

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	361.239	361.239	13.0753
Error	1342	37076.350	27.628	Prob>F
C Total	1343	37437.590		0.0003

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	10.853575	0.167655	64.74	0.0000
Log(Number)	-0.94241	0.260624	-3.62	0.0003

Wahoo Commercial Landings

Wahoo Commercial Totals by Gear-All years

Gear	N Rows	Pounds	% Pounds
Combined Gears	45	1278379	42.50
Not Coded	4	656797	21.83
Lines Long Set With Hooks	80	586741	19.51
Lines Troll Other	29	244463	8.13
Lines Hand Other	56	186817	6.21
Floating Traps (Shallow)	1	15882	0.53
Lines Long Reef Fish	4	10120	0.34
Reel Electric or Hydraulic	5	8465	0.28
Rod and Reel	8	8441	0.28
Gill Nets Drift Runaround	5	7200	0.24
Trawl Midwater Paired	2	3445	0.11
Gill Nets Sink/Anchor Other	2	1019	0.03
Lines Long Shark	1	221	0.01
Gill Nets Drift Other	2	63	0.00
Lines Troll Tuna	2	37	0.00
Gill Nets Drift Large Pelagic	1	16	0.00
Dredge Scallop Sea	1	14	0.00

Wahoo Commercial Totals by State All years

State	N Rows	Pounds	% Pounds
Louisiana	13	1572783	52.08
Florida West Coast	24	527182	17.46
Florida East Coast	24	330205	10.93
North Carolina	19	266503	8.82
Texas	9	132063	4.37
South Carolina	17	130089	4.31
Rhode Island	4	16252	0.54
New Jersey	10	11565	0.38
New York	14	8361	0.28
Georgia	6	7175	0.24
Alabama	3	6743	0.22
Maryland	8	2941	0.10
Virginia	14	2750	0.09
Mississippi	1	2718	0.09
Massachusetts	4	1327	0.04
Connecticut	2	1241	0.04

Wahoo Commercial Totals by State 94-97

State	N Rows	Pounds	% Pounds
Louisiana	4	513534	51.76
Florida West Coast	4	183631	18.51
North Carolina	4	107871	10.87
Florida East Coast	4	88069	8.88
South Carolina	4	41719	4.20
Texas	4	22466	2.26
Rhode Island	4	16252	1.64
New Jersey	4	6990	0.70
New York	4	5616	0.57
Georgia	2	3775	0.38
Maryland	3	2002	0.20
Massachusetts	2	122	0.01
Virginia	2	109	0.01
Connecticut	1	41	0.00

Wahoo All Areas

Gear	1994	1995	1996	1997
Hook & Line	63,778	95,177	73,275	95,280
Longline	26,840	30,590	31,878	34,809
Other	19,391	4,257	555	1,718
Unknown	140,677	135,576	127,369	133,162
Total	250,404	265,314	232,789	264,678

Wahoo Commercial Size Limits

Wahoo All Areas

Size Mm FL	Hand Line				Long Line				Other				Total			
	Number		Weight		Number		Weight		Number		Weight		Number		Weight	
	Int %	Cum %	Int %	Cum %	Int %	Cum %	Int %	Cum %	Int %	Cum %	Int %	Cum %	Int %	Cum %	Int %	Cum %
< 600	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	0.0	0.0	0.0	0.0
601-800	2.5	2.5	0.8	0.8	0.9	0.9	0.2	0.2	-	-	-	-	2.3	2.3	0.7	0.7
801-900	7.3	9.8	2.9	3.7	12.3	13.2	4.2	4.4	-	-	-	-	7.7	10.0	3.0	3.8
901-1000	12.7	22.5	7.1	10.7	12.5	25.7	6.7	11.1	-	-	-	-	12.7	22.8	7.0	10.8
1001-1050	9.8	32.4	6.6	17.3	12.5	38.2	7.8	18.9	-	-	-	-	10.0	32.8	6.7	17.5
1051-1100	13.0	45.4	9.7	27.1	5.3	43.6	3.6	22.5	-	-	-	-	12.4	45.2	9.2	26.7
1101-1150	8.3	53.7	7.1	34.2	4.0	47.6	3.2	25.7	-	-	-	-	8.0	53.2	6.8	33.5
1151-1200	6.8	60.5	6.7	40.9	3.7	51.3	3.1	28.9	-	-	-	-	6.6	59.8	6.4	39.9
1201-1250	5.9	66.4	6.2	47.1	3.8	55.1	3.8	32.6	-	-	-	-	5.7	65.5	6.0	45.9
1251-1300	8.0	74.4	9.5	56.6	10.3	65.4	11.5	44.1	-	-	-	-	8.2	73.8	9.7	55.6
1301-1350	5.8	80.2	7.7	64.3	12.5	78.0	15.2	59.3	-	-	-	-	6.3	80.0	8.3	63.9
1351-1400	6.5	86.7	9.5	73.8	8.2	86.2	11.3	70.6	-	-	-	-	6.6	86.6	9.6	73.5
1401-1450	3.9	90.6	6.4	80.2	2.2	88.4	3.4	73.9	-	-	-	-	3.8	90.5	6.1	79.7
1451-1500	2.8	93.4	5.1	85.2	4.0	92.4	6.6	80.5	-	-	-	-	2.9	93.3	5.2	84.9

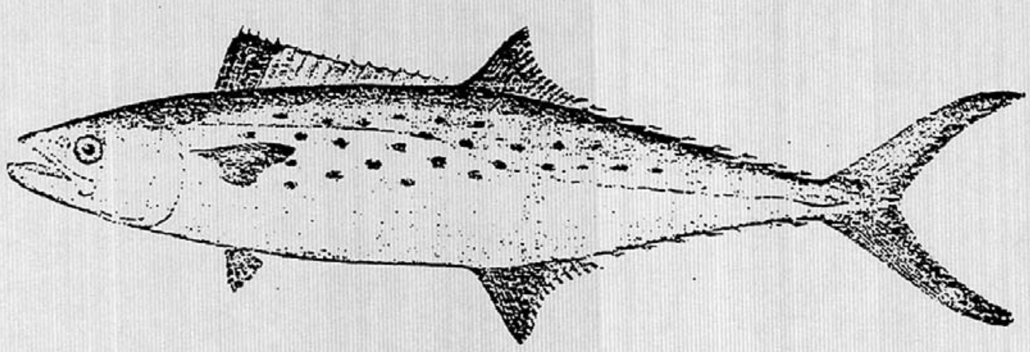
Wahoo Commercial Trip Limits

Wahoo All Areas

Trip Limit	Hand Line/R&R				Long Line				Other					
	Trips		Weight		Trips		Weight		Trips		Weight		Trips	
	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Red	Int %	% Re[illegible]
0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	100.0	-	[illegible]
50	64.8	35.2	54.7	45.3	36.3	63.7	28.6	71.4	87.3	12.7	92.1	7.9	50.1	[illegible]
100	24.1	11.1	15.3	29.9	22.5	41.2	17.1	54.3	12.7	0.0	7.9	0.0	23.3	[illegible]
150	4.2	7.0	6.5	23.4	11.9	29.2	11.6	42.8	-	0.0	-	0.0	8.2	[illegible]
200	2.6	4.4	4.2	19.2	6.7	22.6	8.6	34.2	-	0.0	-	0.0	4.7	[illegible]
250	2.0	2.3	2.5	16.7	4.8	17.7	6.7	27.5	-	0.0	-	0.0	3.5	[illegible]
300	0.4	2.0	1.6	15.1	3.5	14.2	5.2	22.2	-	0.0	-	0.0	2.0	
350	0.3	1.7	1.4	13.8	2.4	11.8	4.4	17.9	-	0.0	-	0.0	1.4	
400	0.3	1.4	1.2	12.6	2.5	9.3	3.5	14.4	-	0.0	-	0.0	1.4	
450	0.1	1.3	1.0	11.6	1.7	7.7	2.8	11.6	-	0.0	-	0.0	0.9	
500	0.1	1.2	1.0	10.7	1.5	6.2	2.3	9.3	-	0.0	-	0.0	0.8	
750	0.7	0.4	3.1	7.5	4.2	2.0	6.1	3.2	-	0.0	-	0.0	2.5	
1000	0.2	0.2	1.3	6.3	1.5	0.5	2.2	1.0	-	0.0	-	0.0	0.9	
1500	0.1	0.1	1.3	5.0	0.4	0.1	0.7	0.3	-	0.0	-	0.0	0.3	
2000	-	0.1	0.8	4.2	0.1	0.0	0.2	0.1	-	0.0	-	0.0	0.0	
2500	-	0.1	0.8	3.4	0.0	0.0	0.0	0.1	-	0.0	-	0.0	0.0	

Appendix I. Commercial Landings Update: Coastal Migratory Pelagic Fish (SERO-ECON-99-06)

Commercial Landings Update
Coastal Migratory Pelagic Fish



John Vondruska
National Marine Fisheries Service
Fisheries Economics Office

April 2, 1999

SERO-ECON-99-06

Commercial Landings Update,
Coastal Migratory Pelagic Fish
April 2, 1999

This report updates summaries of data on commercial landings and exvessel prices for coastal migratory pelagic fish for the Atlantic and Gulf coast states (Maine to Texas), with emphasis on the southeast (North Carolina to Texas). The data is preliminary for recent years and not complete for 1998.

Methods, Data and Caveats

This report is based mostly on data obtained in early March 1999 from the Northeast (Woods Hole) and Southeast (Miami) Fisheries Science Centers of the National Marine Fisheries Service (NMFS). The southeast data has been collected under a cooperative state-federal program since the late 1970s. Most of the source files for this report consist of confidential, monthly data records that are identified by dealer (first buyer in the marketing chain going from fisherman to consumer). This affects what can be shown in tables.

In so far as possible, consistent annual time series are shown for individual states or groups of states in Table 4 for each of seven fish for 1962-98, and exceptions are footnoted. The seven fish are bluefish, bonito, cobia, dolphin fish, king mackerel and cero, Spanish mackerel, and wahoo. Monthly landings and real exvessel prices for each are shown for the southeast as a whole for 1977-98 (Tables 7-8). For king mackerel and cero, annual landings are shown for groups of Florida counties (Table 6), and monthly landings and real exvessel prices are shown for groups of southeastern states (Tables 9-10). Annual landings by fish and gear are shown in Table 5 for two regions, the South Atlantic (North Carolina to Dade County on the east coast of Florida) and Gulf of Mexico (Monroe County on the west coast of Florida to Texas). However, gear is not specified in all data records, including those for some Gulf states for 1991-98. Also, totals in Table 5 and other tables may differ. On the other hand, data on landings by gear for Florida became monthly and more timely for 1997 onward, based on Florida trip tickets.[1]

In this report, real prices are expressed in terms of 1990 cents per pound (whole or live weight). They are computed from the current dollar value of landings divided by the quantity of landings. The Bureau of Labor Statistics (BLS) Producer Price Index for all commodities is used as a deflator.

It is difficult to ascertain annual landings for 1998 with the data used in this report (obtained in early March 1999). While the annual data in Table 1 may suggest shortfalls for 1998, that is less clear from monthly data in Table 7. December landings in Florida are normally quite important to the annual totals for king and Spanish mackerel, but observations are

[1]Historically, breakouts of landings (by gear, water body, etc.) in Florida were not part of the ongoing collection of data from dealer records by port agents, and the data was managed by NMFS in separate annual files for Florida. The breakouts of Florida landings were based on an annual general canvass of Florida dealers and port agent records on fishing craft.

missing for Florida for December 1998. For cobia, dolphin fish and wahoo, the monthly numbers seem low for about August 1998 onward (Table 7).

Data for bonito (here combined with data for little tuna or little tunny) has not been entered separately in the source data files for Florida since 1994. For reasons of confidentiality, relatively small landings for other Gulf states are not shown.

Trends

Spanish mackerel

Commercial landings of Spanish mackerel on Florida's west coast appear to have been affected from July 1995 onward by the implementation of an Amendment to that State's Constitution that was intended to restrict the use of net gear (Tables 4, 6 and 7). Florida's "net ban" took effect in July 1995 and it extends to 9 nautical miles from shore on Florida's west coast compared with 3 nautical miles for Florida's east coast. However, as the term coastal migratory pelagic fish implies, it is also possible that changes in availability of harvestable concentrations of Spanish mackerel over time and space, weather, or other factors could have affected landings in Florida in recent years. Regardless of the precise effect of new state regulations on net gear, landings of Spanish mackerel for Florida's west coast and Louisiana were notably less in 1996-98 than in previous years. Consequently lower fishing mortality allowed stock conditions to improve for Gulf group Spanish mackerel especially in terms of biomass and transitional spawning potential ratio (MSAP, 1998).

Because the harvest occurred in federal waters (more than 3 nautical miles from shore), landings of Spanish mackerel have remained well within the range that had prevailed since the mid-1980s in southeast Florida (Volusia-Dade Counties in Table 6). That area has been the leading harvest area for Spanish mackerel since 1995. Whether that situation will continue is unclear. Roughly similar amounts of Spanish mackerel are now being landed in North Carolina, Alabama, the Florida west coast and the northeast (Table 4).

King mackerel

Among the seven coastal migratory pelagic fish considered in this report, king mackerel-cero now leads in terms of tonnage as well as value in the southeast, given the drop for Spanish mackerel that began in 1995. While bluefish does account for more tonnage than king mackerel and cero for the U.S. Atlantic and Gulf coasts as a whole, it is landed mostly in the northeast and North Carolina, and its low price means that the total exvessel value for bluefish was similar to that for Spanish mackerel in 1996-98 (Tables 1-3).

Total landings of king mackerel in recent years have been roughly the same as in the early 1960s, prior to most of the expansion attributable to fishing with gill nets. However, more of the total is now being landed in North Carolina-Georgia and Louisiana-Texas, while less is being landed in Florida (Tables 4 and 5).

The landings in North Carolina-Georgia tend to be concentrated in October-November, though large monthly amounts have been landed sporadically during January-April in recent years (monthly percentages, Table 9). Reportedly, there was a rumor that the landings in November 1998 could have been high enough to trigger events leading to closure for commercial fishing activity prior to the end of the (April-March) 1998/99 fishing year for Atlantic group king mackerel.[2] While quota closures have not been as much of a concern as for Gulf group king mackerel, the TAC has been reduced.[3]

Fishing for king mackerel in Alabama-Texas (mostly in Louisiana) began to be notable in 1982. It is now limited by a quota for the western zone for Gulf group king mackerel. Most of that quota has been landed in as little as the first two months of the fishing year for the Gulf group, which begins in July, and further fishing is curtailed (e.g., closure occurred on August 25, 1998). Reportedly, the fish landed in Alabama-Texas tend to be larger in size. This could help explain why the exvessel price per pound for them has tended to be lower than for king mackerel landed elsewhere (Table 10).

Landings of king mackerel in Florida once accounted for most of what was landed commercially in the Atlantic and Gulf coastal states, but they have been relatively flat in trend since the mid-1980s and appear to be a bit below their historical norm for the 1950s and earlier years (Table 4 and NMFS, 1990). Compared with the past, regulation of commercial fishing on the two stocks of king mackerel in Florida has become quite complex, more so than for any other state, given the Councils' response to the annual stock assessments that began in the mid-1980s. Also, recreational fishing activity today is much greater than in the past, and the Councils have allocated larger percentages of the total allowable catch (TAC) to recreational fishing than commercial fishing. Although allocations have been exceeded for both the commercial and recreational fishing on Gulf group king mackerel, the Councils have moved away from the idea of

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[2]Although preliminary, the data in this report is more complete than whatever was available prior to March 1999, and it indicates that 482,000 pounds of king mackerel-cero were landed in November 1998 in North Carolina, South Carolina and Georgia, taken together. The November 1998 amount is higher than that for November 1997 (346,000 pounds) and it exceeds the previous record for a month (407,000 pounds in November 1987).

[3]If the cumulative landings estimated through November 1998 under the quota-monitoring program were high enough, it is possible that this could have led to a chain of events that closed the commercial fishery for Atlantic group king mackerel early. The allocation was reduced (in proportion to the reduction in total allowable catch) from 3.9 million pounds (for fishing years 1991/92 to 1993/94) to 2.52 million pounds (for fishing years 1996/97 onward). The number for 1996/97 cited by the Mackerel Stock Assessment Panel in April 1998, 2.702 million pounds, did exceed the quota (MSAP, 1998, p. 10). Atlantic group king mackerel has not been considered to be overfished, although overfishing was said to be occurring during fishing year 1996/97, because the rate of fishing mortality (F) was greater than the rate necessary to achieve a target of 30% static spawning potential ratio in 1996/97 (MSAP, 1998, p. 9).

recreational fishery closure, to the extent that closure may be said to occur with a zero bag limit.[4]

For the South Atlantic region as a whole, landings by hook-and-line gear are higher than in the early 1960s, and they approached the peak levels of 1980-81 in 1997. On the other hand, for the Gulf region as a whole, landings by hook-and-line gear were well below those for runaround gill nets even in the hey day for gill nets.[5] Landings in the Gulf region via hook-and-line gear do not appear to be much different than in the early 1960s.[6] Today, differences along the Florida coast in "winter" (November-March) harvestable concentrations and differences in viable fishery practice for gill-net and hook-and-line boats are reflected in complex regulations that involve different trip limits and stepped quotas.[7]

Cobia, dolphin fish, and wahoo

Cobia, dolphin fish and wahoo are landed commercially in much smaller amounts than bluefish or Spanish mackerel, but they have higher prices, roughly similar to those for king mackerel-cero, and the value for dolphin fish is second to that for king mackerel-cero (Tables 1-3). As for king mackerel, landings for recreational fishing exceed those for commercial fishing. The South Atlantic Fishery Management Council hosted a workshop on May 6-8, 1998, respecting the biological characteristics and management options for dolphin fish and wahoo (SAFMC, 1998).

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[4]That is, even if a zero bag limit were imposed on all individuals on a fishing trip (e.g., all crew members, customers and passengers on for-hire boats), catch-and-release recreational fishing could continue.

[5]After a period of relatively high landings from the mid-1960s to 1983, a drop in the commercial landings of king mackerel via runaround gill net began in 1984 in both the South Atlantic and Gulf regions for several reasons. Perhaps the harvestable concentrations may not have been high enough in the normally peak months in south Florida (for viable gill net fishing). Also, the State of Florida implemented regulations on the use of net gear, which apparently applied to federal as well as state waters by default (lack of federal regulation). Later, a short-lived (1986-89) shift to drift gill nets was curtailed by Council action (Table 5, South Atlantic Region).

[6]Landings by hook and line gear for Gulf region as a whole may be understated in their amount for 1991 onward (Table 5) to the extent that they occur in states other than Florida. That is, significant amounts of landings have not been broken out by gear since 1991 for some of the Gulf states other than Florida.

[7]During the months of November-March, landings in Florida from the border with Alabama to the Flagler-Volusia County line on the east coast are said to consist of Eastern Zone fish of the Gulf group of king mackerel for purposes of stock assessment and commercial fishery regulation. On the east coast of Florida (from the Flagler-Volusia County line to the Dade-Monroe County line), a 50-fish trip limit applied in fishing year 1998/99 from November 1 until the quota for that area was reached (1,170,000 pounds, with a formal closure on March 13, 1999). On the west coast of Florida (through the Dade-Monroe County line), equal quotas were assigned for gill-net and hook-and-line fishing, 585,000 pounds each. With a 25,000 pound trip limit, the gill-net quota was reached earlier in fishing year 1998/99 (January 1, 1999) than the hook-and-line fishing quota (1250 pound trip limits until 438,750 pounds was reached, and then 500 pounds per trip until 585,000 pounds was reached, and formal closure occurred on March 16, 1999).

Cobia is landed under a two-fish bag limit, whether by commercial, charter, or private recreational fishing boats. While this has restrained commercial landings, the record amount, about 428,000 pounds in 1996, is several times that for 1966, about 55,000 pounds. Cobia went from being the lowest priced coastal migratory pelagic fish to being the highest priced (20 cents a pound in 1966 and 171 cents in 1998, both in terms of 1990 dollars, Table 3). If an individual fish is 15-30 pounds, it may have an exvessel value of about $25 to $50 (size data from Scott and Phares, 1999). Landings occur throughout the Atlantic and Gulf coast states, but they are highest for the west coast of Florida (Table 4). Hook-and-line gear accounts for much of what is landed commercially, though it is not as dominant as for king mackerel (Table 5).

Without the restraint of a 2-fish (recreational) bag limit, commercial landings of dolphin fish have grown more rapidly than landings of cobia. As for cobia, real prices of dolphin fish have advanced considerably since the 1960s (Table 3). Landings of dolphin fish surpassed a million pounds in 1989, and the record of 2.57 million pounds of 1995 is two orders of magnitude greater than the 32,000 pounds of 1965, when virtually all landings occurred in Florida. Significant landings began to occur in North Carolina-Georgia in the mid-1970s, and a bit later in Alabama-Texas and the northeast (Maine-Virginia) (Table 4). The most important commercial fishing gear types are hook-and-line, and long and trot lines gear (landings for the latter two are shown together in Table 5).

So far as could be determined for this report from NMFS-managed data files, the first separately reported commercial landings of wahoo on the Atlantic and Gulf coasts occurred in Florida in 1974 when they amounted to about a thousand pounds (Table 4). Landings now occur elsewhere, but to a large extent in Louisiana, where they are now much less than in 1992-93. In 1994-98, the landings total has been in the middle of the range of about 0.14 million pounds (1987) to 0.37 million pounds (1993). As for dolphin fish, the most important commercial fishing gear types are hook-and-line, long and trot lines (landings for the latter two are shown together in Table 5).

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List of tables on commercial landings, coastal migratory pelagic fish

Table 1.--Landings by fish, east & Gulf coasts
(thousands of pounds, whole weight)
(Data for 1998 is not complete)

Year	Bluefish	Bonito	Cobia	Dolphin fish	King mackerel & cero	Spanish mackerel	Wahoo	Total
1962	5,938	168	81	24	4,157	9,601	.	19,968
1963	5,595	212	95	9	5,058	7,794	.	18,762
1964	4,651	63	53	28	3,460	6,072	.	14,326
1965	5,031	182	45	32	4,593	8,012	.	17,896
1966	5,532	124	55	77	4,520	9,471	.	19,779
1967	4,295	50	61	189	6,099	7,885	.	18,576
1968	5,417	94	101	97	6,201	11,776	.	23,686
1969	5,993	217	85	61	6,204	10,918	.	23,477
1970	7,456	183	129	84	6,729	12,140	.	26,719
1971	6,328	198	125	60	5,667	10,391	.	22,770
1972	6,258	52	135	70	4,869	10,615	.	21,997
1973	8,598	578	125	88	5,937	9,711	.	25,037
1974	8,365	205	149	85	10,416	10,926	1	30,147
1975	8,260	325	139	133	6,333	11,350	5	26,546
1976	9,276	190	153	110	7,640	18,012	5	35,386
1977	11,542	493	116	135	9,406	13,693	7	35,392
1978	11,931	453	116	164	5,376	7,258	13	25,312
1979	13,521	868	105	111	5,527	7,023	15	27,170
1980	16,451	450	128	173	7,088	11,856	23	36,169
1981	17,446	855	161	132	8,816	7,940	26	35,376
1982	16,791	457	158	307	8,255	7,419	30	33,416
1983	16,787	565	169	321	6,969	8,265	34	33,109
1984	12,658	354	174	444	5,220	6,043	30	24,923
1985	14,245	241	165	422	5,398	6,457	39	26,967
1986	15,371	214	221	687	5,772	7,155	52	29,472
1987	15,244	387	274	648	5,211	7,178	160	29,101
1988	16,881	515	262	780	4,557	6,163	312	29,469
1989	10,494	594	337	1,561	3,657	6,985	300	23,928
1990	11,072	621	285	1,848	4,864	5,639	203	24,532
1991	11,141	879	318	2,430	4,053	7,819	252	26,892
1992	9,786	1,565	373	1,136	4,999	6,932	365	25,157
1993	8,874	864	392	1,242	5,687	7,518	335	24,912
1994	7,084	1,773	399	1,417	4,299	6,804	249	22,024
1995	8,081	227	399	2,570	4,680	5,220	264	21,440
1996	7,704	263	428	1,646	5,117	3,655	231	19,043
1997	8,387	332	361	1,995	5,949	3,812	256	21,093
1998	7,168	191	298	941	5,118	1,944	228	15,888

Table 2.--Real value by fish, east & Gulf coasts
(1990 dollars)
(Data for 1998 is not complete)

Year	Bluefish	Bonito	Cobia	Dolphin fish	King mackerel & cero	Spanish mackerel	Wahoo	Total
1962	2,372	75	17	7	1,955	3,435	.	7,862
1963	2,281	74	25	3	2,046	2,652	.	7,081
1964	2,107	35	12	9	1,494	2,077	.	5,734
1965	2,098	72	11	11	2,288	3,253	.	7,734
1966	2,274	39	11	25	2,314	3,789	.	8,452
1967	1,846	23	15	66	2,972	2,742	.	7,664
1968	2,452	45	29	41	3,296	4,127	.	9,990
1969	2,317	78	23	26	3,325	4,062	.	9,830
1970	2,420	168	36	37	4,219	4,635	.	11,515
1971	2,214	53	33	29	3,960	3,631	.	9,920
1972	2,244	31	36	36	3,819	3,865	.	10,031
1973	2,640	126	35	51	5,522	4,064	.	12,438
1974	2,075	57	37	47	7,121	4,225	0	13,562
1975	2,003	92	45	66	4,698	3,894	4	10,802
1976	1,904	60	60	63	6,543	6,203	5	14,838
1977	2,339	172	51	88	6,794	4,510	6	13,961
1978	2,800	414	61	113	4,564	2,368	10	10,330
1979	3,361	261	49	88	6,001	2,410	13	12,183
1980	3,360	160	64	133	7,027	4,070	19	14,833
1981	4,059	218	91	116	8,899	2,955	21	16,359
1982	4,374	102	95	280	9,149	2,769	25	16,794
1983	2,929	122	118	298	7,386	2,826	33	13,711
1984	2,633	93	132	449	4,632	1,966	30	9,935
1985	2,769	67	151	504	6,109	2,207	44	11,853
1986	3,076	76	220	801	6,612	2,573	64	13,423
1987	3,716	99	304	879	6,352	2,820	190	14,360
1988	3,263	208	312	1,031	5,465	2,642	348	13,270
1989	2,271	195	408	1,766	4,556	2,786	290	12,272
1990	1,501	95	368	1,949	5,565	2,246	245	11,970
1991	1,346	185	430	2,771	4,619	3,049	276	12,676
1992	2,041	282	538	1,250	6,076	2,422	382	12,991
1993	2,013	150	581	1,505	6,580	2,796	376	14,001
1994	1,149	409	605	1,971	5,455	2,816	287	12,693
1995	1,512	57	628	3,214	5,686	2,164	357	13,618
1996	1,132	55	687	2,158	5,830	1,588	303	11,752
1997	1,601	42	577	2,086	6,989	1,799	343	13,436
1998	1,231	61	510	1,234	6,063	1,129	306	10,536

Table 3.--Real exvessel prices by fish, east & Gulf coasts
(1990 cents/pound, whole weight)
(Data for 1998 is not complete)

Year	Bluefish	Bonito	Cobia	Dolphin fish	King mackerel & cero	Spanish mackerel	Wahoo
1962	40	45	22	28	47	36	.
1963	41	35	27	36	40	34	.
1964	45	56	24	33	43	34	.
1965	42	40	25	35	50	41	.
1966	41	31	20	33	51	40	.
1967	43	46	25	35	49	35	.
1968	45	48	29	42	53	35	.
1969	39	36	27	42	54	37	.
1970	32	92	28	44	63	38	.
1971	35	27	26	49	70	35	.
1972	36	59	27	52	78	36	.
1973	31	22	28	58	93	42	.
1974	25	28	25	55	68	39	62
1975	24	28	33	50	74	34	73
1976	21	31	39	57	86	34	86
1977	20	35	44	65	72	33	79
1978	23	91	52	69	85	33	73
1979	25	30	46	80	109	34	88
1980	20	36	50	77	99	34	84
1981	23	25	57	88	101	37	80
1982	26	22	60	91	111	37	84
1983	17	22	70	93	106	34	97
1984	21	26	76	101	89	33	100
1985	19	28	92	119	113	34	112
1986	20	36	100	117	115	36	122
1987	24	26	111	136	122	39	119
1988	19	40	119	132	120	43	112
1989	22	33	121	113	125	40	97
1990	14	15	129	105	114	40	121
1991	12	21	135	114	114	39	109
1992	21	18	144	110	122	35	105
1993	23	17	148	121	116	37	112
1994	16	23	152	139	127	41	115
1995	19	25	158	125	121	41	135
1996	15	21	161	131	114	43	131
1997	19	13	160	105	117	47	134
1998	17	32	171	131	118	58	134

Table 4.--Landings by fish, region and state
(thousands of pounds, whole weight, NE=Maine-Virginia)
(Data for 1998 is not complete)

Bluefish

Year	Northeast		South Atlantic				Gulf				
	NE	Region total	NC	SC-GA	FL ec	Region total	FL wc	AL-MS	LA-TX	Region total	Total
1962	2,638	2,638	955	5	1,393	2,352	944	4	.	949	5,938
1963	2,408	2,408	813	114	1,363	2,289	889	8	.	898	5,595
1964	1,813	1,813	515	316	1,202	2,033	779	26	.	804	4,651
1965	2,452	2,452	704	84	855	1,643	859	78	.	937	5,031
1966	2,489	2,489	821	159	1,354	2,333	584	126	.	711	5,532
1967	1,417	1,417	888	48	1,347	2,282	513	83	.	596	4,295
1968	1,967	1,967	872	24	1,911	2,807	556	87	.	644	5,417
1969	2,450	2,450	871	5	2,080	2,957	529	57	0	586	5,993
1970	4,211	4,211	496	9	2,046	2,550	650	44	0	694	7,456
1971	3,579	3,579	578	13	1,625	2,216	510	22	.	533	6,328
1972	3,834	3,834	.	.	1,876	1,876	511	36	0	548	6,258
1973	6,485	6,485	.	.	1,583	1,583	493	38	0	530	8,598
1974	6,556	6,556	.	.	1,273	1,273	501	25	11	536	8,365
1975	6,708	6,708	.	.	1,021	1,021	436	83	12	531	8,260
1976	7,290	7,290	.	.	1,380	1,380	528	77	1	606	9,276
1977	6,889	6,889	2,342	.	1,373	3,715	902	35	.	938	11,542
1978	7,763	7,763	1,961	.	1,336	3,297	850	21	0	871	11,931
1979	7,663	7,663	3,419	.	1,489	4,908	900	50	.	950	13,521
1980	7,551	7,551	5,532	4	2,167	7,703	1,155	42	.	1,197	16,451
1981	7,792	7,792	6,627	4	2,158	8,789	777	88	0	865	17,446
1982	9,167	9,167	4,308	12	2,008	6,328	1,158	139	.	1,296	16,791
1983	7,692	7,692	6,802	12	1,499	8,313	725	57	0	782	16,787
1984	6,801	6,801	3,633	2	1,586	5,221	588	48	0	636	12,658
1985	9,345	9,345	3,679	2	638	4,319	564	15	2	581	14,245
1986	10,099	10,099	3,528	11	1,165	4,704	458	108	3	568	15,371
1987	8,397	8,397	4,710	8	1,548	6,266	445	115	21	581	15,244
1988	9,447	9,447	5,146	9	1,316	6,470	709	243	12	963	16,881
1989	5,410	5,410	3,396	6	998	4,401	513	135	35	683	10,494
1990	4,594	4,594	4,709	4	1,077	5,790	388	119	181	688	11,072
1991	4,987	4,987	4,030	6	1,482	5,519	378	111	146	635	11,141
1992	4,287	4,287	3,014	6	1,090	4,109	303	56	1,031	1,390	9,786
1993	3,996	3,996	2,852	6	1,197	4,055	172	64	586	823	8,874
1994	3,833	3,833	1,988	8	933	2,930	239	10	72	322	7,084
1995	3,818	3,818	3,193	1	701	3,895	299	45	24	368	8,081
1996	3,659	3,659	3,433	17	258	3,708	277	43	19	338	7,704
1997	3,096	3,096	4,374	1	462	4,838	281	74	99	454	8,387
1998	2,894	2,894	3,537	4	448	3,990	141	31	112	284	7,168

Bluefish: NC includes SC & GA in 1977-79. AL-MS includes LA in 1977.

Table 4.--Landings by fish, region and state
(thousands of pounds, whole weight, NE=Maine-Virginia)
(Data for 1998 is not complete)

Bonito

Year	Northeast		South Atlantic			Gulf		
	NE	Region total	NC	FL ec	Region total	FLwc-TX	Region total	Total
1962	163	163	.	2	2	3	3	168
1963	210	210	.	1	1	1	1	212
1964	63	63	.	0	0	.	.	63
1965	182	182	.	0	0	.	.	182
1966	31	31	.	4	4	89	89	124
1967	40	40	.	6	6	4	4	50
1968	82	82	.	6	6	6	6	94
1969	206	206	.	3	3	8	8	217
1970	141	141	.	7	7	34	34	183
1971	65	65	.	6	6	127	127	198
1972	45	45	.	3	3	4	4	52
1973	78	78	.	10	10	491	491	578
1974	101	101	.	5	5	99	99	205
1975	193	193	.	11	11	121	121	325
1976	46	46	.	21	21	123	123	190
1977	180	180	.	18	18	295	295	493
1978	360	360	.	6	6	87	87	453
1979	527	527	0	30	30	311	311	868
1980	179	179	17	81	98	173	173	450
1981	244	244	4	79	83	528	528	855
1982	102	102	31	70	101	254	254	457
1983	201	201	11	28	40	324	324	565
1984	235	235	1	38	39	80	80	354
1985	138	138	1	5	6	97	97	241
1986	114	114	1	4	5	95	95	214
1987	151	151	7	29	35	201	201	387
1988	197	197	3	56	59	259	259	515
1989	268	268	4	148	153	172	172	594
1990	179	179	4	18	22	420	420	621
1991	187	187	5	17	22	670	670	879
1992	499	499	12	51	63	1,003	1,003	1,565
1993	206	206	16	91	107	552	552	864
1994	280	280	37	81	119	1,374	1,374	1,773
1995	192	192	35	.	35	.	.	227
1996	246	246	16	.	16	.	.	263
1997	290	290	42	.	42	.	.	332
1998	160	160	31	.	31	.	.	191

Bonito: NC includes GA in 1982. Gulf coast landings not shown for 1995-98.

Table 4.--Landings by fish, region and state
(thousands of pounds, whole weight, NE=Maine-Virginia)
(Data for 1998 is not complete)

Cobia

Year	Northeast		South Atlantic				Gulf				
	NE	Region total	NC	SC-GA	FL ec	Region total	FL wc	AL-MS	LA-TX	Region total	Total
1962	21	21	20	.	3	23	17	6	14	37	81
1963	33	33	17	.	7	24	10	4	25	38	95
1964	13	13	12	.	2	14	11	1	14	26	53
1965	10	10	10	.	4	14	11	1	11	22	45
1966	3	3	10	.	5	15	28	2	8	38	55
1967	3	3	10	.	9	19	24	4	12	40	61
1968	4	4	7	.	9	16	41	14	26	81	101
1969	3	3	6	.	4	11	45	10	17	72	85
1970	2	2	7	.	14	21	60	13	33	106	129
1971	4	4	11	.	7	18	77	8	18	104	125
1972	4	4	.	.	14	14	74	15	29	117	135
1973	2	2	.	.	11	11	77	15	21	113	125
1974	4	4	.	.	12	12	89	14	30	133	149
1975	6	6	.	.	14	14	84	8	28	119	139
1976	3	3	.	.	13	13	104	6	27	137	153
1977	2	2	.	.	11	11	80	22	.	102	116
1978	1	1	.	.	11	11	87	3	14	104	116
1979	1	1	.	.	11	11	80	6	8	94	105
1980	1	1	5	2	20	27	90	3	7	100	128
1981	1	1	5	11	25	41	100	2	17	118	161
1982	2	2	11	19	17	46	85	26	.	110	158
1983	1	1	4	13	18	35	111	3	18	132	169
1984	2	2	7	5	18	30	115	11	16	142	174
1985	3	3	7	2	17	26	105	8	23	136	165
1986	1	1	18	6	34	59	94	21	45	161	221
1987	0	0	33	7	58	98	111	17	48	175	274
1988	6	6	16	7	71	94	106	10	47	163	262
1989	11	11	15	7	92	114	128	20	64	212	337
1990	18	18	22	3	77	103	109	8	47	164	285
1991	15	15	23	6	97	126	132	2	44	177	318
1992	9	9	19	9	101	128	159	3	73	235	373
1993	7	7	20	12	91	124	171	4	86	261	392
1994	8	8	31	8	88	127	149	4	111	264	399
1995	25	25	35	8	90	133	158	1	82	241	399
1996	23	23	33	5	103	142	179	2	81	262	428
1997	16	16	42	4	91	137	136	4	69	208	361
1998	10	10	30	4	66	100	130	.	58	188	298

Cobia: FL ec includes NC-GA in 1977-79. AL-MS includes LA-TX in 1977 and 1982. LA-TX includes AL-MS in 1998.

Table 4.--Landings by fish, region and state
(thousands of pounds, whole weight, NE=Maine-Virginia)
(Data for 1998 is not complete)

Dolphin fish

Year	Northeast		South Atlantic					Gulf				
	NE	Region total	NC	SC	GA	FL ec	Region total	FL wc	AL-LA	TX	Region total	Total
1962	.	.	.	.	.	8	8	16	.	.	16	24
1963	.	.	.	.	.	4	4	5	.	.	5	9
1964	.	.	.	.	.	6	6	22	.	.	22	28
1965	0	0	.	.	.	14	14	18	.	.	18	32
1966	.	.	.	.	.	16	16	61	.	.	61	77
1967	.	.	.	.	.	35	35	154	.	.	154	189
1968	.	.	.	.	.	21	21	76	.	.	76	97
1969	0	0	.	.	.	12	12	49	.	.	49	61
1970	.	.	.	.	.	21	21	63	.	.	63	84
1971	.	.	.	.	.	22	22	38	.	.	38	60
1972	.	.	.	.	.	14	14	55	.	.	55	70
1973	.	.	.	.	.	18	18	70	.	.	70	88
1974	.	.	.	.	.	15	15	70	.	.	70	85
1975	.	.	.	.	.	26	26	106	.	.	106	133
1976	.	.	.	.	.	27	27	84	.	.	84	110
1977	0	0	.	.	.	71	71	64	.	.	64	135
1978	1	1	13	.	.	57	70	93	.	.	93	164
1979	.	.	10	.	.	35	45	66	.	.	66	111
1980	1	1	24	7	.	47	78	95	.	.	95	173
1981	.	.	6	8	0	45	59	73	.	.	73	132
1982	0	0	41	21	1	80	144	162	.	.	162	307
1983	2	2	30	35	0	62	128	191	.	.	191	321
1984	2	2	47	20	10	82	159	283	0	.	283	444
1985	10	10	42	18	14	68	143	260	10	.	270	422
1986	4	4	36	11	15	127	190	448	44	.	493	687
1987	15	15	71	19	8	115	213	342	78	.	421	648
1988	44	44	56	28	11	117	212	351	172	.	523	780
1989	97	97	99	67	8	251	425	634	327	78	1,039	1,561
1990	83	83	96	70	12	329	508	858	326	73	1,257	1,848
1991	101	101	141	95	14	401	650	1,064	562	54	1,679	2,430
1992	81	81	72	58	8	188	327	368	321	39	728	1,136
1993	121	121	149	91	13	267	520	403	188	9	600	1,242
1994	115	115	161	107	9	342	619	556	118	9	683	1,417
1995	210	210	356	288	27	496	1,166	926	247	21	1,194	2,570
1996	52	52	127	144	8	268	547	743	294	11	1,047	1,646
1997	120	120	230	296	.	364	889	717	262	7	986	1,995
1998	96	96	199	51	.	189	439	337	68	1	406	941

Dolphin fish: FL ec includes SC in 1977. NC includes SC & GA in 1978-79. SC includes GA in 1980, 1997 and 1998. AL-LA includes TX in 1984-87.

Table 4.--Landings by fish, region and state
(thousands of pounds, whole weight, NE=Maine-Virginia)
(Data for 1998 is not complete)

King mackerel & cero

Year	Northeast		South Atlantic					Gulf				
	NE	Region total	NC	SC	GA	FL ec	Region total	FL wc	AL-MS	LA-TX	Region total	Total
1962	8	8	49	3	0	2,076	2,128	2,021	.	.	2,021	4,157
1963	10	10	53	4	1	2,173	2,231	2,817	.	.	2,817	5,058
1964	37	37	89	0	0	2,020	2,109	1,314	.	.	1,314	3,460
1965	6	6	139	.	.	2,549	2,688	1,898	.	.	1,898	4,593
1966	7	7	95	4	.	1,782	1,880	2,633	.	.	2,633	4,520
1967	3	3	24	.	.	2,988	3,012	3,084	.	.	3,084	6,099
1968	3	3	8	0	.	2,586	2,594	3,604	.	.	3,604	6,201
1969	2	2	16	2	.	2,943	2,960	3,242	.	.	3,242	6,204
1970	5	5	12	0	1	4,338	4,352	2,372	.	.	2,372	6,729
1971	7	7	9	6	1	2,907	2,923	2,738	.	.	2,738	5,667
1972	2	2	.	.	.	3,489	3,489	1,378	.	.	1,378	4,869
1973	8	8	.	.	.	3,712	3,712	2,217	.	.	2,217	5,937
1974	15	15	.	.	.	4,267	4,267	6,134	.	.	6,134	10,416
1975	14	14	.	.	.	3,697	3,697	2,622	.	.	2,622	6,333
1976	18	18	.	.	.	4,821	4,821	2,801	.	.	2,801	7,640
1977	18	18	256	.	.	3,915	4,171	5,217	.	.	5,217	9,406
1978	9	9	220	.	.	3,402	3,622	1,745	0	.	1,746	5,376
1979	11	11	478	.	.	3,346	3,824	1,691	.	0	1,691	5,527
1980	20	20	769	208	17	3,073	4,067	3,002	.	.	3,002	7,088
1981	3	3	736	135	11	4,858	5,739	3,073	.	.	3,073	8,816
1982	13	13	1,207	186	4	4,647	6,045	1,968	.	229	2,197	8,255
1983	6	6	843	179	2	3,108	4,132	1,340	2	1,490	2,832	6,969
1984	3	3	758	138	38	2,437	3,370	1,095	4	749	1,847	5,220
1985	6	6	833	82	96	2,636	3,647	768	3	973	1,744	5,398
1986	4	4	1,006	95	202	2,421	3,724	1,707	1	336	2,044	5,772
1987	12	12	1,349	128	72	2,573	4,121	543	4	531	1,078	5,211
1988	15	15	886	124	30	2,461	3,502	577	9	453	1,040	4,557
1989	8	8	720	175	8	1,801	2,705	286	4	653	944	3,657
1990	16	16	1,131	162	18	1,881	3,191	1,018	2	637	1,657	4,864
1991	22	22	1,103	266	24	1,641	3,034	413	1	583	997	4,053
1992	31	31	1,035	256	13	1,413	2,716	1,108	11	1,132	2,251	4,999
1993	23	23	888	162	10	1,614	2,674	2,088	2	900	2,990	5,687
1994	4	4	850	92	7	1,557	2,506	904	5	878	1,788	4,299
1995	6	6	1,013	83	11	1,618	2,725	1,190	3	755	1,948	4,680
1996	5	5	794	95	4	1,817	2,710	1,665	4	733	2,402	5,117
1997	16	16	1,559	61	8	2,536	4,164	976	5	789	1,770	5,949
1998	4	4	1,438	42	8	1,513	3,001	1,151	.	962	2,113	5,118

*King mackerel & cero: NC includes SC and GA in 1977-79. LA-TX includes AL-MS in 1998.

Table 4.--Landings by fish, region and state
(thousands of pounds, whole weight, NE=Maine-Virginia)
(Data for 1998 is not complete)

Spanish mackerel

Year	Northeast		South Atlantic				Gulf				Total
	NE	Region total	NC	SC-GA	FL ec	Region total	FL wc	AL-MS	LA-TX	Region total	
1962	15	15	83	14	2,578	2,675	6,869	41	1	6,911	9,601
1963	79	79	135	9	2,123	2,268	5,405	41	2	5,447	7,794
1964	33	33	78	3	2,002	2,083	3,880	75	2	3,956	6,072
1965	75	75	117	14	2,901	3,032	4,883	18	5	4,906	8,012
1966	142	142	79	3	2,181	2,262	7,004	59	3	7,066	9,471
1967	30	30	73	5	1,802	1,879	5,867	101	8	5,976	7,885
1968	60	60	69	9	4,407	4,484	7,066	153	13	7,231	11,776
1969	124	124	89	4	2,359	2,451	8,175	97	70	8,342	10,918
1970	202	202	63	2	3,574	3,640	8,100	169	29	8,298	12,140
1971	52	52	95	4	2,582	2,681	7,383	235	40	7,658	10,391
1972	23	23	.	.	3,369	3,369	6,532	576	114	7,222	10,615
1973	50	50	.	.	3,203	3,203	6,194	174	89	6,458	9,711
1974	26	26	.	.	2,346	2,346	8,267	95	192	8,554	10,926
1975	68	68	.	.	5,145	5,145	5,621	316	200	6,138	11,350
1976	82	82	.	.	9,589	9,589	7,783	424	135	8,341	18,012
1977	22	22	48	.	10,987	11,035	2,393	243	.	2,636	13,693
1978	2	2	41	.	5,511	5,551	1,600	105	.	1,705	7,258
1979	1	1	15	.	4,886	4,901	1,946	143	33	2,122	7,023
1980	9	9	75	8	9,811	9,895	1,770	126	55	1,952	11,856
1981	5	5	52	1	4,174	4,227	3,550	91	68	3,709	7,940
1982	14	14	189	2	3,759	3,950	3,287	153	15	3,456	7,419
1983	9	9	41	1	5,947	5,989	2,087	104	74	2,266	8,265
1984	10	10	127	1	2,397	2,526	3,476	12	18	3,506	6,043
1985	15	15	173	1	3,245	3,419	2,915	76	32	3,023	6,457
1986	174	174	232	8	4,004	4,244	2,577	139	22	2,738	7,155
1987	321	321	504	1	3,497	4,002	2,665	129	61	2,855	7,178
1988	335	335	438	2	3,072	3,512	2,138	156	22	2,316	6,163
1989	422	422	589	2	2,853	3,444	2,991	104	24	3,119	6,985
1990	240	240	839	1	1,979	2,819	2,385	181	13	2,579	5,639
1991	531	531	859	1	2,987	3,846	3,262	144	36	3,442	7,819
1992	396	396	738	2	2,023	2,763	3,564	151	58	3,773	6,932
1993	413	413	590	1	3,892	4,482	2,475	127	20	2,623	7,518
1994	392	392	531	0	3,100	3,632	2,420	279	83	2,781	6,804
1995	196	196	402	0	3,065	3,467	1,160	377	20	1,557	5,220
1996	345	345	402	0	2,245	2,646	409	245	9	663	3,655
1997	211	211	767	0	2,269	3,036	211	350	4	565	3,812
1998	128	128	519	0	919	1,438	156	218	4	378	1,944

Spanish mackerel: NC includes SC & GA in 1977-79. AL-MS includes LA-TX in 1977-78.

Table 4.--Landings by fish, region and state
(thousands of pounds, whole weight, NE=Maine-Virginia)
(Data for 1998 is not complete)

Wahoo

Year	Northeast		South Atlantic				Gulf				
	NE	Region total	NC	SC-GA	FL ec	Region total	FL wc	AL-LA	TX	Region total	Total
1974	.	.	.	.	1	1	0	.	.	0	1
1975	.	.	.	.	4	4	1	.	.	1	5
1976	.	.	.	.	4	4	1	.	.	1	5
1977	.	.	.	.	6	6	1	.	.	1	7
1978	.	.	.	.	9	9	4	.	.	4	13
1979	.	.	.	.	12	12	3	.	.	3	15
1980	.	.	2	2	16	20	3	.	.	3	23
1981	0	0	1	4	12	17	9	0	.	9	26
1982	0	0	3	6	12	21	9	.	.	9	30
1983	0	0	7	7	11	25	9	.	.	9	34
1984	0	0	9	5	8	22	8	.	.	8	30
1985	0	0	9	5	12	27	8	4	.	12	39
1986	1	1	6	5	10	21	21	9	.	30	52
1987	0	0	16	7	17	40	53	66	.	119	160
1988	1	1	20	8	17	44	58	208	.	266	312
1989	1	1	10	13	12	35	35	193	37	265	300
1990	2	2	17	8	19	43	68	74	16	158	203
1991	1	1	19	8	22	48	45	137	21	203	252
1992	3	3	14	16	22	52	46	232	31	310	365
1993	3	3	24	12	21	57	56	214	5	275	335
1994	20	20	20	13	15	48	40	136	5	181	249
1995	7	7	41	14	23	78	44	125	10	179	264
1996	2	2	26	10	24	60	42	123	4	169	231
1997	2	2	21	10	29	60	61	130	3	194	256
1998	2	2	26	5	23	54	31	138	2	171	228

Wahoo: FL ec includes NC in 1978-79 and SC in 1979. AL-LA includes TX in 1984-87.

Table 5.--Landings by region, fish and gear (thousands of pounds, whole weight)
(Data is not complete for 1998. Breakout not available for some states in 1991-98)

South Atlantic
Bluefish

Year	Haul seines	Purse seines	Trawls	Pound, fyke & hoop nets	Pots & traps	Drift gill nets	Run-around gill nets	Other gill nets	Hook & line gear	Long & trot lines	Other or unknown gear	Tot[illegible]
1962	652	.	5	.	.	.	1,254	185	208	.	48	[illegible]
1963	682	.	6	.	.	.	1,324	137	99	.	40	[illegible]
1964	707	.	3	3	.	.	1,167	63	75	.	13	[illegible]
1965	564	.	4	10	.	.	850	120	95	.	.	[illegible]
1966	926	.	23	2	.	.	1,137	130	112	.	2	[illegible]
1967	835	.	15	6	.	34	1,271	10	109	.	1	[illegible]
1968	960	.	16	3	.	.	1,557	68	204	.	.	[illegible]
1969	941	.	21	1	.	.	1,662	187	145	.	.	[illegible]
1970	768	.	27	4	.	.	1,543	72	135	.	2	[illegible]
1971	833	.	52	3	.	.	1,168	78	83	.	.	[illegible]
1972	728	.	1	.	.	.	1,076	.	70	.	.	[illegible]
1973	568	.	29	.	.	.	859	.	127	.	.	[illegible]
1974	434	.	32	.	.	.	715	.	92	.	.	[illegible]
1975	418	.	21	.	.	.	508	.	74	.	.	[illegible]
1976	580	.	51	.	.	.	655	.	94	.	.	[illegible]
1977	940	.	1,257	44	1	0	1,118	121	234	.	.	[illegible]
1978	503	.	1,105	56	.	0	1,161	227	243	.	.	[illegible]
1979	704	.	1,792	71	.	1	1,380	521	438	.	.	[illegible]
1980	661	.	3,003	325	.	1	1,834	1,217	654	.	.	[illegible]
1981	535	.	4,439	142	.	2	1,843	1,391	437	.	.	[illegible]
1982	547	.	1,798	227	.	2	1,737	1,498	518	3	.	[illegible]
1983	449	.	3,857	87	.	3	1,277	2,339	300	0	.	[illegible]
1984	406	.	1,164	93	.	1	1,320	1,930	306	0	0	[illegible]
1985	588	.	1,017	135	2	.	522	1,944	108	.	1	[illegible]
1986	546	.	773	80	0	3	1,101	2,133	67	.	.	[illegible]
1987	627	.	538	125	0	.	1,459	3,349	169	0	.	[illegible]
1988	565	.	1,267	91	.	.	1,246	3,217	85	.	.	[illegible]
1989	364	.	674	41	.	10	1,017	2,172	123	0	.	[illegible]
1990	607	.	307	58	0	.	1,209	3,495	112	1	1	[illegible]
1991	684	.	314	61	0	.	1,391	2,908	160	0	0	[illegible]
1992	510	.	762	29	.	1	996	1,671	138	0	1	[illegible]
1993	186	.	377	18	.	0	1,165	2,201	108	1	0	[illegible]
1994	226	.	47	14	4	18	877	1,683	55	6	0	[illegible]
1995	166	.	401	14	3	3	525	2,646	130	7	2	[illegible]
1996	182	.	221	7	2	0	92	2,958	122	2	11	[illegible]
1997	237	18	314	18	2	3	362	3,731	138	3	12	[illegible]
1998	150	21	220	7	6	30	351	3,046	135	3	20	[illegible]

Table 5.--Landings by region, fish and gear (thousands of pounds, whole weight)
(Data is not complete for 1998. Breakout not available for some states in 1991-98)

South Atlantic
Bonito

Year	Haul seines	Purse seines	Trawls	Pound, fyke & hoop nets	Pots & traps	Drift gill nets	Run-around gill nets	Other gill nets	Hook & line gear	Long & trot lines	Other or unknown gear	To
1962	.	.	.	.	.	.	.	.	2	.	.	
1963	.	.	.	.	.	.	.	.	1	.	.	
1964	.	.	.	.	.	.	.	.	0	.	.	
1965	.	.	.	.	.	.	.	.	0	.	.	
1966	.	.	.	.	.	.	.	.	4	.	.	
1967	.	.	.	.	.	.	.	.	6	.	.	
1968	.	.	.	.	.	.	.	.	6	.	.	
1969	.	.	.	.	.	.	.	.	3	.	.	
1970	.	.	.	.	.	.	.	.	7	.	.	
1971	.	.	.	.	.	.	.	.	6	.	.	
1972	.	.	.	.	.	.	.	.	3	.	.	
1973	.	.	.	.	.	.	.	.	10	.	.	
1974	.	.	.	.	.	.	.	.	5	.	.	
1975	.	.	.	.	.	.	.	.	11	.	.	
1976	.	.	.	.	.	.	.	.	21	.	.	
1977	.	.	.	.	.	.	.	.	18	.	.	
1978	.	.	.	.	.	.	.	.	6	.	.	
1979	.	.	.	.	.	.	.	.	30	.	.	
1980	0	.	.	.	.	.	.	.	98	.	.	
1981	.	.	0	.	.	.	.	3	80	.	.	
1982	1	.	1	.	.	.	.	15	84	0	.	
1983	1	.	.	.	.	.	.	9	29	0	.	
1984	0	.	0	.	.	.	.	0	38	.	.	
1985	0	.	.	.	.	.	0	1	5	.	.	
1986	0	.	0	.	.	.	1	0	3	.	.	
1987	.	.	0	.	.	12	9	1	14	.	.	
1988	.	.	.	.	.	37	1	0	21	.	.	
1989	.	.	1	.	.	57	56	2	36	0	.	
1990	.	2	0	.	.	.	3	3	14	.	.	
1991	10	.	0	.	.	.	1	3	8	.	.	
1992	2	4	5	.	.	.	1	4	48	0	0	
1993	.	.	1	.	.	.	6	5	95	1	.	
1994	1	.	0	.	.	0	34	31	53	.	.	
1995	0	.	.	0	0	.	.	30	5	.	.	
1996	0	.	0	0	.	.	.	6	10	0	.	
1997	.	.	0	0	0	.	0	36	6	0	.	
1998	0	.	0	.	0	0	0	25	5	.	.	

Table 5.--Landings by region, fish and gear (thousands of pounds, whole weight)
(Data is not complete for 1998. Breakout not available for some states in 1991-98)

South Atlantic
Cobia

Year	Haul seines	Purse seines	Trawls	Pound, fyke & hoop nets	Pots & traps	Drift gill nets	Run-around gill nets	Other gill nets	Hook & line gear	Long & trot lines	Other or unknown gear	Tot
1962	18	.	.	.	.	.	.	0	3	.	2	
1963	13	.	1	.	.	.	.	2	6	.	2	
1964	11	.	.	1	.	.	.	.	2	.	.	
1965	8	.	.	2	.	.	.	.	4	.	.	
1966	8	.	.	1	.	.	.	1	5	.	.	
1967	10	.	0	.	.	0	.	.	9	.	.	
1968	7	.	.	.	.	.	.	1	9	.	.	
1969	6	.	.	.	.	.	.	.	4	.	.	
1970	6	.	.	1	.	.	.	.	14	.	.	
1971	10	.	.	0	.	.	.	.	7	.	.	
1972	.	.	.	.	.	.	.	.	14	.	.	
1973	.	.	1	.	.	.	.	.	10	.	.	
1974	.	.	.	.	.	.	.	.	12	.	.	
1975	.	.	.	.	.	.	.	.	14	.	.	
1976	.	.	.	.	.	.	.	.	13	.	.	
1977	1	.	.	.	.	.	.	.	10	.	.	
1978	2	.	0	.	.	.	.	.	10	.	.	
1979	1	.	0	0	.	.	.	.	10	.	.	
1980	.	.	5	0	.	.	.	.	22	.	.	
1981	.	.	13	.	.	.	.	.	29	.	.	
1982	0	.	18	0	.	.	.	1	27	0	.	
1983	0	.	9	0	.	.	.	0	26	0	.	
1984	0	.	4	1	.	.	.	1	24	0	.	
1985	0	.	1	0	.	.	.	1	43	.	.	
1986	1	.	3	1	.	4	.	1	47	1	.	
1987	1	.	3	2	.	17	.	1	74	1	.	
1988	0	.	4	1	.	27	0	2	57	2	0	
1989	0	.	3	1	.	26	1	4	73	3	3	
1990	1	.	3	1	.	.	2	4	87	5	0	
1991	1	.	2	1	.	2	4	2	87	7	21	
1992	1	0	2	1	.	0	4	3	84	9	25	
1993	0	.	4	1	.	1	4	6	84	10	14	
1994	1	.	3	0	0	0	6	10	80	6	19	
1995	1	.	3	1	1	.	10	12	76	10	19	
1996	0	.	4	1	0	.	14	13	76	13	11	
1997	1	.	5	0	0	.	12	26	59	8	26	
1998	1	.	7	0	0	2	11	8	49	3	17	

Table 5.--Landings by region, fish and gear (thousands of pounds, whole weight)
(Data is not complete for 1998. Breakout not available for some states in 1991-98)

South Atlantic
Dolphin fish

Year	Trawls	Pots & traps	Drift gill nets	Run-around gill nets	Other gill nets	Hook & line gear	Long & trot lines	Other or unknown gear	Total
1962	.	.	.	.	.	8	.	.	8
1963	.	.	.	.	.	4	.	.	4
1964	.	.	.	.	.	6	.	.	6
1965	.	.	.	.	.	14	.	.	14
1966	.	.	.	.	.	16	.	.	16
1967	.	.	.	.	.	35	.	.	35
1968	.	.	.	.	.	21	.	.	21
1969	.	.	.	.	.	12	.	.	12
1970	.	.	.	.	.	21	.	.	21
1971	.	.	.	.	.	22	.	.	22
1972	.	.	.	.	.	14	.	.	14
1973	.	.	.	.	.	18	.	.	18
1974	.	.	.	.	.	15	.	.	15
1975	.	.	.	.	.	26	.	.	26
1976	.	.	.	1	.	26	.	.	27
1977	.	.	.	.	.	71	.	.	71
1978	.	.	.	.	.	70	.	.	70
1979	.	.	.	.	.	45	.	.	45
1980	.	.	.	.	.	72	5	.	78
1981	0	.	.	.	.	57	1	.	59
1982	.	.	.	.	.	135	9	.	144
1983	0	.	.	.	.	118	10	.	128
1984	.	.	.	.	.	152	7	.	159
1985	.	.	.	.	.	138	5	0	143
1986	0	.	.	.	.	186	3	.	190
1987	.	.	1	.	.	195	17	.	213
1988	.	.	1	.	.	160	51	0	212
1989	.	.	3	.	.	360	63	.	425
1990	.	0	.	.	.	374	133	0	508
1991	0	0	.	0	.	485	164	0	650
1992	0	.	.	0	.	212	114	1	327
1993	0	.	.	.	.	367	153	0	520
1994	.	0	.	.	0	364	254	0	619
1995	0	0	.	0	.	520	643	1	1,164
1996	0	0	.	.	.	263	262	0	525
1997	.	1	.	0	.	355	532	1	889
1998	32	1	0	0	0	214	183	9	439

Table 5.--Landings by region, fish and gear (thousands of pounds, whole weight)
(Data is not complete for 1998. Breakout not available for some states in 1991-98)

South Atlantic
King mackerel & cero

Year	Haul seines	Purse seines	Trawls	Pound, fyke & hoop nets	Pots & traps	Drift gill nets	Run-around gill nets	Other gill nets	Hook & line gear	Long & trot lines	Other or unknown gear	T
1962	8	.	.	.	.	.	126	.	1,995	.	.	
1963	3	.	.	.	.	.	531	.	1,697	.	.	
1964	9	.	0	.	.	.	446	.	1,654	.	.	
1965	6	.	1	.	.	.	902	.	1,779	.	.	
1966	4	.	.	.	.	.	770	0	1,106	.	.	
1967	0	.	1	.	.	.	1,900	.	1,111	.	.	
1968	.	.	0	.	.	.	1,483	.	1,111	.	.	
1969	1	.	0	.	.	.	1,756	.	1,203	.	.	
1970	.	.	1	.	.	.	2,354	1	1,995	.	.	
1971	5	.	1	.	.	.	1,630	0	1,286	.	.	
1972	.	.	.	.	.	.	1,291	.	2,199	.	.	
1973	.	.	.	.	.	.	1,176	.	2,536	.	.	
1974	.	.	.	.	.	.	1,593	.	2,674	.	.	
1975	.	.	.	.	.	.	1,198	.	2,499	.	.	
1976	.	.	.	.	.	.	2,069	.	2,752	.	.	
1977	.	.	0	0	.	.	1,204	0	2,966	.	.	
1978	.	.	2	.	.	.	1,225	0	2,395	.	.	
1979	.	.	9	.	.	14	1,039	14	2,748	.	.	
1980	.	.	14	.	.	.	683	90	3,280	.	.	
1981	.	.	46	.	.	.	1,151	130	4,413	0	.	
1982	.	.	13	.	.	.	1,277	401	4,352	1	.	
1983	.	.	9	6	.	.	1,036	133	2,948	0	.	
1984	0	.	7	0	.	0	824	59	2,480	0	.	
1985	.	.	4	.	.	.	739	19	2,885	0	.	
1986	0	.	4	.	.	221	.	19	3,480	0	.	
1987	0	.	4	0	.	859	.	39	3,219	0	.	
1988	.	113	2	.	.	777	212	74	2,323	.	1	
1989	0	8	3	.	.	757	.	12	1,925	.	.	
1990	.	.	7	.	0	0	3	46	3,135	0	0	
1991	1	.	1	.	0	0	13	8	3,011	.	0	
1992	.	.	2	.	.	.	12	7	2,696	0	0	
1993	0	.	10	.	0	0	14	6	2,642	0	0	
1994	1	.	3	0	2	0	32	61	2,401	2	5	
1995	0	.	0	0	2	.	104	58	2,556	4	1	
1996	0	.	0	0	1	0	131	53	2,219	1	.	
1997	0	1	1	0	1	0	226	168	3,763	4	0	
1998	0	.	1	0	1	17	22	64	2,847	7	42	

Table 5.--Landings by region, fish and gear (thousands of pounds, whole weight)
(Data is not complete for 1998. Breakout not available for some states in 1991-98)

South Atlantic
Spanish mackerel

Year	Haul seines	Purse seines	Trawls	Pound, fyke & hoop nets	Pots & traps	Drift gill nets	Run-around gill nets	Other gill nets	Hook & line gear	Long & trot lines	Other or unknown gear	Tot
1962	62	.	.	.	.	.	2,475	5	126	.	7	2
1963	89	.	2	.	.	.	2,043	45	76	.	14	2
1964	50	.	1	9	.	.	1,955	4	65	.	.	2
1965	72	.	10	16	.	.	2,787	1	145	.	.	3
1966	19	.	5	1	.	25	2,021	15	177	.	.	2
1967	45	.	8	1	.	3	1,690	0	131	.	.	1
1968	57	.	17	26	.	.	4,219	13	152	.	.	4
1969	102	.	7	0	.	.	2,240	3	100	.	.	2
1970	40	.	10	12	.	.	3,457	15	106	.	.	3
1971	58	.	8	3	.	.	2,416	61	135	.	.	2
1972	40	.	3	.	.	.	3,221	.	104	.	.	3
1973	7	.	21	.	.	.	3,020	.	155	.	.	3
1974	7	.	7	.	.	.	2,164	.	168	.	.	2
1975	16	.	1	.	.	.	4,754	.	374	.	.	5
1976	34	.	0	.	.	.	8,731	.	822	.	.	9
1977	20	.	2	9	.	.	10,665	18	321	.	.	11
1978	8	.	1	1	.	.	5,486	30	25	.	.	5
1979	1	.	3	0	.	1	4,843	4	50	.	.	4
1980	8	.	9	4	.	0	9,745	56	73	.	.	9
1981	4	.	4	1	.	1	4,148	24	45	.	.	4
1982	5	.	4	11	.	1	3,733	115	83	.	.	3
1983	11	.	1	10	.	1	5,923	11	32	.	.	5
1984	18	.	4	14	.	0	2,365	69	56	.	.	2
1985	17	.	15	33	13	.	3,214	99	29	.	.	3
1986	34	.	45	38	.	.	3,921	132	73	.	.	4
1987	47	.	48	231	.	4	3,420	152	101	.	.	4
1988	53	.	38	176	.	3	3,013	171	57	.	0	3
1989	80	.	38	163	.	156	2,678	293	37	.	.	3
1990	32	.	53	56	.	1	2,021	546	110	.	0	2
1991	54	.	60	114	.	.	2,918	558	141	.	0	3
1992	44	1	20	203	.	1	1,967	478	49	.	1	2
1993	44	.	13	86	.	.	3,823	420	97	.	.	4
1994	27	.	14	30	3	9	3,037	455	55	0	0	3
1995	15	.	6	49	2	0	2,840	336	204	.	15	3
1996	10	.	8	45	1	0	683	330	82	.	37	1
1997	18	1	13	61	1	1	1,960	672	92	0	217	3
1998	8	.	3	27	1	2	793	466	67	0	72	1

Table 5.--Landings by region, fish and gear (thousands of pounds, whole weight)
(Data is not complete for 1998. Breakout not available for some states in 1991-98)

South Atlantic
Wahoo

Year	Trawls	Drift gill nets	Run-around gill nets	Other gill nets	Hook & line gear	Long & trot lines	Other or unknown gear	Total
1974	.	.	.	.	1	.	.	1
1975	.	.	.	.	4	.	.	4
1976	.	.	.	.	4	.	.	4
1977	.	.	.	.	6	.	.	6
1978	.	.	.	.	9	.	.	9
1979	.	.	.	.	12	.	.	12
1980	0	.	.	.	19	1	.	20
1981	0	.	0	.	13	3	.	17
1982	0	.	.	.	16	4	.	21
1983	0	.	.	.	21	4	.	25
1984	.	.	.	.	19	2	.	22
1985	.	.	.	.	25	2	.	27
1986	.	.	.	.	20	1	.	21
1987	.	1	.	.	37	2	.	40
1988	.	1	.	.	35	8	0	44
1989	.	1	.	.	25	8	.	35
1990	.	.	.	.	35	8	.	43
1991	.	.	0	.	39	9	0	48
1992	0	.	0	.	42	10	0	52
1993	.	.	0	.	44	14	.	57
1994	.	.	.	0	39	9	.	48
1995	.	.	0	0	63	15	0	78
1996	.	.	0	.	43	14	.	57
1997	.	.	0	.	49	11	.	60
1998	.	.	0	0	46	7	2	54

Table 5.--Landings by region, fish and gear (thousands of pounds, whole weight)
(Data is not complete for 1998. Breakout not available for some states in 1991-98)

Gulf
Bluefish

Year	Haul seines	Purse seines	Trawls	Pots & traps	Drift gill nets	Run-around gill nets	Other gill nets	Hook & line gear	Long & trot lines	Other or unknown gear	Total
1962	230	.	0	.	.	497	11	86	.	125	94
1963	220	.	.	.	.	449	29	70	.	129	89
1964	271	.	0	.	41	356	.	46	.	91	80
1965	368	.	1	.	5	400	.	49	.	114	93
1966	362	16	.	.	.	243	.	26	.	64	71
1967	303	.	1	.	.	236	.	16	.	40	59
1968	267	.	2	.	.	299	.	30	.	46	64
1969	318	.	13	.	.	197	.	21	.	38	58
1970	295	.	5	.	.	292	4	55	.	43	69
1971	209	.	3	.	.	241	8	23	.	48	53
1972	223	.	17	.	.	218	12	21	.	57	54
1973	209	.	9	.	.	232	.	45	.	35	53
1974	243	.	10	.	.	209	.	30	.	44	53
1975	202	.	11	.	.	255	.	33	.	30	53
1976	267	.	1	.	0	276	.	25	.	37	60
1977	265	.	1	.	.	603	.	33	.	35	93
1978	417	0	1	.	.	389	.	19	.	46	87
1979	491	1	0	.	.	394	9	18	.	37	95
1980	557	.	0	.	.	559	2	36	.	43	1,19
1981	261	74	0	.	.	471	4	18	.	37	86
1982	543	121	.	.	.	556	2	28	.	47	1,29
1983	320	54	0	.	.	383	1	7	.	16	78
1984	199	46	0	.	202	164	0	11	.	14	63
1985	214	13	0	.	206	125	0	10	0	11	58
1986	2	167	0	.	97	290	0	11	0	1	56
1987	128	169	1	.	62	172	17	30	1	2	58
1988	155	113	1	.	58	327	83	62	160	3	96
1989	101	102	0	.	26	235	66	139	11	1	68
1990	95	101	5	.	11	279	1	10	105	80	68
1991	79	78	.	.	36	234	13	14	0	181	63
1992	53	4	0	.	23	212	0	42	24	1,030	1,39
1993	46	.	0	.	2	111	0	64	0	600	82
1994	40	1	0	0	8	172	1	7	.	92	32
1995	27	34	6	0	1	218	.	23	0	57	36
1996	15	169	0	0	.	78	0	33	0	36	33
1997	2	215	2	0	.	95	1	25	0	113	45
1998	5	113	4	0	.	28	0	13	0	120	28

Table 5.--Landings by region, fish and gear (thousands of pounds, whole weight)
(Data is not complete for 1998. Breakout not available for some states in 1991-98)

Gulf
Bonito

Year	Haul seines	Purse seines	Trawls	Pots & traps	Run-around gill nets	Other gill nets	Hook & line gear	Long & trot lines	Other or unknown gear	Total
1962	.	.	.	.	.	.	3	.	.	3
1963	.	.	.	.	.	.	1	.	.	1
1966	13	58	.	.	14	.	4	.	.	89
1967	3	.	.	.	.	.	2	.	.	4
1968	2	.	.	.	.	.	4	.	.	6
1969	5	.	.	.	.	.	3	.	.	8
1970	17	15	.	.	1	.	2	.	.	34
1971	64	53	.	.	.	.	9	.	.	127
1972	2	1	.	.	.	.	1	.	.	4
1973	13	475	1	.	0	.	1	.	.	491
1974	25	70	.	.	0	.	5	.	.	99
1975	28	86	.	.	.	.	7	.	.	121
1976	11	110	.	.	0	.	3	.	.	123
1977	119	87	.	.	46	.	36	.	6	294
1978	28	44	.	.	6	.	9	.	1	88
1979	73	220	.	.	7	.	11	.	1	311
1980	40	83	.	.	1	.	15	.	32	173
1981	23	88	.	.	2	.	53	.	363	528
1982	35	107	.	.	18	.	33	.	60	254
1983	76	224	.	.	3	.	8	.	14	324
1984	17	53	.	.	2	.	6	.	1	80
1985	47	15	.	.	3	.	27	0	4	97
1986	.	2	.	.	4	.	90	.	.	95
1987	16	49	.	.	1	.	34	.	.	100
1988	10	160	0	.	2	1	84	2	.	259
1989	4	141	.	.	8	.	20	0	.	172
1990	9	186	135	.	16	.	68	.	6	420
1991	28	605	.	.	17	.	14	3	4	670
1992	25	930	16	.	15	.	17	.	1	1,003
1993	0	208	322	.	8	.	12	0	2	552
1994	48	1,265	0	0	3	.	18	0	40	1,374

Table 5.--Landings by region, fish and gear (thousands of pounds, whole weight)
(Data is not complete for 1998. Breakout not available for some states in 1991-98)

Gulf
Cobia

Year	Haul seines	Purse seines	Trawls	Pots & traps	Drift gill nets	Run-around gill nets	Other gill nets	Hook & line gear	Long & trot lines	Other or unknown gear	Total
1962	1	.	5	.	.	0	.	31	.	.	37
1963	0	.	1	.	.	0	.	37	.	.	38
1964	.	.	0	.	.	0	.	25	.	.	26
1965	.	.	2	.	.	1	.	19	.	.	22
1966	0	.	5	.	.	2	.	30	.	.	38
1967	0	.	7	.	.	5	.	27	.	.	40
1968	1	.	16	.	.	11	.	53	.	.	81
1969	0	.	15	.	.	12	.	45	.	.	72
1970	0	.	31	.	.	15	.	60	.	.	106
1971	.	.	17	.	.	20	.	66	.	.	104
1972	0	.	27	.	.	23	.	66	.	.	117
1973	1	.	23	.	.	20	.	69	.	1	113
1974	.	.	28	.	.	25	.	80	.	.	133
1975	.	.	14	.	.	37	.	69	.	.	119
1976	0	.	16	.	.	34	.	87	.	.	137
1977	.	.	9	.	.	25	.	69	.	.	102
1978	.	.	6	.	.	20	.	64	.	14	104
1979	.	.	8	.	.	21	.	57	.	8	94
1980	0	.	9	.	.	6	.	68	.	15	99
1981	0	.	18	.	.	6	.	80	.	14	118
1982	1	.	25	.	.	4	.	73	.	8	110
1983	0	.	21	.	.	5	.	96	.	11	132
1984	.	.	6	1	8	2	.	122	.	4	142
1985	0	.	15	1	2	1	.	114	0	2	136
1986	.	.	5	0	2	5	.	143	4	.	160
1987	.	.	7	.	3	3	.	154	9	0	175
1988	0	.	2	.	2	3	0	139	13	0	161
1989	.	.	2	.	.	11	0	182	12	3	210
1990	.	.	0	.	.	9	0	106	7	39	161
1991	.	.	1	.	.	14	.	97	15	50	177
1992	.	.	2	1	.	17	.	121	16	79	235
1993	.	.	1	0	.	13	.	131	17	98	261
1994	0	.	1	1	.	11	.	116	15	119	264
1995	0	.	1	1	.	8	.	131	7	93	241
1996	.	.	0	0	.	1	.	149	17	85	252
1997	0	.	0	1	.	1	.	117	17	72	208
1998	2	0	0	1	.	1	.	108	11	66	188

Table 5.--Landings by region, fish and gear (thousands of pounds, whole weight)
(Data is not complete for 1998. Breakout not available for some states in 1991-98)

Gulf
Dolphin fish

Year	Trawls	Pots & traps	Run-around gill nets	Hook & line gear	Long & trot lines	Other or unknown gear	Total
1962	.	.	.	16	.	.	16
1963	.	.	.	5	.	.	5
1964	.	.	.	22	.	.	22
1965	.	.	.	18	.	.	18
1966	.	.	.	61	.	.	61
1967	.	.	.	154	.	.	154
1968	.	.	.	76	.	.	76
1969	.	.	.	49	.	.	49
1970	.	.	.	63	.	.	63
1971	.	.	.	38	.	.	38
1972	.	.	.	55	.	.	55
1973	.	.	.	70	.	.	70
1974	.	.	.	70	.	.	70
1975	.	.	.	106	.	.	106
1976	.	.	.	84	.	.	84
1977	.	.	.	64	.	.	64
1978	.	.	.	94	.	.	94
1979	.	.	.	66	.	.	66
1980	.	.	.	94	0	.	95
1981	.	.	.	73	0	.	73
1982	.	.	.	162	0	.	162
1983	.	.	.	191	0	.	191
1984	.	.	.	283	0	.	283
1985	.	.	.	265	4	.	270
1986	.	.	0	386	107	.	492
1987	.	.	.	302	102	.	404
1988	.	.	.	300	199	.	499
1989	.	.	.	607	423	.	1,030
1990	.	.	.	838	261	.	1,099
1991	.	.	.	920	194	561	1,675
1992	.	0	0	289	105	334	728
1993	.	0	.	347	53	200	600
1994	.	0	.	505	48	130	683
1995	0	0	.	811	95	287	1,194
1996	.	0	.	601	128	305	1,034
1997	.	1	.	600	116	269	986
1998	.	.	.	261	22	123	406

Table 5.--Landings by region, fish and gear (thousands of pounds, whole weight)
(Data is not complete for 1998. Breakout not available for some states in 1991-98)

Gulf
King mackerel & cero

Year	Haul seines	Purse seines	Trawls	Pots & traps	Drift gill nets	Run-around gill nets	Other gill nets	Hook & line gear	Long & trot lines	Other or unknown gear	Total
1962	48	.	.	.	.	1,159	.	809	.	5	2,021
1963	20	.	.	.	.	2,134	.	656	.	8	2,817
1964	31	.	.	.	25	1,032	.	226	.	.	1,314
1965	62	.	.	.	20	1,542	.	264	.	10	1,898
1966	52	.	.	.	24	2,262	.	280	.	15	2,633
1967	42	282	.	.	45	2,399	.	303	.	13	3,084
1968	78	333	.	.	15	2,881	.	296	.	1	3,604
1969	63	116	.	.	45	2,389	.	628	.	1	3,242
1970	97	.	.	.	19	1,796	.	459	.	.	2,372
1971	51	.	.	.	52	2,294	.	340	.	1	2,738
1972	46	.	.	.	.	978	.	354	.	.	1,378
1973	74	.	.	.	.	1,747	.	395	.	0	2,217
1974	33	.	.	.	.	5,109	.	991	.	.	6,134
1975	81	.	.	.	.	1,895	.	646	.	.	2,622
1976	42	.	.	.	.	2,355	.	405	.	.	2,801
1977	4	.	.	.	.	4,687	.	526	.	.	5,217
1978	4	.	.	.	.	1,199	.	542	.	0	1,746
1979	14	.	.	.	.	1,088	.	590	.	0	1,691
1980	36	.	.	.	.	2,303	.	663	.	.	3,002
1981	8	.	.	.	.	2,278	.	788	.	.	3,073
1982	3	.	.	.	.	1,469	.	725	.	.	2,197
1983	5	.	2	.	.	1,003	.	1,822	.	.	2,832
1984	4	0	0	.	.	822	.	1,020	.	.	1,847
1985	1	.	0	.	.	536	.	1,207	0	.	1,744
1986	.	37	0	.	.	1,292	.	715	0	.	2,044
1987	0	1	0	.	.	270	.	806	0	.	1,078
1988	.	0	0	.	.	340	.	698	1	.	1,040
1989	.	14	.	.	.	52	.	877	.	.	943
1990	.	1	.	.	.	600	.	1,049	1	.	1,651
1991	1	.	0	.	.	59	0	352	1	582	996
1992	6	.	0	0	.	371	.	783	1	1,091	2,251
1993	2	.	0	0	.	1,401	.	683	1	900	2,987
1994	.	0	0	0	.	70	.	834	1	880	1,784
1995	.	0	0	24	.	430	.	689	0	802	1,946
1996	.	.	.	.	.	559	.	824	3	733	2,119
1997	.	0	0	0	.	389	.	591	1	789	1,770
1998	0	3	0	.	.	626	.	507	1	976	2,113

Table 5.--Landings by region, fish and gear (thousands of pounds, whole weight)
(Data is not complete for 1998. Breakout not available for some states in 1991-98)

Gulf
Spanish mackerel

Year	Haul seines	Purse seines	Trawls	Pots & traps	Drift gill nets	Run-around gill nets	Other gill nets	Hook & line gear	Long & trot lines	Other or unknown gear	Total
1962	376	.	2	.	.	5,644	516	302	.	72	6,911
1963	222	.	2	.	.	4,538	325	298	.	62	5,447
1964	289	.	1	.	42	3,437	.	160	.	27	3,956
1965	400	.	6	.	101	4,058	.	258	.	83	4,906
1966	593	.	4	.	97	5,973	.	302	.	97	7,066
1967	655	195	25	.	70	4,675	.	236	.	120	5,976
1968	824	199	24	.	70	5,777	.	218	.	120	7,231
1969	890	.	84	.	113	6,966	.	190	.	98	8,342
1970	1,226	.	52	.	98	6,511	41	248	.	121	8,298
1971	1,320	.	71	.	67	5,677	165	220	.	140	7,658
1972	1,541	.	77	0	.	4,595	473	336	.	200	7,222
1973	602	.	114	.	.	5,505	.	121	.	115	6,458
1974	486	.	190	.	.	7,066	.	647	.	165	8,554
1975	266	.	126	.	.	4,914	.	740	.	92	6,138
1976	286	.	86	.	10	7,078	0	791	.	90	8,341
1977	146	.	64	.	.	1,806	.	580	.	39	2,636
1978	154	5	28	.	.	964	0	512	.	43	1,705
1979	235	0	58	.	.	1,654	59	58	.	57	2,122
1980	308	.	69	.	.	1,431	4	76	.	64	1,951
1981	633	4	37	.	.	2,750	23	157	.	104	3,709
1982	282	76	29	.	.	2,820	4	155	.	90	3,456
1983	294	0	43	.	.	1,736	17	124	.	52	2,260
1984	136	1	17	.	325	2,956	0	49	.	21	3,506
1985	205	5	22	.	233	2,475	0	58	6	19	3,023
1986	2	147	17	.	586	1,947	1	35	.	3	2,738
1987	5	7	31	.	613	1,115	842	225	.	16	2,855
1988	50	55	18	.	359	1,794	3	24	.	12	2,310
1989	33	97	7	.	457	2,384	5	53	67	15	3,118
1990	163	32	13	.	622	1,682	8	16	.	42	2,578
1991	193	13	2	.	58	2,877	38	145	0	115	3,442
1992	182	2	4	.	246	3,139	2	34	.	164	3,773
1993	133	82	2	1	112	2,191	6	26	0	70	2,623
1994	45	2	1	0	159	2,338	14	22	.	200	2,781
1995	64	0	1	3	.	1,362	2	25	0	99	1,556
1996	3	3	0	0	.	559	3	41	0	22	630
1997	0	3	0	0	.	488	0	66	0	7	565
1998	7	16	3	.	.	272	0	38	0	41	378

Table 5.--Landings by region, fish and gear (thousands of pounds, whole weight)
(Data is not complete for 1998. Breakout not available for some states in 1991-98)

Gulf
Wahoo

Year	Trawls	Pots & traps	Run-around gill nets	Hook & line gear	Long & trot lines	Other or unknown gear	Total
1974	.	.	0	.	.	.	0
1975	.	.	1	.	.	.	1
1976	.	.	1	.	.	.	1
1977	.	.	1	0	.	.	1
1978	.	.	4	.	.	.	4
1979	.	.	0	3	.	.	3
1980	.	.	1	2	.	.	3
1981	.	.	0	9	0	.	9
1982	.	.	2	7	.	.	9
1983	.	.	.	9	.	.	9
1984	.	.	2	7	.	.	8
1985	.	.	2	9	2	.	12
1986	.	.	4	19	7	.	30
1987	.	.	6	22	74	.	101
1988	.	.	3	16	217	.	236
1989	.	.	3	18	230	.	251
1990	.	.	1	20	33	74	128
1991	.	.	.	20	44	137	201
1992	0	.	.	22	54	234	310
1993	.	.	.	23	33	219	275
1994	.	.	.	26	14	141	181
1995	.	0	.	31	12	136	179
1996	.	.	.	25	14	127	166
1997	.	.	.	43	18	133	194
1998	.	.	.	16	13	142	171

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Table 6.--Florida landings by fish and area
(thousands of pounds, whole weight)
(1998 data may be incomplete)

King mackerel & cero

Year	Northeast (Nassua-Flagler)	Southeast (Volusia-Dade)	Monroe County	West (Collier-Wakulla)	Northwest (Franklin-Escambia)	Other	Total
1977	119	3,796	4,885	291	40	.	9,132
1978	34	3,367	1,328	383	34	.	5,147
1979	36	3,310	1,490	53	148	.	5,038
1980	50	3,023	2,184	635	183	.	6,075
1981	52	4,806	2,946	69	57	.	7,931
1982	78	4,569	1,837	107	24	.	6,615
1983	61	3,047	1,282	21	36	.	4,448
1984	42	2,395	1,030	32	32	.	3,531
1985	60	2,576	710	45	13	.	3,404
1986	63	2,358	1,601	56	49	.	4,128
1987	39	2,533	472	49	21	1	3,115
1988	51	2,410	534	21	23	0	3,038
1989	47	1,755	216	46	23	0	2,087
1990	84	1,796	942	38	32	6	2,898
1991	132	1,509	259	66	88	1	2,054
1992	70	1,343	933	111	65	0	2,521
1993	35	1,580	1,890	89	109	.	3,702
1994	42	1,515	438	75	390	1	2,461
1995	44	1,574	997	83	88	21	2,808
1996	56	1,762	1,271	168	225	0	3,482
1997	49	2,487	659	59	259	.	3,513
1998	51	1,461	1,025	26	99	0	2,663

Spanish mackerel

Year	Northeast (Nassua-Flagler)	Southeast (Volusia-Dade)	Monroe County	West (Collier-Wakulla)	Northwest (Franklin-Escambia)	Other	Total
1977	10	10,977	1,735	441	217		13,381
1978	4	5,506	1,023	151	426	.	7,111
1979	3	4,883	1,278	127	541	.	6,832
1980	6	9,805	1,054	103	613	.	11,581
1981	4	4,170	2,213	218	1,119	.	7,724
1982	3	3,755	2,284	321	683	.	7,046
1983	11	5,936	1,317	192	579	.	8,035
1984	13	2,384	3,099	121	256	.	5,873
1985	16	3,229	2,137	346	432	.	6,160
1986	36	3,967	1,832	256	489	0	6,581
1987	38	3,459	1,822	377	465	0	6,162
1988	34	3,038	1,011	665	462	1	5,210
1989	20	2,834	2,285	463	243	1	5,845
1990	39	1,941	1,151	749	484	1	4,364
1991	50	2,937	1,456	1,380	425	0	6,249
1992	56	1,967	1,344	1,570	650	0	5,587
1993	16	3,876	374	1,486	616	0	6,367
1994	26	3,074	318	1,661	439	2	5,519
1995	12	3,053	207	571	381	1	4,225
1996	6	2,239	324	76	9	.	2,654
1997	7	2,262	169	37	4	.	2,480
1998	1	918	35	114	7	0	1,076

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Table 7.--Southeast landings by fish and month
thousands of pounds, whole weight
(1998 data may not be complete)

Bluefish

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1977	800	567	772	503	130	142	113	110	291	418	340	467	4653
1978	432	611	468	519	296	145	78	173	242	313	223	668	4168
1979	590	1196	863	817	447	247	133	136	130	462	474	363	5856
1980	1236	1030	1065	1264	362	187	260	331	302	949	686	1226	8900
1981	1912	1526	1234	1009	507	185	166	289	350	507	576	1394	9653
1982	1143	647	1064	836	230	269	324	393	751	662	462	844	7624
1983	1250	2207	1392	1823	256	205	188	226	199	300	382	668	9095
1984	927	895	862	986	339	225	162	212	229	247	284	489	5857
1985	410	655	585	626	305	167	212	325	331	332	300	653	4900
1986	624	826	862	495	172	92	153	326	425	442	281	573	5272
1987	700	853	1141	990	371	149	238	196	329	402	577	901	6847
1988	1108	1223	1294	1093	359	220	170	186	269	364	444	703	7433
1989	539	345	824	506	180	99	138	234	254	414	463	1089	5084
1990	882	582	1085	619	268	206	179	262	380	386	670	958	6478
1991	891	698	862	971	433	132	146	224	367	517	320	593	6154
1992	904	576	534	798	532	398	192	208	263	273	247	574	5499
1993	600	614	817	501	433	164	340	120	152	285	176	676	4878
1994	455	528	783	487	93	49	51	107	165	233	84	216	3251
1995	871	635	842	515	380	82	77	81	127	113	99	441	4263
1996	476	663	599	478	259	76	54	96	215	104	371	656	4046
1997	557	1109	538	443	270	126	103	99	271	166	608	1001	5292
1998	1003	398	505	572	320	150	85	49	74	134	111	415	3814

Bonito

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1977	0	.	0	0	11	69	33	45	150	4	0	.	312
1978	0	0	2	1	1	12	0	7	17	51	1	0	93
1979	0	1	8	7	89	79	0	8	20	123	2	3	341
1980	0	0	2	0	47	38	36	71	43	22	4	6	271
1981	19	24	64	165	158	58	32	19	13	39	11	9	611
1982	1	4	18	33	19	134	52	24	6	52	8	3	355
1983	5	6	2	5	11	126	117	31	38	15	6	1	364
1984	0	0	32	0	54	6	5	6	3	4	4	3	119
1985	5	0	4	5	9	2	12	3	1	23	40	1	103
1986	1	1	2	64	4	1	1	2	4	20	1	1	100
1987	1	1	3	10	47	28	119	5	16	2	1	4	236
1988	1	4	2	8	91	17	94	34	25	35	4	4	318
1989	4	4	45	61	21	48	46	36	6	6	22	25	325
1990	6	2	7	104	27	13	165	11	38	55	13	2	442
1991	11	3	7	3	55	123	39	160	262	13	11	4	692
1992	2	9	17	96	24	229	72	198	334	61	13	11	1067
1993	26	62	13	23	9	30	67	111	294	11	3	9	658
1994	16	7	24	18	28	4	53	159	877	229	48	31	1493

Table 7.--Southeast landings by fish and month
thousands of pounds, whole weight
(1998 data may not be complete)

Cobia

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1977	6	4	3	12	6	8	10	5	7	11	14	6	113
1978	8	8	21	17	4	11	17	11	6	2	2	9	116
1979	5	21	8	8	7	9	9	9	6	5	11	6	105
1980	14	17	13	12	6	10	12	12	8	5	6	12	127
1981	22	19	16	13	11	7	15	15	9	5	8	18	160
1982	17	21	15	13	14	8	19	11	6	15	9	10	156
1983	15	21	18	14	16	15	21	10	9	8	9	11	168
1984	25	22	19	11	12	10	10	14	8	8	11	22	172
1985	18	19	24	17	13	9	12	12	5	13	8	13	162
1986	25	18	13	22	20	21	20	25	15	14	11	14	219
1987	18	27	23	28	27	32	34	19	18	12	16	21	273
1988	14	20	22	29	29	25	27	26	13	20	15	16	256
1989	24	23	34	46	40	33	29	20	16	20	26	14	326
1990	29	21	29	37	25	23	18	16	13	11	19	25	266
1991	30	31	35	36	19	29	26	23	13	12	21	29	303
1992	31	36	43	46	41	30	25	15	16	23	20	38	363
1993	32	29	44	62	54	26	27	19	16	26	21	31	385
1994	23	31	47	73	46	26	27	24	26	25	19	24	391
1995	32	35	45	75	46	23	25	16	16	15	19	26	374
1996	32	61	39	84	51	22	18	19	20	22	17	20	404
1997	23	29	44	63	38	25	23	17	18	28	22	15	345
1998	24	21	28	81	40	22	17	9	7	23	6	2	280

Cobia: Total for 1977 includes 20 thousand pounds for which month is not identified.

Dolphin fish

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1977	1	2	6	6	47	32	12	14	3	5	3	3	135
1978	2	4	7	16	47	43	19	9	5	2	2	7	163
1979	0	0	2	9	31	32	15	8	5	4	2	4	111
1980	2	3	4	11	24	78	24	15	6	2	1	1	173
1981	1	2	2	10	25	35	26	13	9	3	2	3	132
1982	1	2	3	12	47	73	71	47	28	11	6	4	306
1983	3	2	2	9	86	130	33	20	12	11	8	4	319
1984	2	4	20	21	143	152	34	21	13	9	13	10	442
1985	4	3	11	22	57	109	110	54	21	9	7	5	412
1986	4	8	13	33	149	147	137	64	53	29	27	18	682
1987	12	7	6	18	95	218	111	79	30	15	21	22	633
1988	12	8	12	63	103	234	141	59	50	22	12	18	735
1989	20	37	32	86	197	286	367	186	134	61	34	22	1464
1990	32	25	36	82	318	526	353	185	108	42	31	28	1765
1991	33	22	88	75	295	656	546	291	151	64	60	49	2330
1992	45	31	27	42	191	253	248	88	63	28	18	20	1055
1993	22	17	24	32	254	276	262	102	53	28	30	21	1121
1994	16	21	36	87	270	294	208	151	93	56	35	34	1301
1995	27	28	53	270	829	514	332	144	76	33	33	20	2360
1996	13	19	17	57	490	424	312	152	45	22	19	24	1594
1997	16	16	51	109	591	560	274	127	59	24	30	19	1876
1998	14	18	13	47	160	250	167	77	18	21	6	5	796

Table 7.--Southeast landings by fish and month
thousands of pounds, whole weight
(1998 data may not be complete)

King mackerel & cero

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1977	2282	2465	1934	206	150	143	234	308	168	235	305	958	9388
1978	928	1132	668	525	506	206	140	272	139	161	205	485	5367
1979	394	1701	669	207	510	259	183	377	107	240	175	694	5515
1980	1012	1012	1171	327	572	197	164	573	449	317	424	850	7068
1981	1377	1790	1555	323	451	183	228	419	181	391	324	1591	8813
1982	1581	646	1529	443	1091	188	378	581	261	400	551	591	8242
1983	1045	1223	1493	251	729	224	170	403	279	317	418	412	6963
1984	1000	761	369	170	328	162	182	389	281	286	312	976	5217
1985	513	463	901	310	780	193	286	304	98	210	530	805	5392
1986	726	1283	472	378	616	138	299	478	340	393	302	344	5768
1987	558	392	143	429	660	285	388	414	381	518	449	583	5199
1988	62	38	96	825	803	142	247	382	270	310	503	865	4542
1989	71	45	35	476	555	154	310	507	247	396	496	357	3649
1990	790	47	230	461	507	166	323	402	340	323	592	668	4848
1991	316	94	122	346	382	138	310	525	381	290	382	743	4031
1992	839	124	149	365	228	212	554	392	370	605	280	851	4968
1993	1380	274	288	328	524	108	511	458	352	208	342	893	5664
1994	407	212	227	427	372	144	594	392	388	275	390	467	4294
1995	626	660	399	278	374	155	621	299	148	234	388	492	4673
1996	406	947	174	439	412	211	561	494	153	349	347	618	5112
1997	774	438	684	428	524	169	913	292	139	425	663	484	5934
1998	663	618	498	477	302	162	663	385	121	323	533	68	4814

Spanish mackerel

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1977	5305	3005	670	182	117	46	41	62	144	292	938	2869	13672
1978	2914	929	270	156	32	6	7	46	198	260	226	2212	7256
1979	1393	3029	194	322	117	41	60	146	56	198	130	1336	7023
1980	4711	1417	110	289	105	34	41	72	210	184	160	4513	11847
1981	2004	224	63	717	172	44	38	81	282	234	733	3345	7936
1982	1046	254	2589	419	181	43	126	139	211	221	717	1459	7405
1983	4184	248	62	321	289	42	56	46	87	209	520	2191	8255
1984	1814	606	815	142	98	21	22	133	57	105	391	1829	6032
1985	1713	1812	405	316	53	66	38	51	58	232	211	1488	6442
1986	2370	2376	217	380	118	44	74	124	150	283	158	686	6982
1987	1328	816	280	671	171	131	104	139	151	205	98	2762	6858
1988	621	210	497	430	317	73	125	77	97	296	318	2766	5828
1989	1853	556	192	217	97	83	146	86	95	448	298	2493	6563
1990	723	595	406	437	142	143	145	184	330	343	428	1520	5398
1991	1013	152	197	430	194	175	167	190	425	566	399	3380	7288
1992	1057	641	510	648	292	126	158	156	239	496	309	1904	6537
1993	838	526	742	701	238	136	90	92	249	349	441	2703	7105
1994	544	1008	793	744	114	107	90	143	353	450	236	1830	6413
1995	1473	1054	692	599	149	62	62	75	176	150	219	314	5024
1996	254	490	144	262	136	72	44	124	90	271	139	1285	3310
1997	512	252	220	272	137	124	103	117	261	412	577	613	3601
1998	322	144	101	196	140	70	66	43	71	354	162	1	1670

Table 7.--Southeast landings by fish and month
thousands of pounds, whole weight
(1998 data may not be complete)

Wahoo

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1977	0	1	0	0	1	1	1	1	0	0	0	0	7
1978	0	2	1	1	1	2	1	1	3	0	0	2	13
1979	1	0	1	0	1	1	4	4	1	1	1	0	15
1980	3	3	0	1	1	2	4	6	2	0	1	1	23
1981	1	1	1	2	2	4	6	4	2	1	1	1	26
1982	1	1	1	2	3	3	6	4	1	5	1	1	30
1983	1	2	1	1	3	7	6	5	5	2	1	1	34
1984	0	0	2	2	4	4	5	7	2	1	1	1	30
1985	1	1	2	4	5	5	7	7	3	2	1	1	39
1986	1	1	1	2	5	5	10	9	8	4	3	1	51
1987	7	3	4	6	9	31	31	26	15	11	9	8	159
1988	10	14	9	7	21	47	72	60	20	28	14	10	311
1989	32	14	10	16	29	46	68	38	28	7	5	7	299
1990	9	7	8	7	18	34	45	34	19	8	7	6	201
1991	7	8	9	11	17	37	57	55	24	9	7	9	252
1992	12	11	28	23	30	55	75	73	22	12	9	13	362
1993	11	16	16	22	26	35	63	87	29	11	7	8	332
1994	9	11	16	12	22	31	41	33	23	10	8	15	229
1995	10	9	15	17	27	41	57	31	20	11	7	11	257
1996	8	13	5	12	19	43	44	40	20	9	9	6	229
1997	7	10	15	17	22	28	37	50	34	13	10	11	254
1998	14	12	15	17	22	25	47	41	10	12	5	3	222

Table 8.--Southeast real exvessel prices by fish and month
1990 cents/pound, whole weight
(1998 data may not be complete)

Bluefish

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977	22	24	19	18	19	17	21	18	19	16	24	25
1978	26	31	26	24	18	21	21	21	18	16	18	25
1979	44	34	30	27	21	18	21	20	22	20	20	21
1980	20	20	26	23	20	17	17	21	19	13	16	18
1981	19	21	32	26	21	17	14	16	17	18	16	26
1982	24	34	40	47	18	18	16	18	16	17	17	21
1983	20	13	16	15	20	21	19	17	17	16	14	16
1984	18	17	25	18	20	20	19	18	16	14	14	13
1985	35	25	19	18	18	17	20	15	14	14	14	16
1986	20	18	19	20	19	19	20	18	18	15	13	16
1987	27	25	24	31	17	19	18	18	16	15	14	13
1988	18	18	19	19	19	20	18	18	17	17	15	15
1989	17	33	25	23	23	28	21	21	22	19	16	16
1990	27	28	26	31	25	22	19	22	15	17	12	12
1991	20	22	25	18	20	26	23	24	19	22	13	13
1992	20	32	29	30	48	65	41	44	32	37	28	42
1993	43	42	36	42	44	56	39	64	37	28	70	15
1994	34	33	34	32	23	24	25	26	26	36	27	29
1995	32	34	37	33	27	25	25	25	26	27	23	35
1996	25	25	26	23	23	23	26	24	27	26	27	26
1997	27	26	28	42	24	24	22	24	32	26	26	26
1998	28	30	29	28	26	24	25	29	27	28	25	28

Bonito

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977	20	.	21	18	12	14	14	14	14	14	13	.
1978	8	9	7	16	13	9	36	25	13	13	11	16
1979	16	23	14	12	13	11	13	12	12	11	10	14
1980	14	7	19	16	14	23	14	12	10	22	11	26
1981	20	18	18	17	16	10	10	10	10	10	11	19
1982	8	17	13	9	8	11	10	13	12	13	12	11
1983	10	11	14	14	15	9	9	11	10	12	23	17
1984	11	21	6	39	9	11	15	14	10	11	13	11
1985	9	15	17	15	22	15	11	12	23	12	12	17
1986	14	28	11	12	12	27	19	11	13	14	22	13
1987	17	31	21	14	10	10	10	13	12	12	26	27
1988	20	23	24	17	15	38	23	20	17	15	19	21
1989	14	17	17	12	27	16	19	25	36	28	19	15
1990	29	16	15	11	12	16	17	18	18	24	17	15
1991	10	20	12	18	24	21	27	23	21	23	17	19
1992	23	26	13	13	21	19	17	36	27	18	16	20
1993	19	23	19	15	32	15	20	21	15	31	28	24
1994	18	30	27	20	21	23	32	23	25	23	28	30
1995	19	19	19	19	23	20	25	17	19	27	18	19
1996	22	22	21	22	22	23	25	24	30	22	21	21
1997	24	20	20	20	21	20	34	21	20	20	20	35
1998	22	21	21	21	21	21	21	22	21	21	21	21

Table 8.--Southeast real exvessel prices by fish and month
1990 cents/pound, whole weight
(1998 data may not be complete)

Cobia

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977	27	44	53	43	39	46	46	30	47	53	53	47
1978	62	64	50	53	51	50	52	46	44	68	70	55
1979	44	50	55	50	48	45	43	41	48	51	37	50
1980	53	50	47	57	48	43	47	54	50	50	51	48
1981	70	68	58	58	45	62	57	56	47	45	49	47
1982	80	55	57	68	59	60	65	59	46	55	54	51
1983	82	81	65	76	71	60	68	57	63	65	70	74
1984	78	67	71	80	84	74	76	65	66	68	84	92
1985	91	99	96	104	83	85	80	86	98	92	92	95
1986	98	119	106	115	95	91	96	85	94	91	106	113
1987	123	115	120	119	108	112	107	108	89	91	114	119
1988	109	119	131	131	128	110	119	122	114	104	117	128
1989	132	133	127	131	123	115	111	116	111	110	122	126
1990	131	133	145	150	131	126	117	113	109	113	128	138
1991	129	135	144	145	126	117	130	139	130	132	150	146
1992	155	156	158	155	141	131	133	125	141	143	142	146
1993	149	152	153	153	142	142	143	144	142	133	147	162
1994	161	163	163	166	145	145	145	145	147	143	147	149
1995	159	176	168	158	151	152	154	158	151	134	158	162
1996	158	172	171	174	159	153	149	160	151	129	157	184
1997	175	169	170	177	160	144	156	165	147	133	156	179
1998	184	175	179	189	173	159	168	167	165	141	158	136

Dolphin fish

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977	84	81	64	67	60	64	70	56	77	94	78	78
1978	75	64	85	69	67	66	69	68	66	105	94	66
1979	87	76	95	89	82	72	81	85	76	88	90	74
1980	95	92	81	86	83	77	70	70	78	85	75	87
1981	76	106	112	88	87	87	79	88	91	85	105	119
1982	91	93	98	92	91	90	88	93	93	94	100	100
1983	97	101	123	119	94	88	95	97	100	93	85	110
1984	103	122	124	114	100	88	106	112	108	118	122	130
1985	116	134	142	132	117	108	119	128	119	126	139	142
1986	141	142	128	125	104	111	118	122	119	123	159	127
1987	140	142	146	138	137	139	132	137	135	114	117	120
1988	130	138	142	130	128	119	115	114	110	443	127	128
1989	128	123	139	120	118	114	105	104	103	116	112	104
1990	106	132	124	113	103	103	108	109	110	115	124	120
1991	124	123	96	121	123	113	109	111	121	121	114	111
1992	96	98	105	115	112	108	106	98	115	117	120	119
1993	119	118	122	126	124	128	110	126	126	128	130	124
1994	131	132	131	139	141	138	141	160	157	149	133	122
1995	143	139	144	139	120	129	134	154	154	154	150	146
1996	141	135	169	146	124	123	138	135	134	148	153	157
1997	121	132	143	126	105	102	107	112	125	135	124	132
1998	129	117	134	131	130	128	143	149	148	168	121	112

Table 8.--Southeast real exvessel prices by fish and month
1990 cents/pound, whole weight
(1998 data may not be complete)

King mackerel & cero

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977	76	62	66	82	112	111	100	92	123	115	82	63
1978	68	67	77	69	88	98	129	122	136	141	118	105
1979	107	99	93	153	125	146	133	129	121	105	111	100
1980	92	94	93	103	100	107	111	113	106	102	113	100
1981	100	98	101	106	98	113	109	102	118	103	102	103
1982	108	113	113	115	105	105	121	112	121	120	102	111
1983	111	110	109	133	113	109	120	116	104	85	73	81
1984	64	74	90	106	100	123	120	125	121	98	87	82
1985	108	128	107	126	108	126	128	127	150	131	112	93
1986	114	105	123	131	118	127	141	99	131	101	102	113
1987	129	118	163	155	117	127	139	135	108	96	99	117
1988	152	182	193	103	114	149	117	129	129	125	126	109
1989	160	206	202	126	102	152	155	128	127	111	112	116
1990	108	136	148	121	114	151	131	128	122	103	95	96
1991	103	143	216	138	123	153	114	98	100	127	100	96
1992	102	168	188	156	157	158	102	112	121	112	125	113
1993	87	165	181	158	129	184	102	103	83	140	125	111
1994	127	137	176	132	119	161	102	124	114	134	131	125
1995	124	101	144	154	122	182	88	107	114	148	138	119
1996	121	91	134	119	111	167	92	96	154	148	143	108
1997	90	134	142	129	96	166	90	129	162	145	118	116
1998	100	104	126	132	139	189	105	115	194	155	142	146

Spanish mackerel

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977	33	33	33	34	35	36	34	34	34	35	36	32
1978	31	31	32	36	34	32	37	37	41	39	39	34
1979	31	33	35	41	45	34	53	46	42	42	41	37
1980	30	41	35	37	36	37	37	48	39	38	46	35
1981	36	34	37	36	35	42	57	44	39	44	38	38
1982	38	37	38	37	36	50	38	34	42	38	39	34
1983	35	40	38	37	31	37	42	42	37	36	31	32
1984	30	33	32	33	38	40	45	42	34	39	36	33
1985	32	31	31	34	39	26	41	40	39	36	41	39
1986	35	34	35	37	42	34	40	38	39	40	43	38
1987	36	43	39	41	43	29	36	34	33	38	42	41
1988	46	33	70	41	39	36	34	38	36	41	46	39
1989	42	42	41	42	43	33	35	42	39	42	45	37
1990	48	45	46	43	41	37	36	42	40	39	48	32
1991	51	57	51	40	38	41	40	38	39	36	40	37
1992	31	35	37	36	39	37	37	41	36	42	43	36
1993	36	45	37	41	40	42	42	45	39	47	46	35
1994	45	40	49	41	41	43	49	43	43	48	47	40
1995	41	38	41	34	35	39	48	48	52	65	69	50
1996	56	49	70	62	47	45	41	46	56	56	57	33
1997	49	38	71	50	51	59	53	58	54	59	40	35
1998	61	88	74	75	64	60	54	62	68	48	46	59

Table 8.--Southeast real exvessel prices by fish and month
1990 cents/pound, whole weight
(1998 data may not be complete)

Wahoo

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977	84	81	83	78	63	73	86	80	84	82	88	74
1978	60	62	76	84	93	73	76	71	69	69	84	72
1979	93	91	102	100	83	86	87	86	102	80	97	89
1980	108	106	99	86	85	77	76	77	69	71	84	85
1981	87	81	75	82	88	83	77	74	81	74	84	83
1982	89	100	77	86	92	86	82	83	82	71	92	107
1983	103	79	107	106	104	103	100	104	77	99	103	80
1984	71	78	86	91	84	101	104	105	110	101	123	109
1985	115	96	121	115	102	111	108	120	112	110	114	115
1986	108	118	117	135	142	120	129	118	120	121	131	119
1987	92	132	121	126	116	120	115	119	125	124	121	114
1988	108	98	123	142	124	113	107	105	115	109	111	124
1989	113	112	102	110	95	93	88	87	82	121	117	135
1990	125	138	122	148	141	119	112	116	114	114	126	133
1991	120	110	120	140	123	107	98	101	117	120	132	111
1992	131	113	107	101	120	107	98	87	109	121	118	115
1993	112	97	112	108	129	118	105	105	107	140	151	132
1994	110	144	117	152	124	120	111	108	127	148	149	131
1995	134	133	123	159	152	125	124	122	135	175	170	148
1996	142	154	142	158	141	105	109	125	134	177	183	180
1997	208	186	137	144	137	123	114	107	133	168	160	163
1998	124	153	127	147	150	120	110	122	166	187	152	117

Table 9.--Southeast monthly landings of king mackerel and cero by state
monthly=% of total, total=thousands of pounds, whole weight
(1998 data is not complete)

North Carolina-Georgia

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1977	0	0	0	1	9	1	2	1	2	37	41	6	256
1978	0	.	0	1	6	4	6	3	5	25	41	9	220
1979	0	0	0	6	7	2	5	8	8	23	24	18	478
1980	0	0	0	3	5	2	4	9	9	24	36	8	993
1981	0	1	1	3	6	5	6	3	7	40	24	3	862
1982	0	0	1	6	9	5	4	4	9	26	24	11	1398
1983	1	1	0	2	11	4	5	5	9	23	28	12	1024
1984	1	1	5	14	7	5	4	3	6	25	19	9	933
1985	1	0	3	10	9	6	4	5	6	13	36	7	1012
1986	2	1	3	7	8	5	5	6	17	25	13	7	1303
1987	1	1	6	3	8	4	5	4	13	25	26	4	1549
1988	5	3	8	5	7	4	4	4	12	22	22	3	1041
1989	4	4	3	15	4	3	6	7	6	18	24	6	903
1990	2	1	16	18	2	4	5	5	10	10	25	4	1311
1991	14	5	7	7	4	4	4	6	6	15	18	10	1393
1992	9	7	10	9	4	7	4	3	4	17	16	10	1303
1993	11	12	8	7	13	4	4	3	2	10	21	4	1060
1994	5	5	10	14	3	3	3	3	5	17	16	15	949
1995	11	3	16	6	3	2	4	1	3	17	20	14	1107
1996	10	4	6	14	2	2	1	3	2	23	27	7	893
1997	1	11	29	8	1	2	2	1	3	15	21	6	1627
1998	8	3	11	8	3	2	1	1	2	14	41	6	1189

Florida, east coast

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1977	17	17	18	1	3	3	5	8	4	2	4	18	3915
1978	10	19	16	4	14	6	4	8	3	3	3	10	3402
1979	4	22	17	5	13	7	4	9	1	3	1	13	3346
1980	11	5	4	4	17	6	4	15	9	2	2	20	3073
1981	13	11	14	5	8	3	3	8	2	1	2	30	4858
1982	10	5	25	8	21	3	7	11	3	1	2	6	4647
1983	17	7	26	6	18	5	2	6	4	1	3	5	3108
1984	8	22	12	1	10	4	3	13	9	0	2	16	2437
1985	10	7	19	7	25	3	7	8	1	1	2	10	2636
1986	10	9	8	9	20	3	9	15	4	1	4	8	2421
1987	9	2	0	13	20	9	10	12	5	0	1	20	2573
1988	0	0	0	29	29	4	4	11	5	1	4	13	2461
1989	1	0	0	16	28	7	9	17	2	1	7	10	1801
1990	4	0	0	9	25	6	5	9	3	2	13	25	1881
1991	1	1	1	15	20	5	6	10	5	3	5	27	1641
1992	15	0	1	14	12	8	5	8	8	3	3	22	1413
1993	3	8	12	15	24	4	4	10	4	3	4	11	1614
1994	10	7	7	11	21	7	6	9	5	2	5	11	1557
1995	10	7	10	11	21	8	4	4	1	2	8	14	1618
1996	8	12	3	7	22	11	5	10	4	3	3	15	1817
1997	10	7	8	11	19	5	5	7	2	3	9	13	2536
1998	13	10	7	12	17	9	9	8	5	6	2	.	1513

Table 9.--Southeast monthly landings of king mackerel and cero by state
monthly=% of total, total=thousands of pounds, whole weight
(1998 data is not complete)

Florida, west coast

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1977	31	35	24	3	0	0	0	0	0	1	1	5	5217
1978	33	28	8	22	0	0	0	0	1	1	0	7	1745
1979	15	57	6	2	2	0	0	3	2	1	1	10	1691
1980	22	28	35	6	0	0	0	0	2	1	0	5	3002
1981	24	40	28	2	0	0	0	0	0	0	0	4	3073
1982	57	20	19	0	0	0	0	0	1	1	1	1	1968
1983	11	45	36	1	0	0	0	1	1	1	1	2	1340
1984	70	18	2	2	1	0	0	0	0	2	3	2	1095
1985	16	34	45	1	0	0	1	0	0	0	0	1	768
1986	23	57	12	3	2	0	0	0	0	0	0	1	1707
1987	40	30	8	8	3	0	1	1	2	1	1	4	543
1988	0	0	0	10	2	1	1	1	1	2	1	81	577
1989	7	1	3	18	2	1	1	1	3	10	13	40	286
1990	69	3	1	6	1	0	0	1	2	1	2	14	1016
1991	25	2	1	2	1	1	4	4	5	6	10	38	413
1992	46	2	1	4	1	0	2	1	2	2	2	36	1108
1993	58	1	1	1	0	0	1	1	1	2	3	32	2088
1994	22	7	2	14	1	1	5	3	3	8	18	17	904
1995	28	43	5	3	1	0	2	1	2	1	3	10	1190
1996	10	42	4	12	0	0	1	1	3	6	3	18	1665
1997	52	9	1	2	1	0	3	1	4	12	9	6	976
1998	33	31	8	17	1	0	1	2	1	5	2	.	1151

Alabama-Texas

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1978	.	.	.	.	.	.	.	.	.	100	.	.	0
1979	.	.	.	.	.	.	100	.	.	.	.	.	0
1982	.	.	.	.	.	.	.	.	.	.	42	58	229
1983	24	27	13	1	3	2	4	10	4	3	1	7	1492
1984	4	4	0	0	0	2	8	6	2	4	6	64	752
1985	11	1	3	1	4	5	5	5	1	6	10	48	976
1986	17	19	5	0	0	0	5	9	6	14	9	15	338
1987	20	30	0	0	0	0	9	10	7	22	2	.	535
1988	0	.	0	.	0	0	23	14	5	12	34	11	463
1989	0	0	.	.	.	0	13	20	22	29	17	.	658
1990	.	0	.	.	.	0	27	26	23	22	.	2	639
1991	.	.	.	0	0	0	22	45	33	0	.	.	584
1992	.	.	0	0	0	0	36	20	16	28	0	0	1143
1993	.	.	0	0	0	0	42	28	28	1	0	.	902
1994	0	.	0	.	.	0	49	23	27	1	0	.	884
1995	.	.	0	0	0	0	64	27	9	0	0	0	759
1996	.	.	.	.	0	0	59	38	3	.	.	.	737
1997	.	.	.	.	0	0	91	9	0	0	0	.	793
1998	.	7	17	0	0	0	51	24	0	.	.	.	962

Table 10.--Southeast monthly real exvessel prices of king mackerel & cero by state
1990 cents/pound, whole weight
(1998 data may not be complete)

King mackerel & cero
North Carolina-Georgia

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977	107	128	90	80	94	91	145	122	112	140	44	82
1978	90	.	93	88	82	87	109	122	101	128	98	88
1979	101	102	92	101	108	94	101	116	128	83	109	110
1980	89	78	133	122	93	95	110	110	101	100	113	95
1981	110	115	115	120	100	102	106	106	115	103	102	109
1982	97	94	108	130	101	97	101	105	124	121	96	111
1983	111	107	108	108	110	108	105	96	93	85	65	68
1984	96	129	100	103	88	98	107	116	134	101	85	79
1985	115	113	117	114	104	100	110	107	138	146	119	112
1986	132	127	133	105	72	111	111	103	120	100	91	103
1987	136	152	183	161	98	119	122	116	94	97	97	112
1988	155	190	196	98	98	127	121	129	129	127	129	151
1989	181	231	232	122	108	153	171	134	148	129	108	122
1990	183	214	148	110	132	154	142	138	120	125	85	92
1991	99	156	235	128	119	148	147	125	110	127	95	96
1992	138	190	202	160	176	157	140	135	143	142	124	122
1993	174	176	191	159	123	162	137	136	138	143	122	162
1994	151	150	148	147	144	136	142	142	136	141	144	141
1995	149	148	148	147	143	141	136	147	148	144	145	144
1996	148	149	149	148	144	142	140	130	143	145	144	139
1997	139	139	140	140	137	136	129	131	135	135	138	140
1998	141	139	142	142	140	150	137	144	142	144	145	146

King mackerel & cero
Florida, east coast

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977	98	66	78	140	120	121	105	92	127	119	111	62
1978	80	73	81	103	88	99	133	123	143	158	135	115
1979	122	108	92	176	135	150	142	141	160	133	124	103
1980	105	130	121	115	100	109	114	114	116	115	116	103
1981	104	97	100	105	99	118	113	102	123	106	106	103
1982	112	126	114	112	105	110	126	113	122	123	112	112
1983	115	128	114	142	114	117	147	126	113	114	97	77
1984	87	82	89	130	103	145	154	128	117	114	111	101
1985	120	163	109	133	109	151	134	135	186	158	120	122
1986	140	151	137	146	126	140	153	98	160	142	134	129
1987	145	150	138	155	123	129	150	150	138	140	126	117
1988	135	139	160	104	115	159	132	133	135	137	125	112
1989	144	105	131	131	102	153	166	127	169	138	121	123
1990	148	161	149	136	113	151	169	174	156	146	108	93
1991	104	106	160	146	123	162	118	115	128	144	114	98
1992	117	116	115	169	154	160	148	147	154	135	134	134
1993	127	163	182	161	131	201	158	132	135	164	141	137
1994	134	138	203	120	117	169	167	167	159	132	132	120
1995	148	142	150	160	121	191	119	148	164	181	129	108
1996	131	110	185	141	110	170	129	116	181	147	143	112
1997	122	145	147	125	94	174	108	140	197	155	95	113
1998	141	167	163	151	140	196	135	154	218	179	124	.

Table 10.--Southeast monthly real exvessel prices of king mackerel & cero by state
1990 cents/pound, whole weight
(1998 data may not be complete)

King mackerel & cero
Florida, west coast

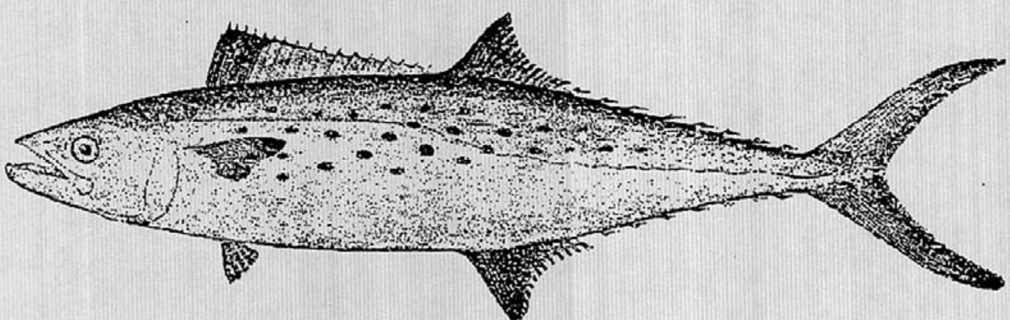
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977	66	60	59	62	64	44	45	65	82	60	63	62
1978	61	59	61	57	55	70	68	65	89	90	89	82
1979	99	93	95	71	15	86	77	66	76	85	84	88
1980	86	87	90	89	85	83	76	73	67	78	87	91
1981	97	98	102	103	82	81	72	75	76	77	84	104
1982	106	105	109	100	92	86	86	89	82	84	83	99
1983	111	111	109	113	87	89	78	71	67	83	84	68
1984	58	50	74	100	83	80	88	85	109	86	88	99
1985	107	103	103	107	99	102	100	92	109	114	97	100
1986	102	95	112	112	135	111	105	126	121	126	119	126
1987	116	116	122	143	111	119	116	103	112	122	111	118
1988	124	138	164	94	97	107	98	103	100	108	108	105
1989	132	144	104	107	103	96	85	94	101	103	107	104
1990	102	106	126	127	115	121	114	105	111	114	114	108
1991	110	99	90	50	104	71	110	104	89	99	102	90
1992	87	92	90	93	97	103	102	97	101	97	119	93
1993	77	106	111	110	104	110	104	98	110	114	119	100
1994	116	125	166	131	119	121	136	101	110	124	120	115
1995	103	89	117	145	106	97	96	122	109	147	128	107
1996	98	82	91	86	107	95	102	94	155	156	140	98
1997	73	103	113	112	100	102	101	110	154	161	99	98
1998	69	74	110	107	108	108	107	109	165	150	116	.

King mackerel & cero
Alabama-Texas

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1978	.	.	.	.	.	.	.	.	.	65	.	.
1979	.	.	.	.	.	.	176	.	.	.	.	.
1982	.	.	.	.	.	.	.	.	.	.	110	110
1983	104	100	93	86	110	69	115	114	114	71	57	107
1984	56	69	67	83	110	81	84	111	120	78	67	66
1985	79	140	112	137	89	119	128	113	110	91	84	73
1986	76	93	88	25	96	107	118	101	107	84	68	73
1987	119	106	76	66	57	68	109	77	81	88	76	.
1988	133	.	133	.	88	145	104	117	111	119	123	107
1989	105	105	..	.	.	86	126	127	108	95	109	.
1990	.	122	.	.	.	90	108	81	112	71	.	78
1991	.	.	.	85	29	39	95	78	85	52	.	.
1992	.	.	120	80	82	60	89	90	98	90	94	80
1993	.	.	20	29	158	81	87	82	63	96	33	.
1994	78	.	39	.	.	139	83	97	95	115	53	.
1995	.	.	47	56	70	54	79	90	85	55	90	93
1996	.	.	.	.	91	84	82	81	79	.	.	.
1997	.	.	.	.	91	86	84	104	83	68	73	.
1998	.	94	96	47	93	103	95	93	94	.	.	.

Appendix J. Summary Report of Methods and Descriptive Statistics for the 1997-98 Southeast Region Marine Recreational Economics Survey Fishery Management Data (SERO-ECON-99-11)

Summary Report of Methods and Descriptive Statistics for the 1997-98 Southeast Region Marine Recreational Economics Survey Fishery Management Data



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Fisheries Economics Office

Prepared for the Gulf of Mexico Fishery Management Council Coastal Migratory Pelagics Fishery Socioeconomic Panel Meeting on April 15-16, 1999

SERO-ECON-99-11

SUMMARY REPORT OF METHODS AND DESCRIPTIVE STATISTICS

FOR THE

1997-98 SOUTHEAST REGION MARINE RECREATIONAL ECONOMICS SURVEY

FISHERY MANAGEMENT DATA

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PREPARED FOR THE GULF OF MEXICO FISHERY
MANAGEMENT COUNCIL COASTAL MIGRATORY PELAGIC FISHERY
SOCIOECONOMIC PANEL MEETING ON
APRIL 15-16, 1999

This document is intended to serve as a reference guide to the future contents of the summary report currently in preparation. It is being distributed to inform people of the types of information soon to be available and to support the development of independent lines of research and inquiry.

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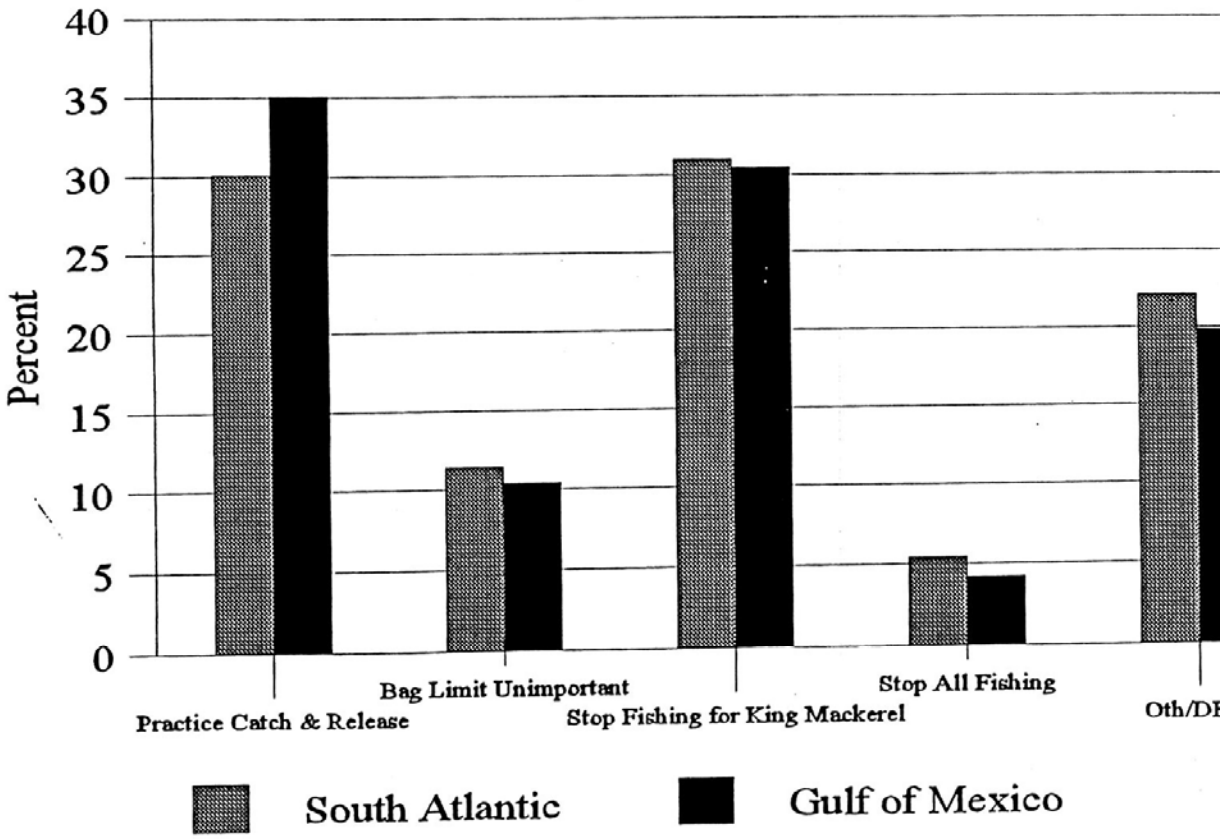

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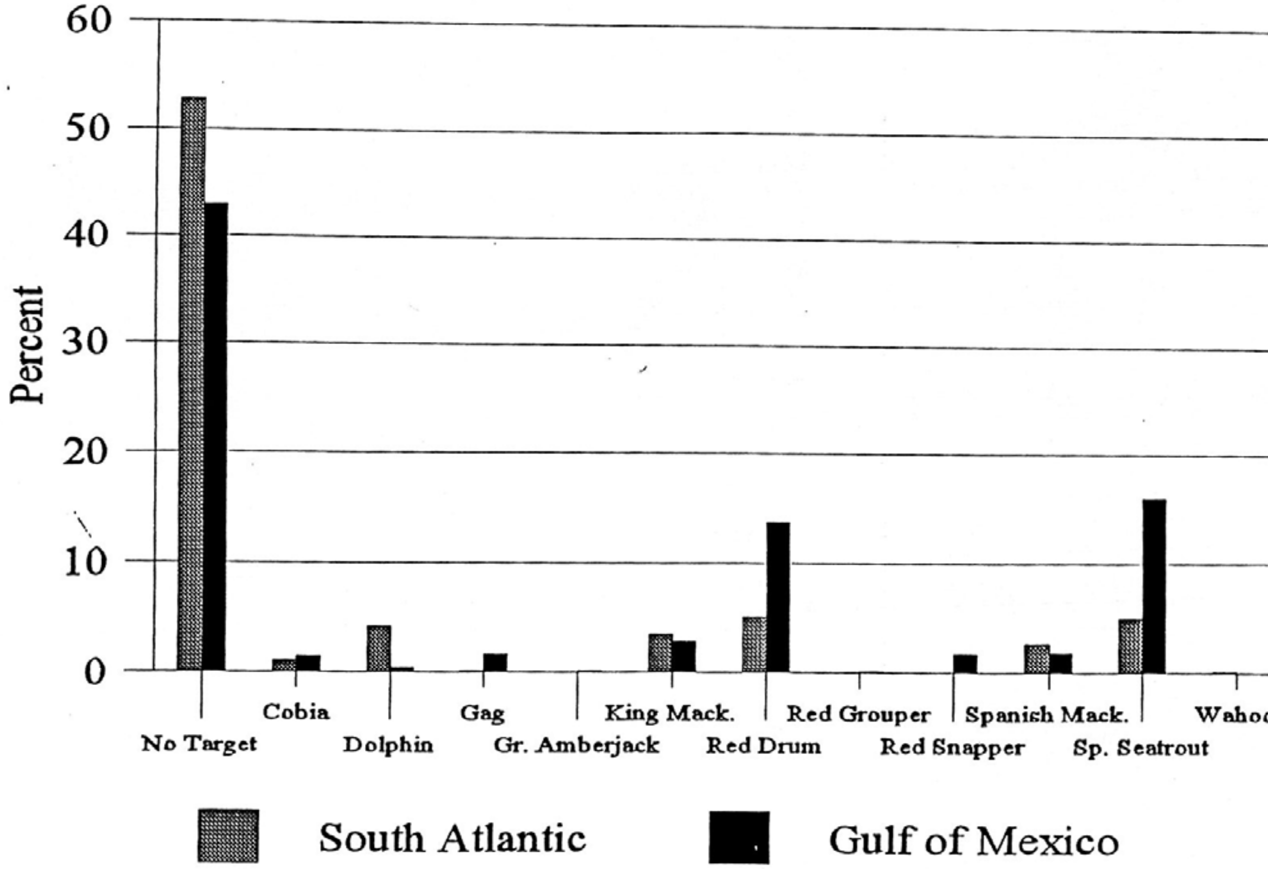

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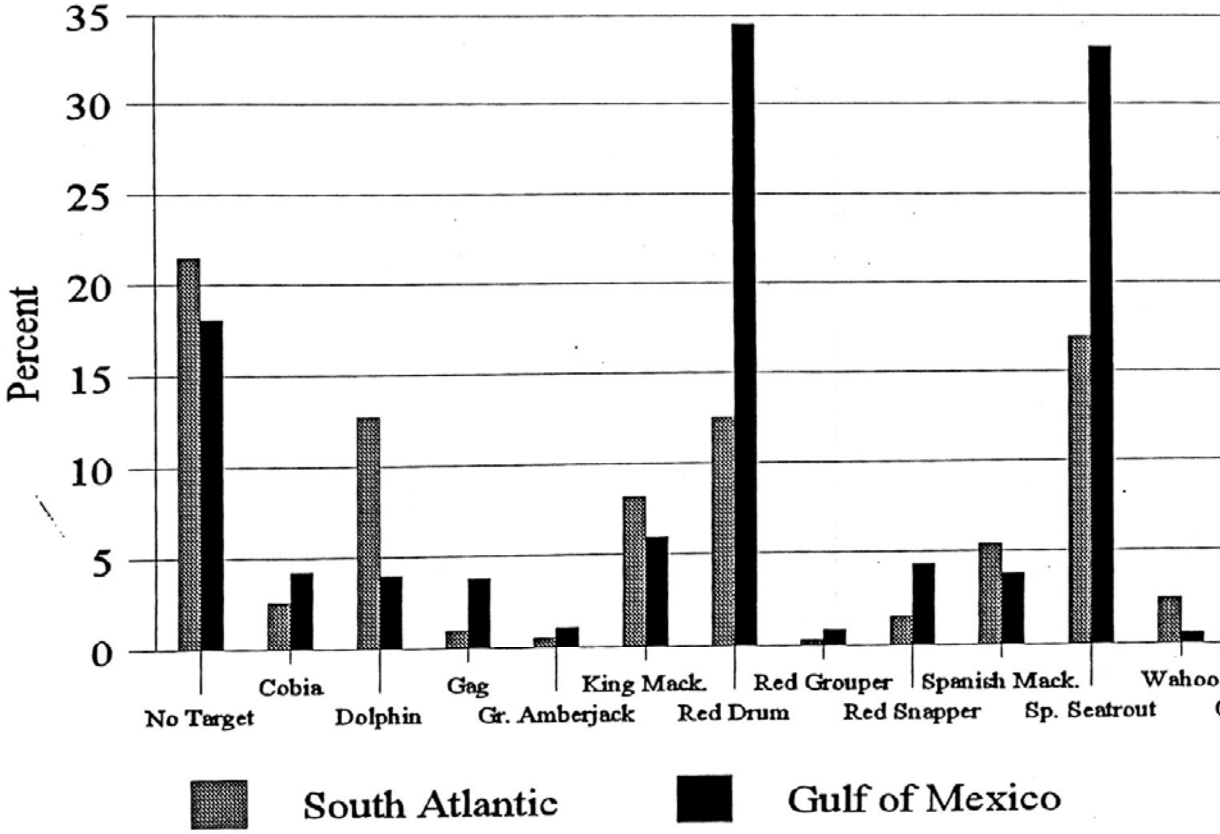

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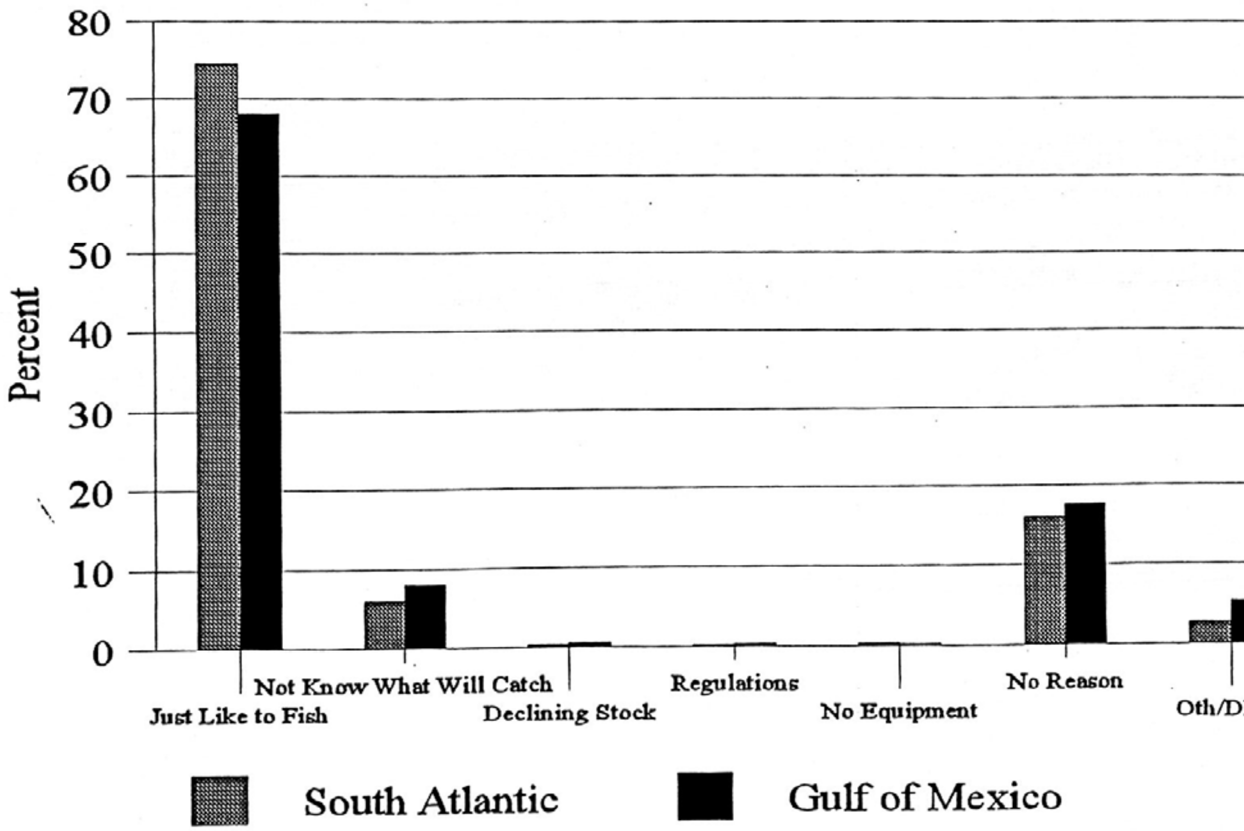
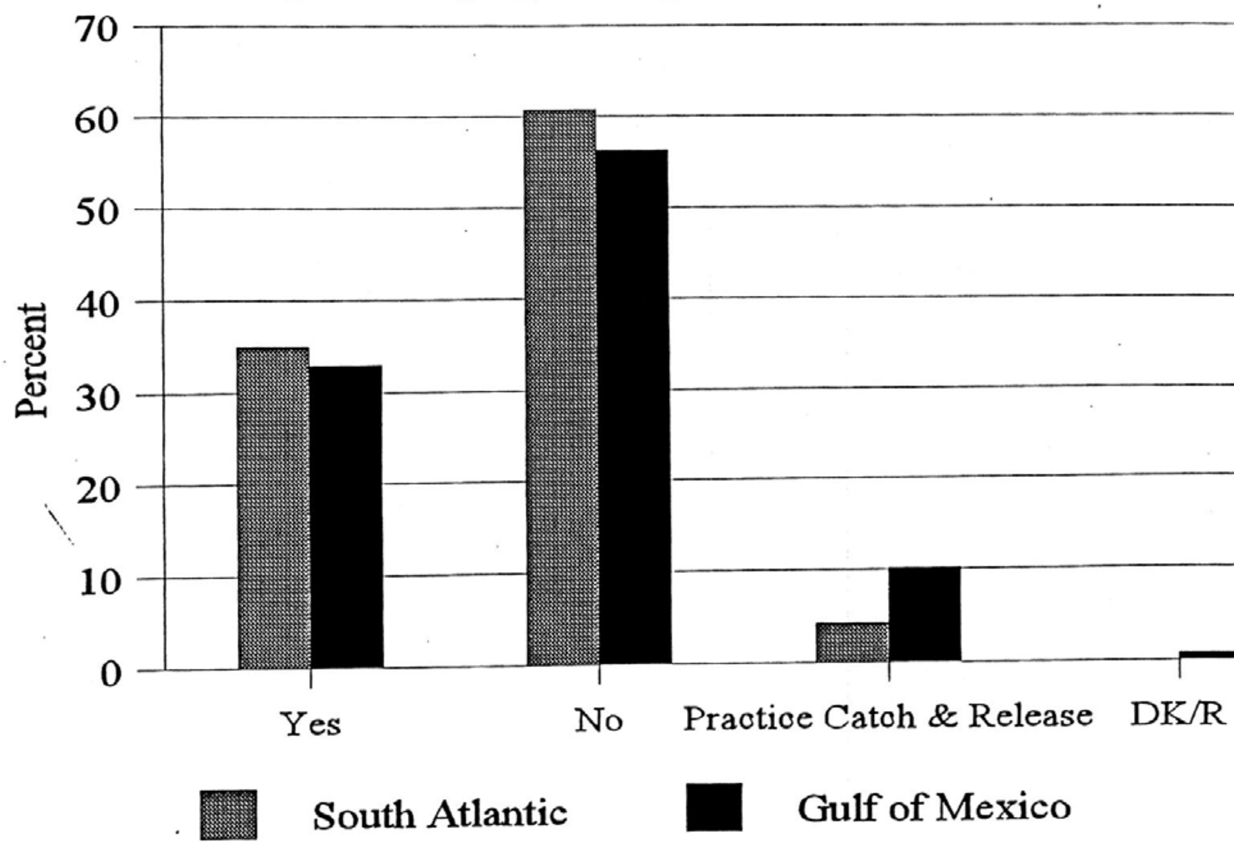


Figure 3-22 Distribution of Recreational Anglers' Expectations of Catching and Keeping the Legal Cobia Limit, by Subregion



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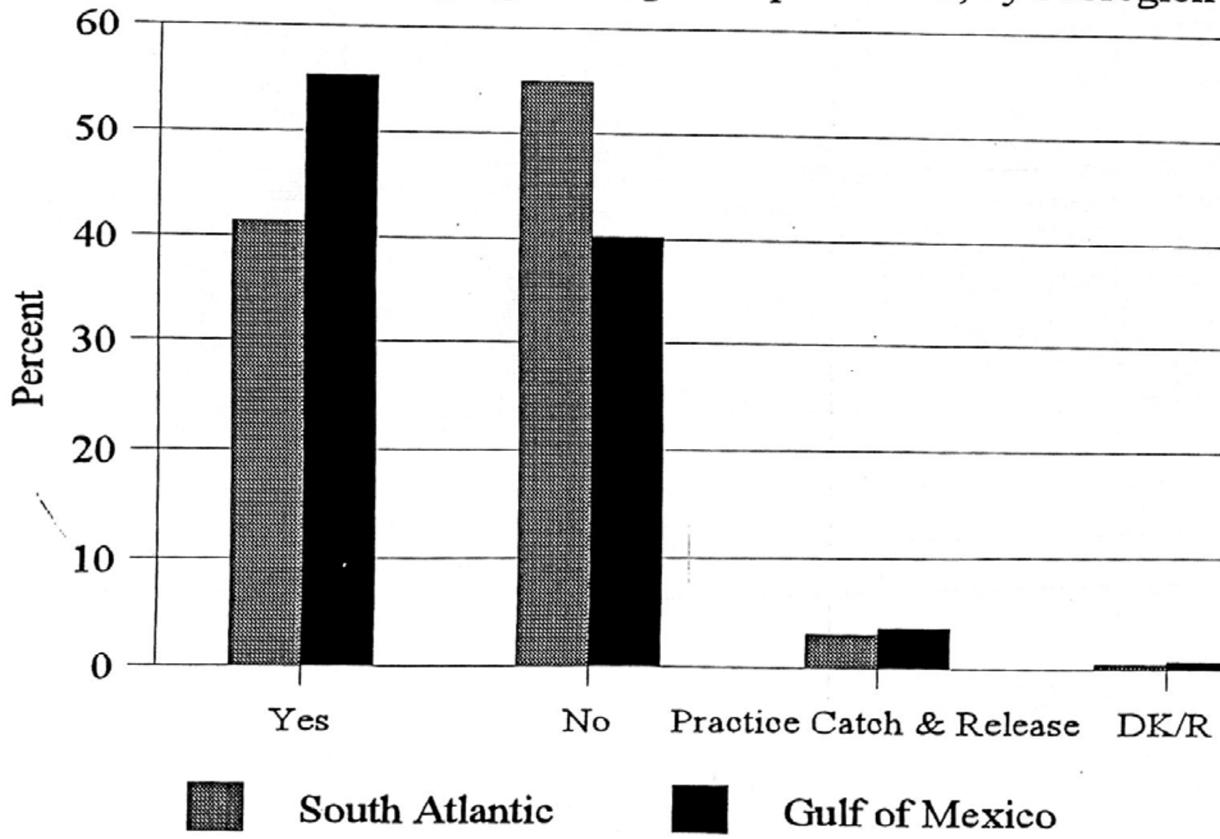

Figure 3-24 Distribution of Recreational Anglers' Expectations of Catching and Keeping the Legal King Mackerel Limit, by Subregion

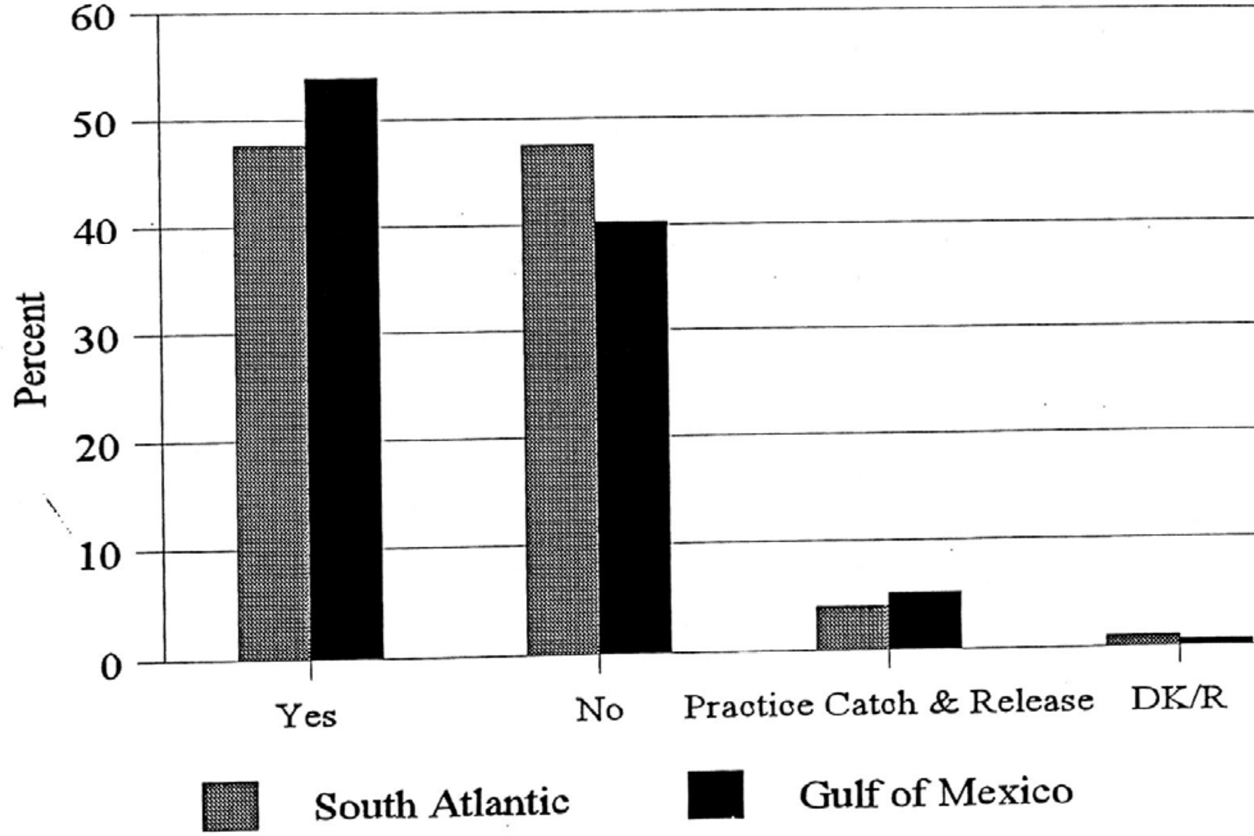

Figure 3-25 Distribution of Recreational Anglers' Expectations of Catching and Keeping the Legal Spanish Mackerel Limit, by Subregion

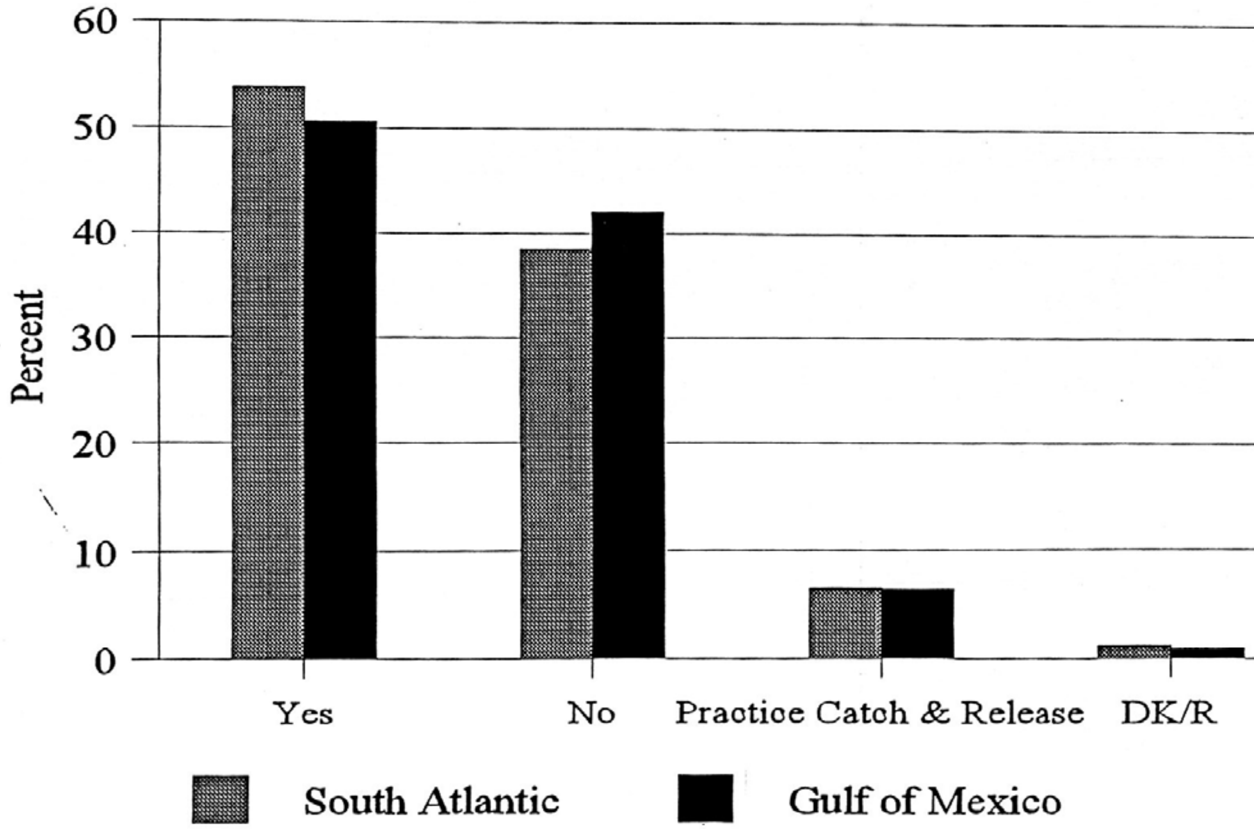

Figure 3-26 Distribution of Species Utilized
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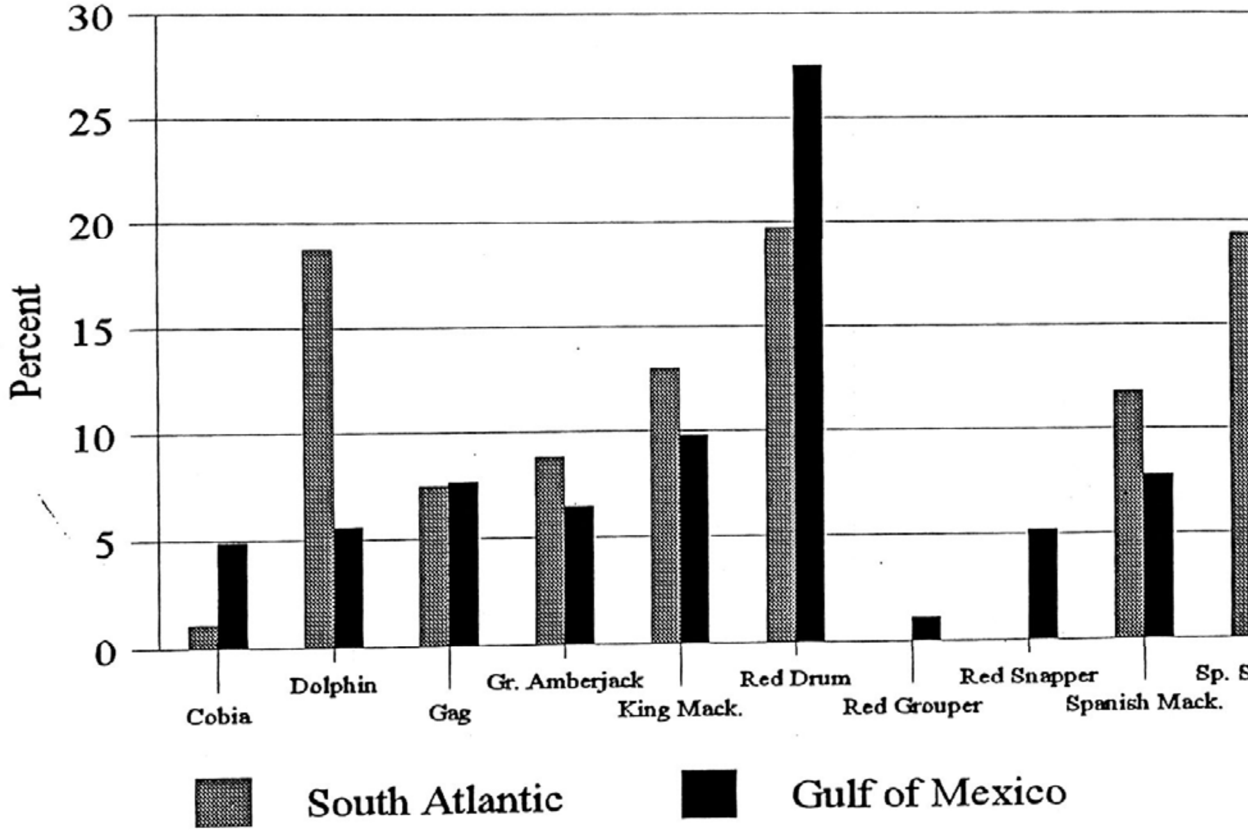


Figure 3-27 Distribution of Recreational Anglers' Behavioral Change in Response to Dolphin Regulations, by Subregion

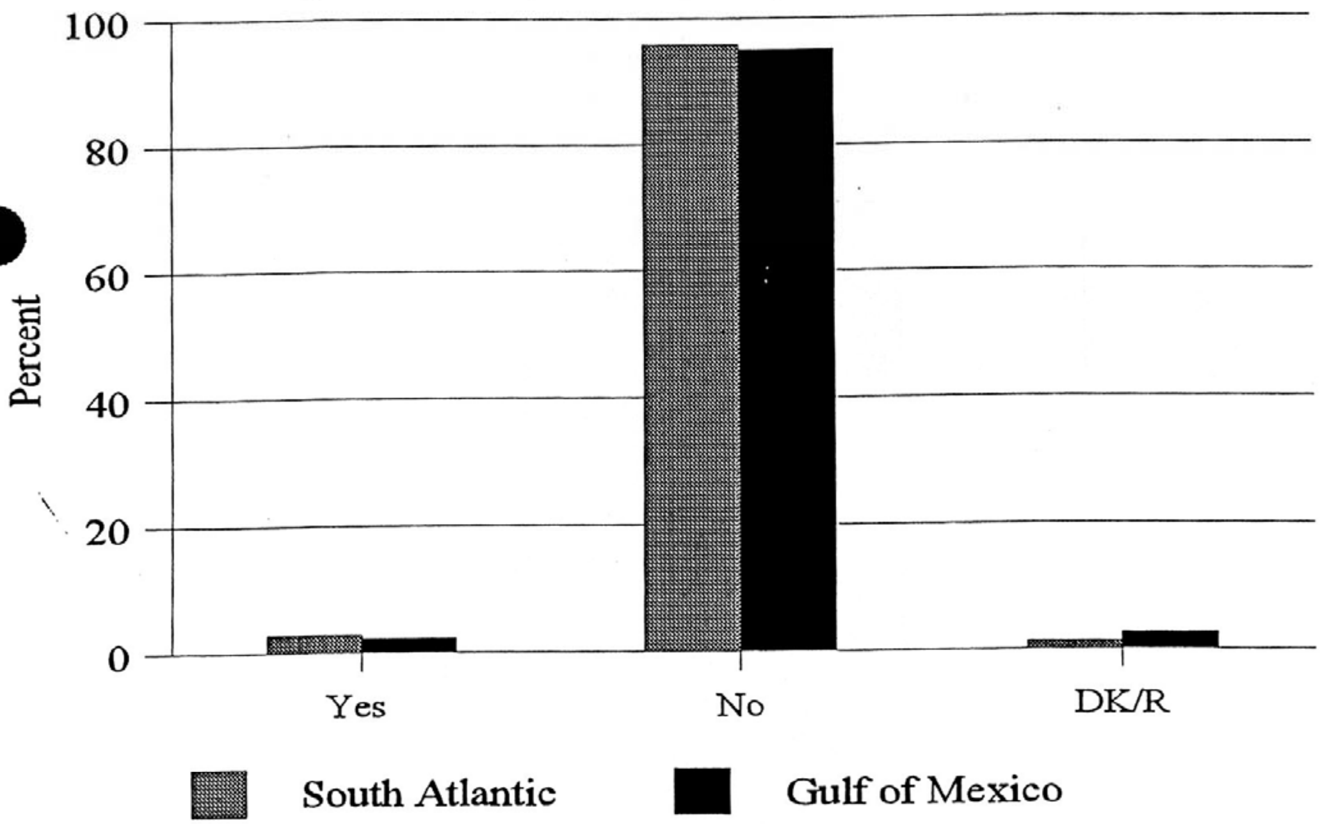


Figure 3-28 Distribution of Recreational Anglers' Behavioral Change in Response to King Mackerel Regulations, by Subregion

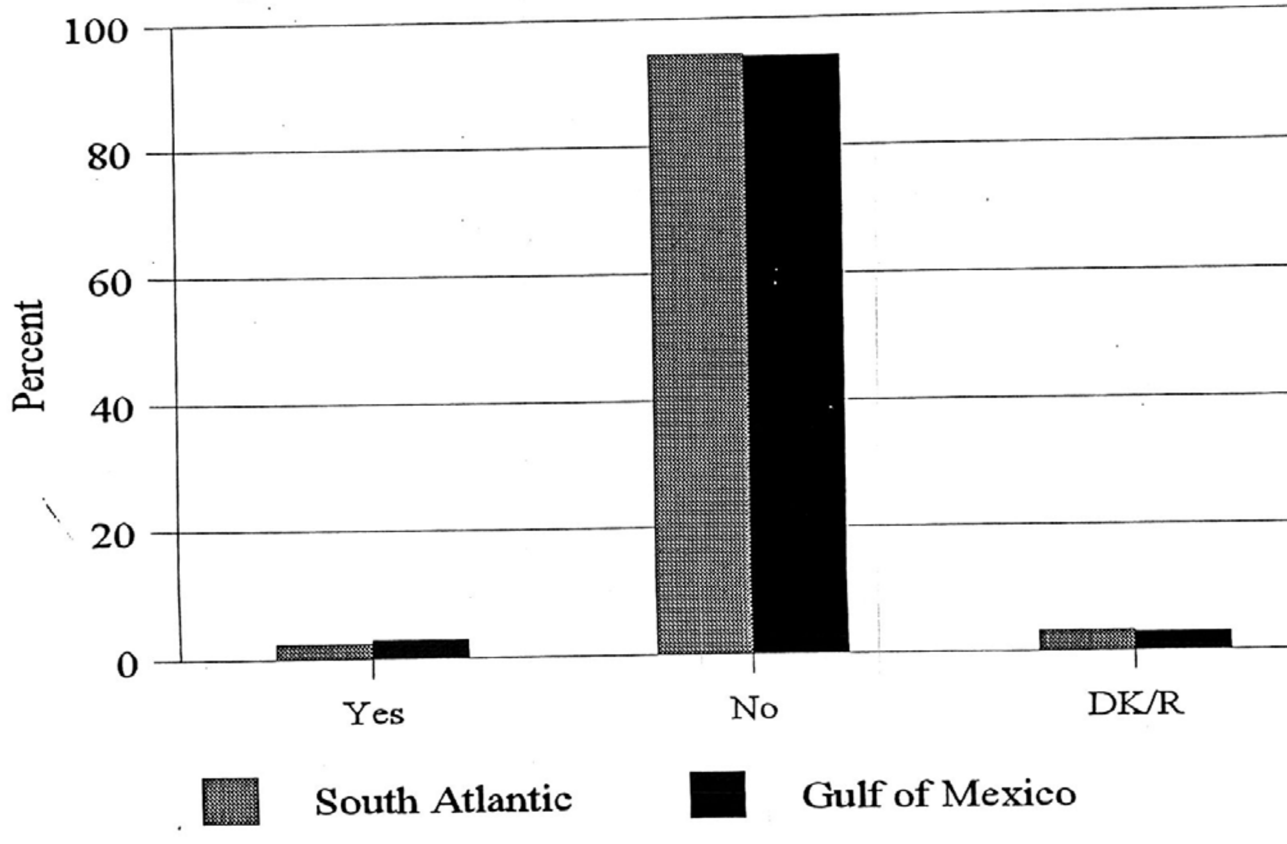


Figure 3-29 Distribution of Recreational Anglers' Behavioral Change in Response to Spanish Mackerel Regulations, by Subregion

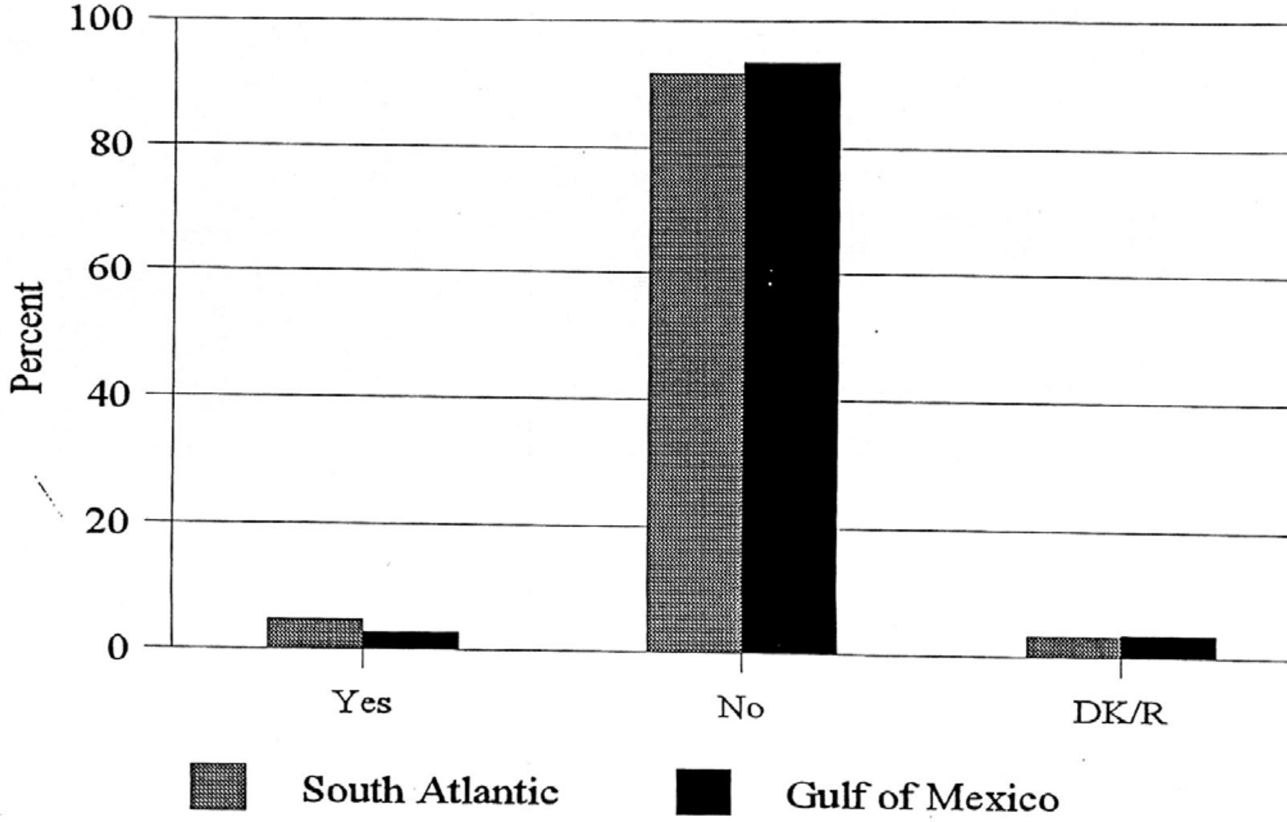
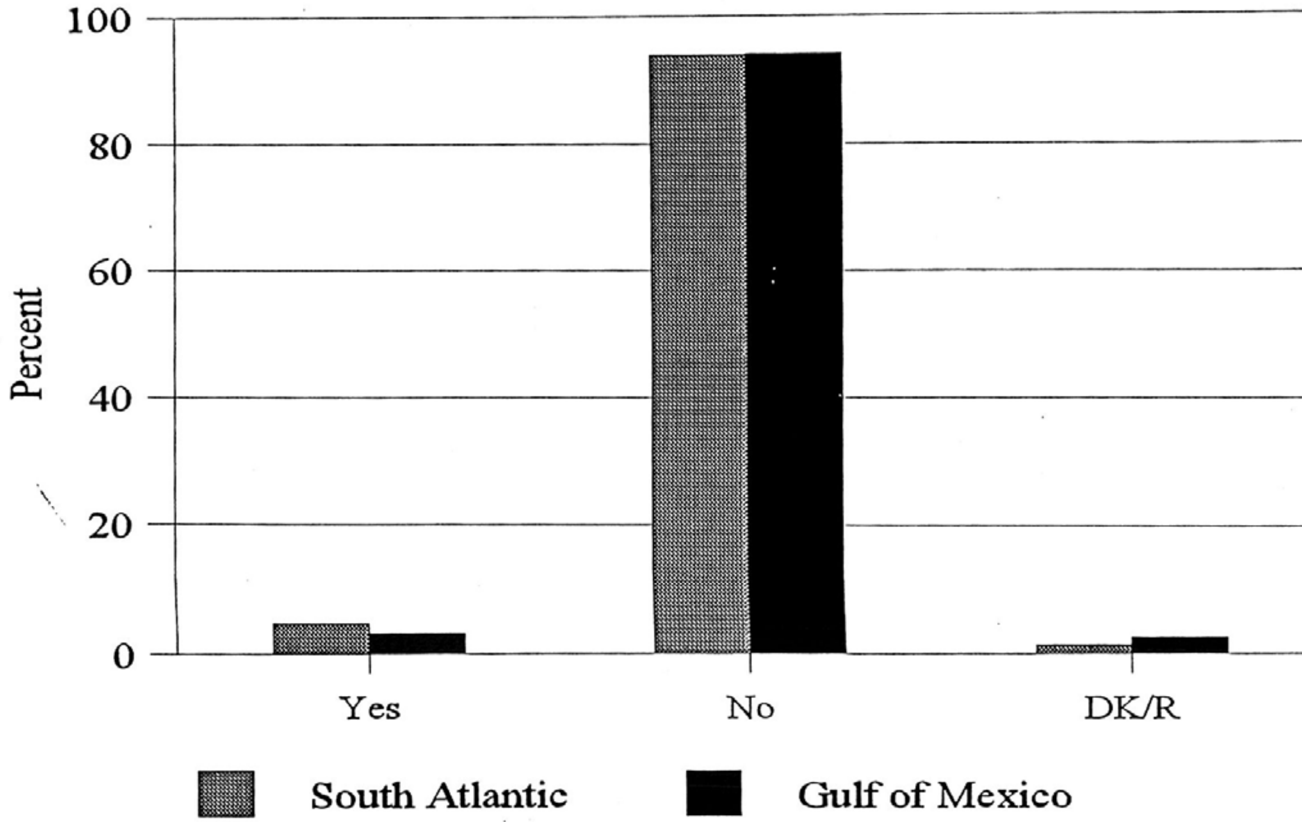


Figure 3-30 Distribution of Recreational Anglers' Behavioral Change in Response to Dolphin Catch Rates, by Subregion



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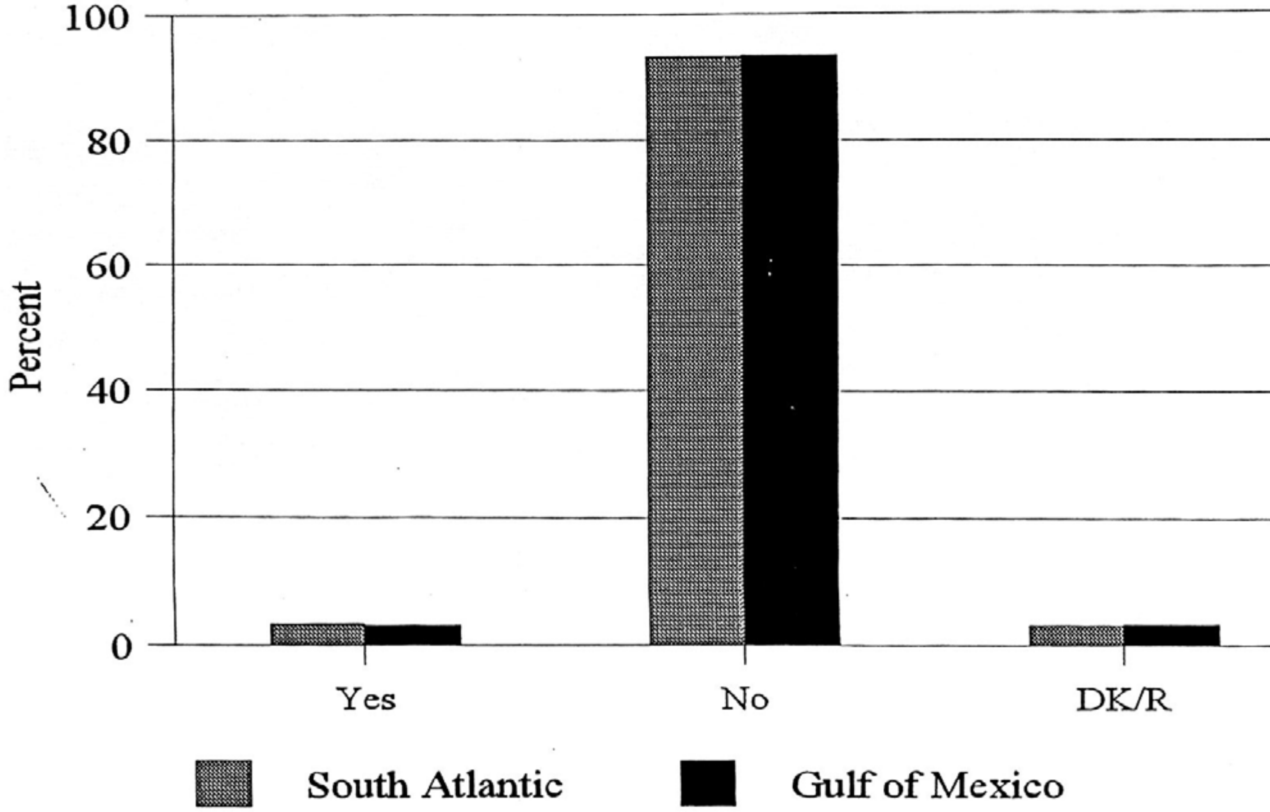

Figure 3-32 Distribution of Recreational Anglers' Behavioral Change in Response to Spanish Mackerel Catch Rates, by Subregion

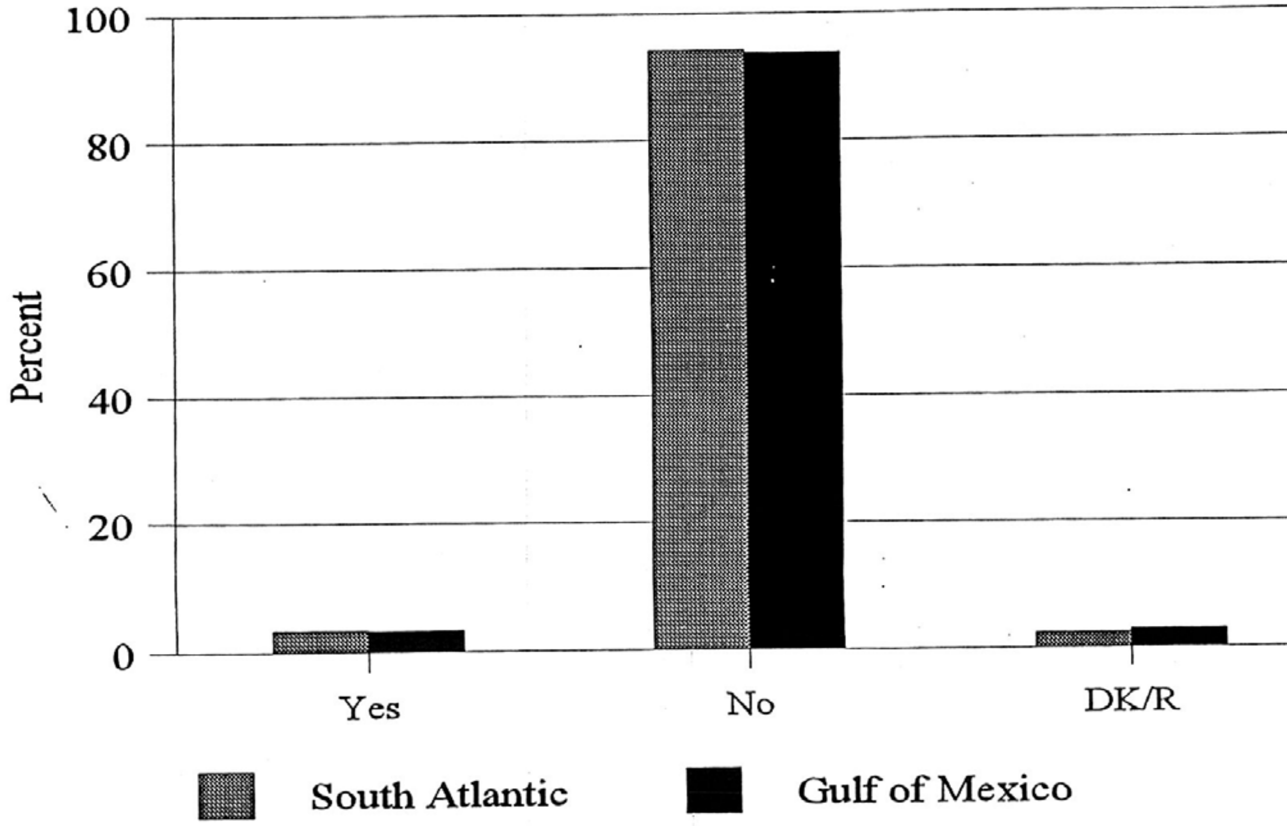

Figure 3-33 Distribution of Recreational Anglers Targeting New Species in Response to Dolphin Regulations or Catch Rates, by Subregion

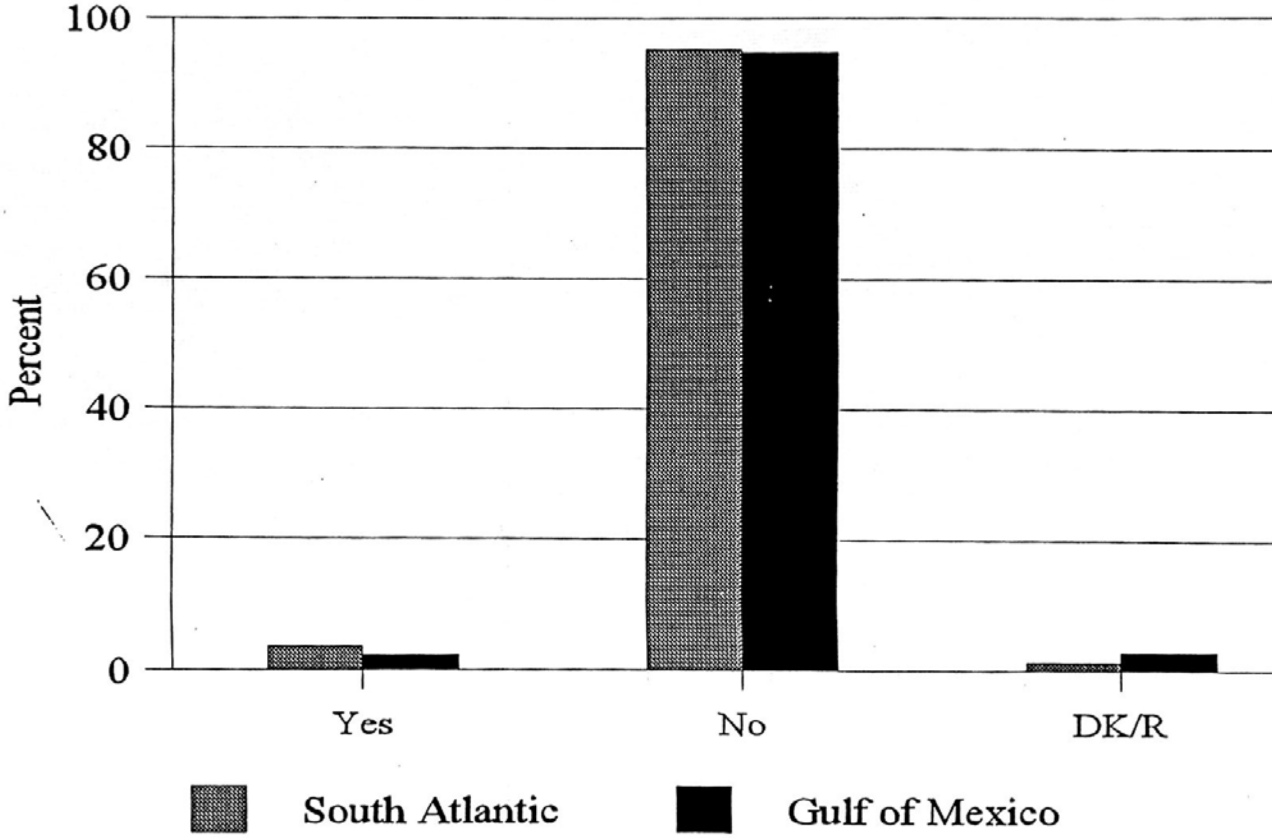

Figure 3-34 Distribution of Recreational Anglers Targeting New Species in Response to King Mackerel Regulations or Catch Rates, by Subregion

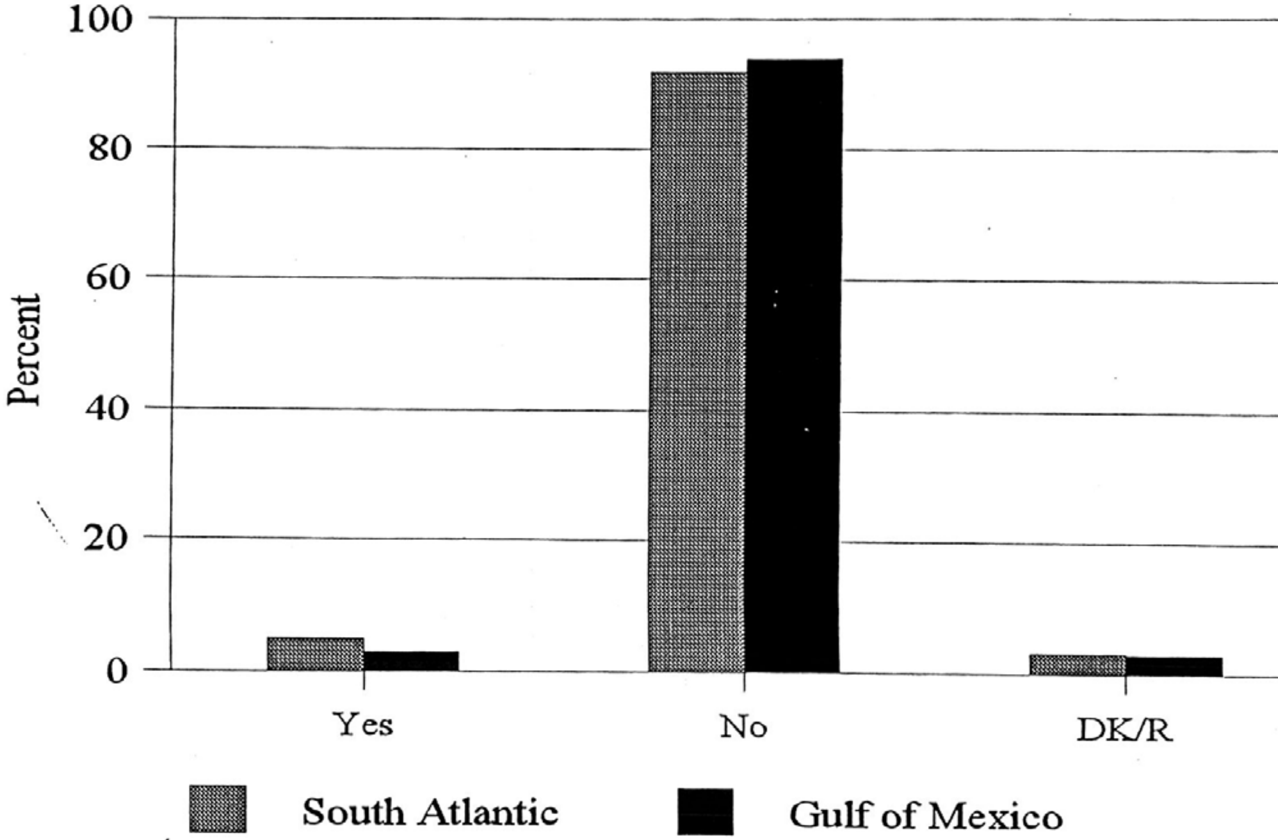

Figure 3-35 Distribution of Recreational Anglers Targeting New Species in Response to Spanish Mackerel Regulations or Catch Rates, by Subregion

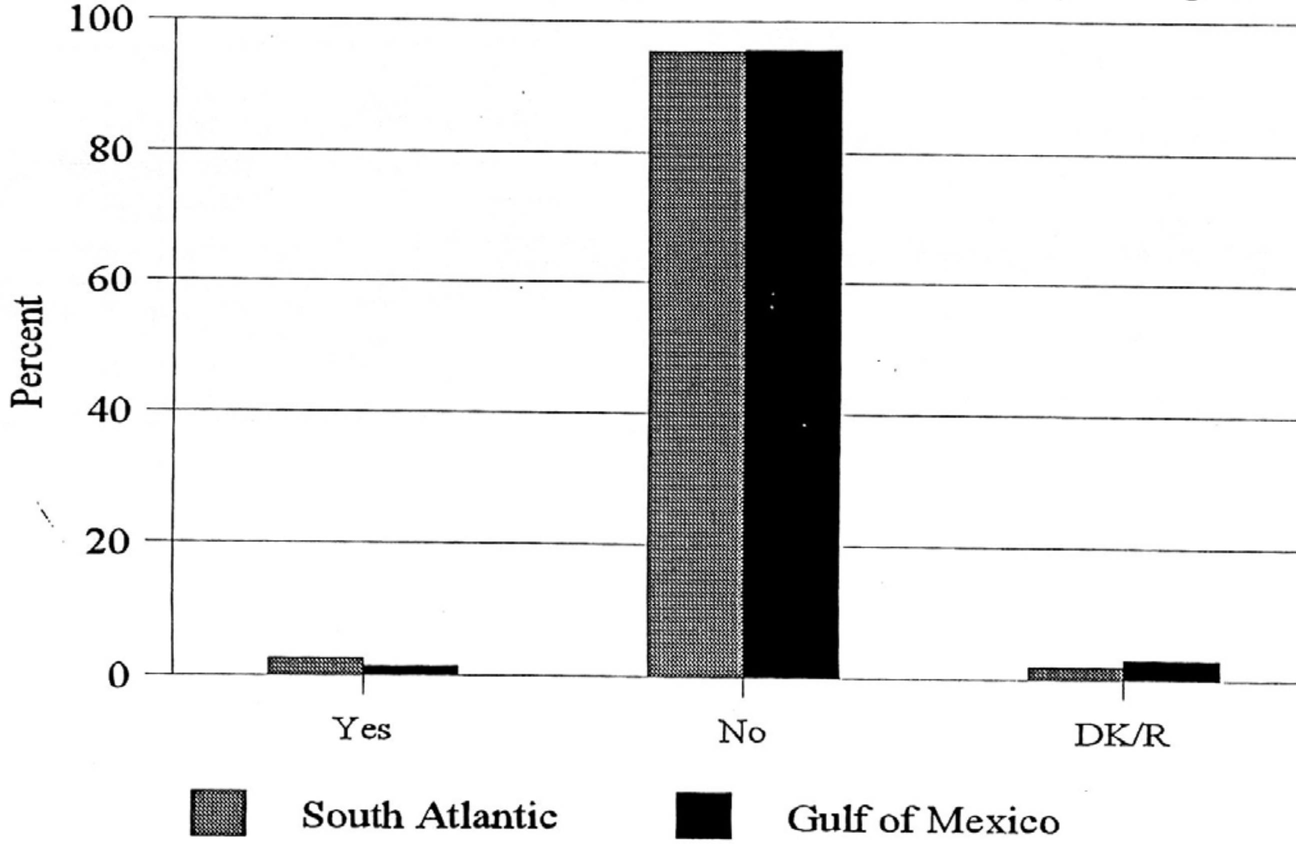

Figure 3- Distribution of Recreational Anglers' Stated Preference for Dolphin Regulations, S.Atl.