GULF STATES MARINE FISHERIES COMMISSION

SPANISH MACKEREL

FISHERY MANAGEMENT PLAN

May 1989 No. 19

SPANISH MACKEREL FISHERY MANAGEMENT PLAN (Gulf of Mexico)

Ronald R. Lukens, editor

published by

Gulf States Marine Fisheries Commission
P.O. Box 726
Ocean Springs, MS 39564

No. 19
May 1989

This project was conducted in cooperation with the U.S. Fish and Wildlife Service, and funded by Federal Aid in Sport Fish Restoration administrative funds Project No. 14-16-0009-87-1203.

TCC SPANISH MACKEREL SUBCOMMITTEE

Roy O. Williams, Chairman
Florida Marine Fisheries Commission
2540 Executive Center Circle West
Suite 106
Tallahassee, FL 32301

Walter M. Tatum
Alabama Department of Conservation
and Natural Resources
Marine Resources Division
Drawer 458
Gulf Shores, AL 36542

Richard S. Waller
Gulf Coast Research Laboratory
P.O. Box 7000
Ocean Springs, MS 39564-7000

Joey Shepard
Louisiana Department of Wildlife
and Fisheries
P.O. Box 15570
Baton Rouge, LA 70895

Hal Osburn
Texas Parks and Wildlife Department
P.O. Box 1717
Rockport, TX 78382

Eugene L. Nakamura
National Marine Fisheries Service
Panama City Laboratory
3500 Delwood Beach Road
Panama City, FL 32407-7499

Alex M. Jernigan
110 Plantation Boulevard
Islamorada, FL 33036

Jerald K. Waller
Alabama Department of Conservation
and Natural Resources
Marine Resources Division
P.O. Box 189
Dauphin Island, AL 36528

Robert Jones
Southeast Fisheries Association
312 East Georgia Street
Tallahassee, FL 32301

PREFACE

During the October 1985 Annual Fall Meeting of the Gulf States Marine Fisheries Commission (GSMFC) in Kissimmee, Florida, the director of the Florida Department of Natural Resources, requested that the Gulf State-Federal Fisheries Management Board address the needs of the Spanish mackerel fishery in the Gulf of Mexico. At that time the Board requested that the Executive Committee of the GSMFC establish a subcommittee to examine the feasibility of developing a profile and/or fishery management plan for the Gulf of Mexico Spanish mackerel fishery while also examining the feasibility of petitioning the Gulf of Mexico Fishery Management Council to release management authority for Spanish mackerel in lieu of a state interjurisdictional FMP. Upon addressing the issue, the Executive Committee concurred with the need for a subcommittee to address Spanish mackerel. By December 1985 the Spanish Mackerel Subcommittee had been appointed to serve under the Technical Coordinating Committee (TCC).

During the Executive Session at the March 1986 Annual Spring Meeting of the GSMFC in Brownsville, Texas, the Chairman of the TCC, J.Y. Christmas, reported that the Spanish Mackerel Subcommittee had met twice, having reviewed a great deal of detailed information regarding the Gulf of Mexico Spanish mackerel fishery. Their conclusions were that the joint fishery management plan of the Gulf and South Atlantic Fishery Management Councils was not advantageous toward management of Spanish mackerel and that the GSMFC should go forward with the development of a coordinated fishery management plan for the state jurisdictional waters of the Gulf of Mexico. It was also suggested that the GSMFC request of the Councils that Spanish mackerel be dropped from the Coastal Pelagics Fishery Management Plan (FMP). It was determined that a preferred alternative would be to continue to have Spanish mackerel managed under the current joint Council FMP while at the same time developing an FMP limited to state jurisdictional waters. This would insure continuity and efficient management.

During the October 1986 Annual Fall Meeting of the GSMFC in New Orleans, Louisiana, the director of Florida Department of Natural Resources indicated that he felt that the Gulf of Mexico Spanish mackerel fishery should be addressed as soon as possible. In anticipation that Dingell-Johnson/Wallop-Breaux (D-J/W-B) funds would become available to the GSMFC, Walter Tatum of the Alabama Department of Conservation and Natural Resources suggested that funding source may be used to develop a fishery management plan.

Beginning in March 1987, the GSMFC received D-J/W-B funds and initiated a program to address a number of fishery issues, one of which was Spanish mackerel. Ronald R. Lukens was hired as the Program Coordinator, and work on the interstate interjurisdictional Spanish Mackerel FMP began following the March 1987 Annual Spring Meeting of the GSMFC in Biloxi, Mississippi.

Since that time, the Spanish Mackerel Subcommittee has met on seven occasions working toward the completion of the GSMFC Spanish Mackerel Fishery Management Plan. Much time, effort and expertise has gone into the development of the following document.

Development of the text of this Spanish Mackerel FMP relied heavily on the original Coastal Pelagics FMP and subsequent amendments developed by the South Atlantic and Gulf of Mexico Fishery Management Councils. Large portions of this text were paraphrased and often quoted verbatim from the original FMP and amendments without due credit indicated.

The Spanish Mackerel Subcommittee would like to express their gratitude to the authors of the joint Council FMP and amendments for their comprehensive treatment of the data pertinent to Spanish mackerel and give credit to those authors for the information contained in this FMP which was so liberally borrowed from the original.

The Subcommittee

ACKNOWLEDGMENTS

The Gulf States Marine Fisheries Commission (GSMFC) would like to thank the Spanish Mackerel Subcommittee of the Technical Coordinating Committee of the GSMFC for their many hours of work and dedication toward completion of this fishery management plan. Grateful acknowledgment is also extended to the many people from the National Marine Fisheries Service who provided information to the Subcommittee. Finally, thanks go to all state personnel and members of private organizations who contributed to the completion of this document. A very special acknowledgment goes to Lucia Hourihan for her tireless dedication to developing and producing a quality document.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

1.0 EXECUTIVE SUMMARY

Spanish mackerel has been an important species for recreational and commercial fishermen throughout the U.S. Gulf of Mexico. Commercial landings have historically been greater in the eastern gulf, primarily due to a major fishery in southwest Florida. Alabama and Mississippi have had annual commercial landings exceeding 200,000 pounds in some years. Although Louisiana has also produced 200,000 pounds in some years, the commercial fishery in the western gulf occurs mostly in Mexico. Texas had a substantial commercial fishery in the 1930s, but it became virtually nonexistent by the 1970s.

Recreationally, Spanish mackerel is an important species throughout the U.S. Gulf of Mexico. Though the largest amount of the recreational harvest is from the eastern gulf, historical records indicate that large catches were once common off Texas. Recent records show that Mississippi, Alabama, and Florida harvest about 90% of the U.S. gulf recreational catch of Spanish mackerel. Relatively few recreational fishermen off Louisiana target Spanish mackerel, possibly due to the high availability of other species which are associated with offshore oil structures.

Spanish mackerel range from the Yucatan Peninsula in Mexico, throughout the Gulf of Mexico, and along the U.S. Atlantic coast to New England. It migrates seasonally along the Atlantic and gulf coasts. Spanish mackerel is a fast moving fish that is most often found in schools of similar sized individuals. It is considered a nearshore species most commonly occurring within jurisdictional waters of the Atlantic and Gulf States. Commercial and recreational catches of Spanish mackerel are taken predominantly from state jurisdictional waters; 78% are taken within state jurisdictional waters and 22% within the Exclusive Economic Zone.

Female Spanish mackerel grow faster and attain a larger size than males. Longevity is at least age VII for males and at least age IX for females. Sexual maturity for both sexes is attained at about age II when fish are about 350 mm FL. Spawning occurs in nearshore waters with larval and juvenile distribution extending into estuarine waters. Though the species is primarily found in nearshore waters, it is estuarine dependent, preying heavily on such estuarine species as the engraulids and clupeids.

This Spanish Mackerel Fishery Management Plan (FMP) is intended to provide a common mechanism through which interjurisdictional management of Spanish mackerel in the Gulf of Mexico can be accomplished. The immediate goal of this FMP is to rebuild stocks of Spanish mackerel in the Gulf of Mexico to a level which could support a harvest at maximum sustainable yield. The long term goal of the FMP is to manage Spanish mackerel at optimum yield. The recommended strategy is to operate through a Spanish Mackerel Management Committee comprised of at least the directors or their proxies of the state resource management agencies from the five Gulf States. This Management Committee will meet as deemed necessary to recommend regulations for the conservation of Spanish mackerel in the Gulf of Mexico. The Management Committee is also responsible for recommending the need for pertinent research to fulfill the goal of the FMP.

2.0 INTRODUCTION

Spanish mackerel is an important species for recreational and commercial fishermen throughout the Gulf of Mexico and along the Atlantic seaboard. The commercial fishery is predominantly centered in south Florida, while recreational fishing occurs throughout its range. Recent analyses by state and federal government agencies indicate that abundance of Spanish mackerel has declined on both the gulf and south Atlantic coasts. These declines coupled with the fact that the majority of harvest (commercial and recreational) occurs in state jurisdictional waters, make it appropriate to develop an interjurisdictional fishery management plan to address the management of Spanish mackerel in state jurisdictional waters.

This document is intended to provide sound scientific information on the status of stock, fishing effort, and regulatory situations existing in the five Gulf States, while identifying important information gaps and recommending management measures to aid in restoring declining stocks.

2.1 Nomenclature/Taxonomy (Robins et al. 1980)

Scientific name	Scomberomorus maculatus (Mitchell)
Common name	Atlantic Spanish mackerel
Class	Osteichthyes
Order	Perciformes
Family	Scombridae

2.2 Morphology

Spanish mackerel is a laterally compressed medium-sized (reaching 720 mm FL) fish. It has silvery sides which are marked with three rows of dark spots. The anterior portion of the first dorsal fin is black, and the second dorsal fin and anal fin are followed by a series of finlets. The caudal fin is narrow and deeply forked, and keels are present on the caudal peduncle.

There are 10 to 16 gillrakers. The first dorsal fin has 17 to 19 spines, while the soft second dorsal fin has 17 to 20 rays followed by 7 to 9 finlets. The anal fin has 17 to 20 rays followed by 7 to 10 finlets. Pectoral fin rays number 20 to 23. The lateral line curves gradually down toward the caudal peduncle. Vertebrae total 51 to 53 (Collette and Nauen 1983).

2.3 Historical Distribution and Significance

2.3.1 Commercial

Historically (circa 1850), the first major commercial fishery for Spanish mackerel was centered around the New York and New Jersey coasts, and by 1870 had become well established off the mid-Atlantic states. During this period less than 2% of total U.S. landings of Spanish mackerel were from the south Atlantic and Gulf of Mexico. During the late 1800s this pattern shifted, and by 1897 about 64% of commercial production was from the south Atlantic and Gulf States. This trend has continued to the present day with 97% of the total U.S. landings coming from south Florida (Trent and Anthony 1979).

During the 1950s the Florida east and west coasts had approximately equal production at around 3.5 million pounds per year. In the 1960s the west coast of Florida began to dominate the east coast at 5.9 million and 2.6 million pounds per year, respectively. This trend continued and increased during the early 1970s, but beginning in 1975 a shift occurred and the east coast began to dominate.

The increase in east coast production was attributable to the introduction of deep-water gill nets and large scale boats, while the west coast decline was thought to be caused by a reduction in effort and a decrease in stock abundance. Currently, Florida west coast production is concentrated in the Florida Keys. Williams et al. (1985) hypothesized that the decline in stock densities has forced this concentration of fishing effort because of fish congregation during the winter at the southern limit of their range in the U.S.

2.3.2 Recreational

Though Spanish mackerel has long been a recreationally important species, it was not until the mid to late 1960s that records of recreational effort and harvest were collected. At that time the center for recreational harvest was the mid to south Atlantic area with the eastern gulf and western gulf following, respectively. As with the commercial harvest, recreational harvest shifted to the south. A 1975 survey indicated that, at that time, 67% of the recreational landings occurred in south Florida. More recent data indicate that larger percentages of the recreational catch are landed in the other four Gulf States (Table 2.1). As noted, Table 2.1 reports data from the U.S. National Marine Fisheries Service, Current Fishery Statistics (1984-1987). It should be noted that those data are most reliable when used in aggregated form. When disaggregated and reported by state, reliability is decreased (R. Essig, pers. comm. 1988).

Table 2.1. Percent of the total recreational catch by state for the Gulf of Mexico from 1979-1986. (U.S. National Marine Fisheries Service, Current Fishery Statistics, 1984-1987.)

	Texas	Louisiana	Mississippi	Alabama	Florida (W)
1979	10	7	3	45	35
1980	16	18	11	26	30
1981[1]	9	1	41	9	40
1982	2	3	28	35	32
1983	2	3	35	23	37
1984	1	1	49	26	23
1985	2	11	32	10	45
1986	<1[2]	<1	2	3	95
$\bar{X}$	4.2	4.6	27.7	20.3	43.4

[1] Only includes data from March 1981-December 1981.
[2] Data provided by Texas Parks and Wildlife Department.

The distribution of Spanish mackerel catches in the Gulf of Mexico by fishing mode is shown in Table 2.2. As would be expected, boat modes far outweighed shore-based modes in number of fish caught.

Table 2.2. Percent of the total catch of Spanish mackerel by mode of recreational fishing in the Gulf of Mexico from 1979-1985. (U.S. National Marine Fisheries Service, Current Fishery Statistics 1984-1987.)

	Man-made[1]	Beach/Bank	Party/Charter	Private/Rental
1979/1980*	10	1	5	84
1981**	18	0	53	29
1982	24	1	29	46
1983	35	1	32	32
1984	16	1	60	23
1985	21	0	34	45

[1]Man-made = pier, jetty, or bridge.

*Averaged.

**Only includes data from March 1981-December 1981.

3.0 DESCRIPTION OF SPANISH MACKEREL (SCOMBEROMORUS MACULATUS) STOCKS

3.1 Distribution and Seasonal Movements

The species S. maculatus, as redefined by Collette and Russo (1979), is restricted to the western Atlantic coast of the U.S. and the Gulf of Mexico. The southward extent of its range in the U.S. is the Florida Keys, though it ranges to the Yucatan Peninsula where it is replaced by the Brazilian mackerel, Scomberomorus brasiliensis (Collette et al. 1978). The northward range in the Atlantic is normally New York or southern New England, although occasional strays are found to the Gulf of Maine (Berrien and Finan 1977).

Spanish mackerel make seasonal migrations along the Atlantic and eastern and northern Gulf of Mexico coasts and appear to be much more abundant in southern Florida during the winter. Historically, the fish are believed to have moved northward each spring, occurring off the Carolinas by April, off Chesapeake Bay by May, and, in some years, as far north as Narragansett Bay by July (Berrien and Finan 1977). Recent information indicates that the northern extent of their range in the Atlantic has decreased. In the eastern Gulf of Mexico they are believed to migrate from their winter range in south Florida northward to Cape San Blas in the spring and then westward. Tagging records (Sutherland and Fable 1980) have documented that westward movement as far as the Alabama/Florida state line. They remain in the northern Gulf until about September and are believed to migrate south in the fall (Beaumariage 1970, Wollam 1970, Sutherland and Fable 1980). Southward migration in the fall along the south Florida coast has been suggested by two fish tagged off Clearwater, Florida and subsequently recovered off Venice and Key West, Florida (Godcharles and Bullock, unpub. report). Seasonal north-south movements of Spanish mackerel along the Mexican and south Texas coasts are suggested by two fish tagged and released off south Texas and recaptured off Veracruz, Mexico (Sutherland and Fable 1980; W. Fable, pers. comm. 1988). Genetic differences in Spanish mackerel from the Atlantic and gulf were detected in biochemical studies by Skow and Chittenden (1981) and Johnson (in prep.). This has resulted in the Gulf of Mexico and South Atlantic Fishery Management Councils' adopting the position that the Atlantic and Gulf of Mexico stocks should be treated separately for management purposes (Anonymous 1987a).

3.2 General Behavior

The Spanish mackerel is a fast-moving, surface-feeding fish that forms schools of similar sized individuals. Schools are often known to pass very near the beach on their seasonal migration journeys. They frequently enter tidal estuaries, bays, and lagoons (Berrien and Finan 1977). They most commonly occur within the jurisdictional waters of the Atlantic and Gulf States.

3.3 Age and Growth Parameters

Several age and growth studies have been conducted on Spanish mackerel. Among those are Klima (1959), Powell (1975), Fable et al. (1987), and Helser and Malvestuto (in press). These authors agree that females grow faster than males, and in most cases attain a larger size than males.

a) Growth Equation

Growth equations from Powell (1975), Fable et al. (1987), and Helser and Malvestuto (in press) are presented in Table 3.1. Figures 3.1 and 3.2 show the growth curves for each of the four sets of growth equations for male and female Spanish mackerel, respectively. Table 3.2 provides back-calculated fork lengths of Spanish mackerel from Powell (1975), Fable et al. (1987)

Table 3.1. Spanish mackerel growth equations developed by Powell (1975), Fable et al. (1987), and Helser and Malvestuto (in press). All lengths are fork length (mm).

	Male	Female
Powell*	$L_t = 554(1-e^{-0.48(t+1.12)})$	$L_t = 694(1-e^{-0.45(t+0.78)})$
Fable et al. (southeast)	$L_t = 794(1-e^{-0.24(t+0.94)})$	$L_t = 739(1-e^{-0.33(t+0.99)})$
Fable et al. (Florida only)	$L_t = 776(1-e^{-0.27(t+0.73)})$	$L_t = 731(1-e^{-0.38(t+0.73)})$
Helser and Malvestuto	$L_t = 552(1-e^{-0.29(t+1.66)})$	$L_t = 604(1-e^{-0.45(t+0.75)})$

*Converted from standard length (SL) to fork length (FL) using the formula FL = 1.0728 SL + 2.4267 (Powell 1975).

Table 3.2 Mean back-calculated fork length (mm) at ages, from Powell (1975), Fable et al. (1987), and Helser and Malvestuto (in press). Powell's data were transformed from standard length by his formula FL = 1.0728 SL + 2.4267.

Age	Males				Females			
	Powell	Fable et al. (Southeast)	Fable et al. (Fla.)	Helser and Malvestuto	Powell	Fable et al. (Southeast)	Fable et al. (Fla.)	Helser and Malvestuto
1	337	301	299	305	373	345	348	332
2	421	400	399	359	481	469	475	430
3	459	490	494	413	542	544	557	489
4	489	556	561	452	580	588	607	533
5	511	604	631	486	621	643	654	-
6	-	657	657	489	-	651	665	-
7	-	672	672	-	-	664	682	-
8	-	-	-	-	-	698	698	-
9	-	-	-	-	-	731	730	-

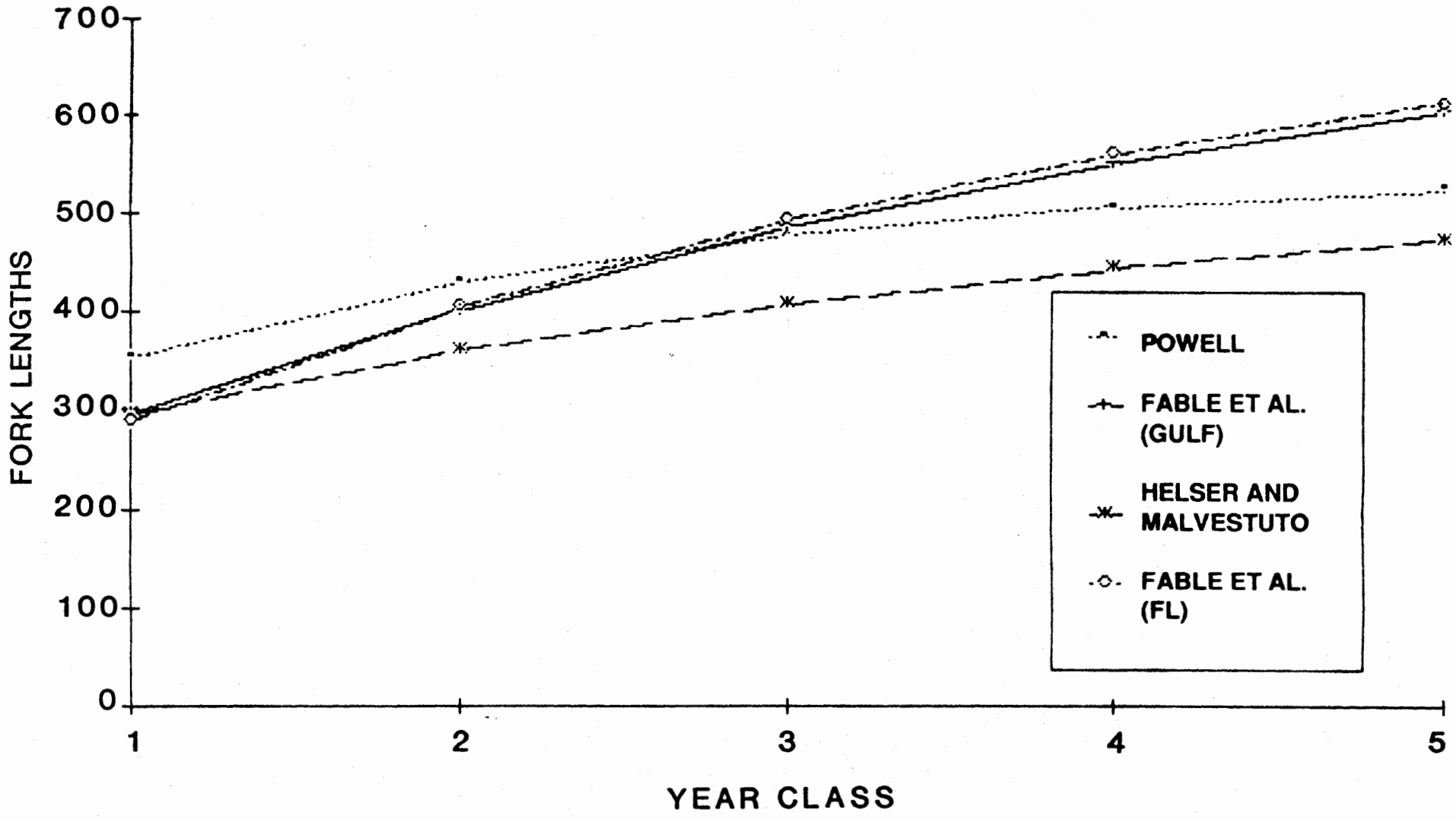
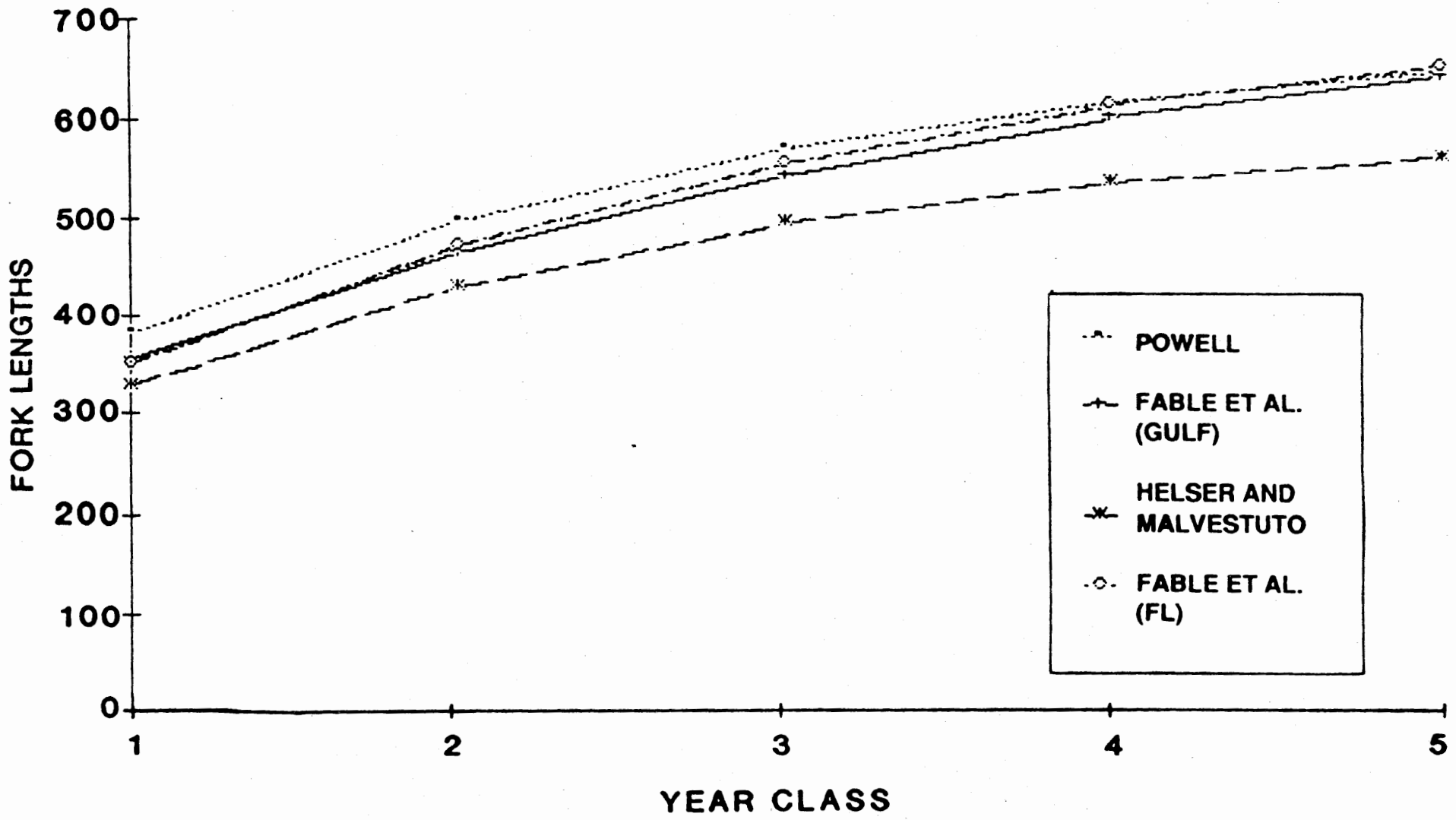


Figure 3.1. Spanish mackerel calculated fork length (mm) at age for males.


700
600
500
400
300
200
100
0
FORK LENGTHS
1
2
3
4
5
YEAR CLASS
POWELL
FABLE ET AL. (GULF)
HELSER AND MALVESTUTO
FABLE ET AL. (FL)

and Helser and Malvestuto (in press). Those data indicate that Helser and Malvestuto's reported growth rates are slower than Powell's for males and females. Data of Fable et al. (1987) show slower growth for age I and II fish, but these begin to exceed those reported by Powell for subsequent ages.

b) Age Frequency Distribution

Powell (1975) studied fish from the Atlantic and gulf coasts of southern Florida. His results showed 93% age III fish or less, with age I the largest single class.

More recently, catch-at-age data were reported by the National Marine Fisheries Service (NMFS) from areas representing the entire Gulf of Mexico (Scott and Burn 1987) and are shown in Table 3.3 for year classes 0-9. Recreational catches from 1980 through 1986 indicated that 95% or greater of the fish were age III or younger. Age I was the single dominant age class with the exception of 1986 when age 0 dominated. Age 0 was the second largest group taken by recreational fishermen, with age II fish following.

Ninety-six and one-half percent of Spanish mackerel landed commercially were age III or less. In 1979, age 0 fish dominated the catch with 62%; thereafter, age I fish dominated through

Table 3.3. Spanish mackerel catch at age (percentage) from the Gulf of Mexico (from Scott and Burn 1987).

	AGE									
YEAR	0	I	II	III	IV	V	VI	VII	VIII	IX
	RECREATIONAL CATCH									
1980	3	56	23	13	3	1	<1	<1	<1	<1
1981	16	55	18	6	3	<1	<1	<1	<1	<1
1982	23	48	17	10	2	<1	<1	<1	<1	<1
1983	7	52	33	7	1	<1	<1	<1	<1	<1
1984	14	55	24	5	2	<1	<1	<1	<1	<1
1985	31	41	16	10	1	<1	<1	<1	<1	<1
1986	43	41	15	<1	<1	<1	<1	<1	<1	<1
	COMMERCIAL CATCH									
1980	60	18	15	4	1	<1	<1	<1	<1	<1
1981	7	62	24	4	2	<1	<1	<1	<1	<1
1982	14	57	23	5	1	<1	<1	<1	<1	<1
1983	9	51	25	10	3	<1	<1	<1	<1	<1
1984	16	42	30	9	3	<1	<1	<1	<1	<1
1985	5	35	39	15	4	1	<1	<1	<1	<1
1986	5	42	34	12	5	2	<1	<1	<1	<1

1986. Unlike recreational catches, however, age II fish were second greatest in abundance followed by age 0 fish.

Data from both NMFS and Powell indicate very few catches, recreational or commercial, of ag IV fish or older. Powell's study identified one age VIII fish and a study by Fable et al. (1987 identified one age IX fish, both using otolith aging techniques; however, catches of Spanis mackerel of these ages are rare.

c) Age at Recruitment

Currently, the commercial fishery is targeting Spanish mackerel between 400 and 450 mm F (17 to 18 inches) (R. Williams, pers. comm. 1987). As indicated above, from 1980 through 1986 the vast majority of fish entered the fishery at age I. If the commercial industry continued t harvest 400 to 450 mm FL fish, the age classes targeted would be II and III.

The 12 inch minimum size limit in the EEZ and as adopted by most states, results in som recruitment at age 0 in the recreational fishery. Most recruitment is at age I, and by age I all fish are recruited into the recreational fishery.

Females grow at a faster initial rate than do males; consequently, females would enter th fishery before males are available. Helser and Malvestuto (in press) support this, indicatin differential mortality between the sexes, with females showing a marked decline between ages I and II and males showing a similar decline, but between ages II and III.

d) Survival Rate

Using age frequency data of Scott and Burn (1987), annual mean survival rate from 198 through 1986 calculated from recreational statistics was 34% of the population (Heincke technique, Ricker 1975). Annual survival calculated from commercial landings yielded a survival rate of 32% of the population.

Based on Powell's (1975) data, a survival rate of 38% of the population was calculated in the Coastal Pelagics Fishery Management Plan, although a different method was used to analyze those data (Anonymous 1982).

3.4 Reproduction

a) Sex Ratio

Klima (1959) found that females made up 51% of the gill net catch and 80% of the hook and line recreational catch in south Florida. More recent studies have indicated a similar disparity in sex ratios between the two gear types. It has been established by Klima (1959), Fable et al. (1987), and Helser and Malvestuto (in press) that female Spanish mackerel have a faster initial growth rate than males, thus recruiting them to the fishery earlier than males. Figure 3.3 illustrates the selectivity of three gear types.

Data from Fable and Nakamura (1986) indicate that out of 13 purse seine hauls containing Spanish mackerel two showed a significant variance from a one-to-one ratio, with males predominant (Table 3.4).

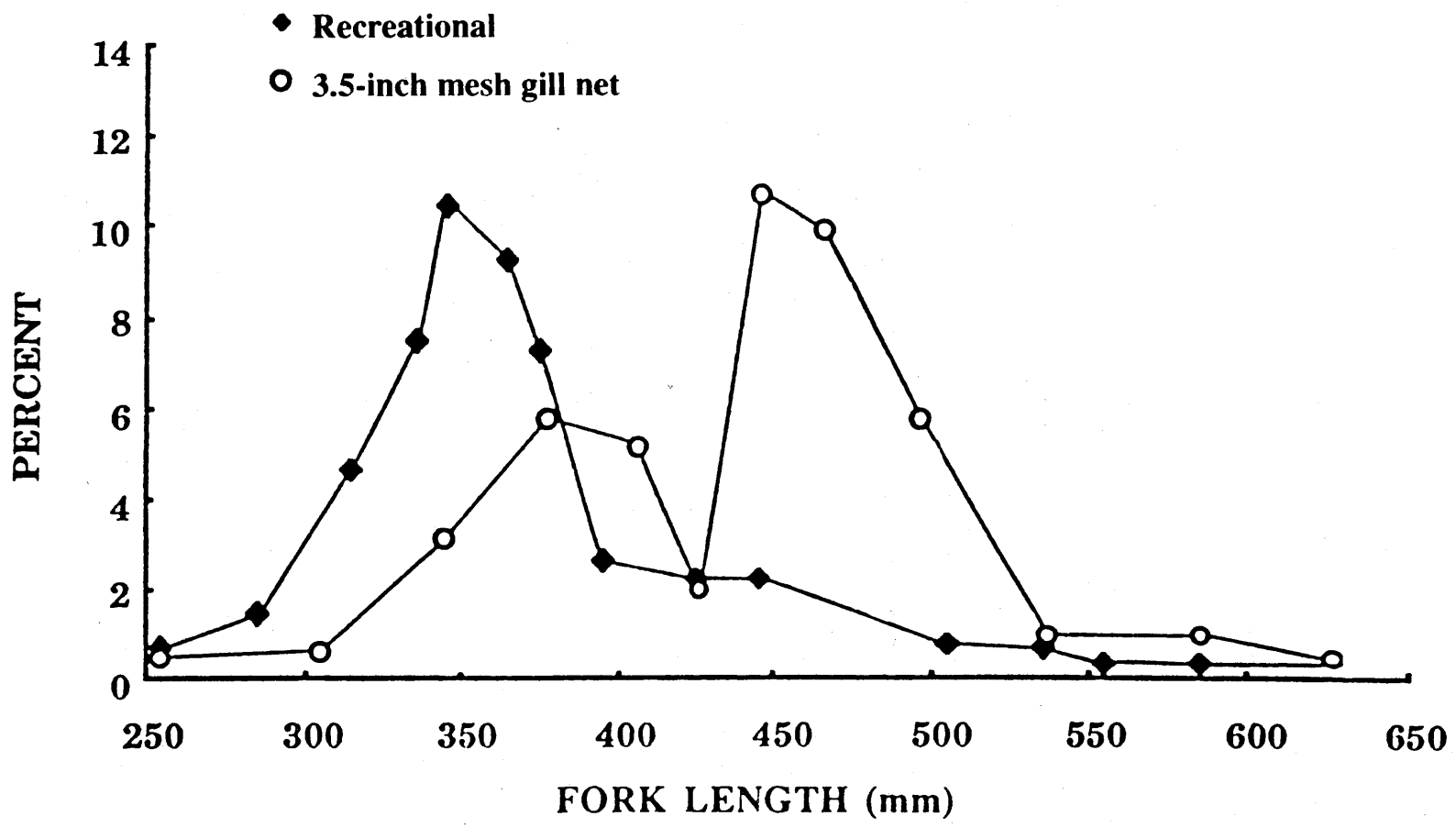


Figure 3.3. A comparison of length frequencies of Spanish mackerel captured by 3.5 inch mesh gill net and hook and line recreational fishermen in Alabama (Helser and Malvestuto, in press).

Table 3.4. Sex ratios of purse-seine caught Spanish mackerel using Chi-square values to test for significant variance from 1:1. Chi-square values in parentheses were determine when the total number of sexed fish was less than 40, and are therefore suspect (fr Fable and Nakamura 1986).

Catch date	Number of males	Number of females	Chi-squar
Nov 1983	46	23	7.6667
Mar 1984	50	46	1.6667
Feb 1985	16	12	(0.5714
Feb 1985	13	21	(1.8824
Feb 1985	32	24	1.1428
Mar 1985	25	12	(4.5676
Jan 1986	9	15	(1.5000
Jan 1986	19	20	(0.0256
Feb 1986	10	10	0
Feb 1986	26	15	2.9512
Feb 1986	17	10	(1.8148
Mar 1986	9	15	(1.5000
Mar 1986	17	15	(0.1250

*Significant ($p < .05$) deviation from 1:1.

b) Maturation

Klima (1959), studying fish from south Florida, listed a 250 mm FL fish as his smallest mature female, while his smallest mature male was 280 mm FL. He felt that at 350 mm FL both sexes were fully mature.

Table 3.5 provides percentages of mature male and female Spanish mackerel from samples taken from the Gulf of Mexico and the south Atlantic (Finucane and Collins 1986). This study indicates some variability of age at maturity between northern and southern gulf areas. Like Klima (1959), Finucane and Collins (1986) suggest that almost all Spanish mackerel from southwest Florida are mature at 350 mm FL. Finucane and Collins (1986) found that females from the Mississippi delta and northwest Florida were completely mature at a larger size than reported by Klima (1959).

Although Powell (1975) found maturing oocytes in age I and age II females his analytical results suggested that very few of these actually spawned. However, this interpretation is questionable (Anonymous 1982) because of the small number of ripe fish in his sample. Given a high mortality rate and short life span, it is more likely that age II females make a significant contribution to the spawning potential of the stock.

c) Fecundity

Earll's (1883) report from the Chesapeake Bay area provides some early estimates on fecundity in S. maculatus. He estimated that a 6 lb (2.7 kg) mackerel carried 1,500,000 eggs. He counted the number of eggs in the ovaries of one immature female weighing 1 lb 13 oz (823 g)

Table 3.5. Total number of fish collected from April through September showing percentages of mature (Stage II - V) Spanish mackerel from the Gulf of Mexico and south Atlantic (from Finucane and Collins 1986).

Fork length (mm)	Mississippi Delta				Northwest Florida				Southwest Florida			
	Females		Males		Females		Males		Females		Males	
	(No.)	(%)	(No.)	(%)	(No.)	(%)	(No.)	(%)	(No.)	(%)	(No.)	(%)
220-224	0	--	1	0.0	0	--	1	0.0	0	--	0	--
225-249	0	--	1	0.0	1	0.0	0	-	0	--	0	--
250-274	4	0.0	7	28.6	2	50.0	0	--	0	--	0	--
275-299	8	0.0	50	27.3	4	0.0	39	43.6	0	--	0	--
300-324	9	66.7	9	100.0	12	41.7	44	68.2	0	--	1	0.0
325-349	24	91.7	53	96.2	51	69.8	61	86.8	4	25.0	3	66.6
350-374	36	88.9	37	100.0	45	75.6	38	100.0	12	83.3	30	93.3
375-399	26	96.1	19	100.0	50	88.0	24	100.0	22	100.0	39	100.0
400-424	23	91.3	27	100.0	56	91.1	23	100.0	24	100.0	27	100.0
425-449	21	85.7	19	100.0	28	82.1	5	100.0	20	100.0	13	100.0
450-474	16	93.8	7	100.0	37	91.9	4	100.0	19	100.0	5	100.0
475-499	21	66.7	1	100.0	21	85.7	0	--	9	100.0	7	100.0
500-524	21	100.0	2	100.0	16	100.0	3	100.0	17	100.0	6	100.0
525-549	21	100.0	0	--	6	100.0	1	100.0	9	100.0	5	100.0
550-574	22	100.0	1	100.0	10	100.0	0	0.0	4	100.0	4	100.0
575-599	24	100.0	0	--	2	100.0	0	--	5	100.0	1	100.0
600-624	18	100.0	0	--	0	--	0	--	2	100.0	0	--
625-649	7	100.0	0	--	0	--	0	--	7	100.0	0	--
650-674	3	100.0	0	--	0	--	0	--	4	100.0	0	--
675-699	0	--	0	--	0	--	0	--	2	100.0	0	--
700-724	0	--	0	--	0	--	0	--	1	100.0	0	--
TOTAL	304	--	234	--	341	--	243	--	161	--	141	--

and 18.5 inches (470 mm) in length and determined that the ovaries contained approximately 525,000 eggs.

Finucane and Collins (1986) estimated fecundity for various sizes of Spanish mackerel from the Gulf of Mexico and the south Atlantic (Table 3.6). Their analysis showed that fecundity ranged from 100,000 eggs to over 2,000,000 eggs for fish that ranged from 295 grams to over 2,415 grams (312 mm to 626 mm). Their data are consistent with estimates of Earll.

d) Spawning Season

Klima (1959) inferred a July through September spawning season based on the observance of ripe fish during the period of his study.

Powell's (1975) study inferred spawning from April through September by histological studies of ovaries.

Table 3.6. Estimated number of eggs for various sizes and weights of Spanish mackerel from the Gulf of Mexico and south Atlantic (from Finucane and Collins 1986).

Mississippi Delta			Northwest Florida			Southeast Florida		
FL (mm)	Total weight (g)	Number of eggs	FL (mm)	Total weight (g)	Number of eggs	FL (mm)	Total weight (g)	Number of eggs
312	290	283,000	326	272	157,000	354	412	194,000
347	408	319,000	328	295	100,000	363	315	197,000
357	332	297,000	338	390	152,000	395	544	274,000
387	590	590,000	372	460	261,000	426	635	453,000
402	768	600,000	387	510	292,000	450	726	430,000
440	738	418,000	412	680	417,000	477	908	430,000
451	908	450,000	437	911	831,000	486	1,343	596,000
511	1,230	653,000	457	915	561,000	573	1,451	606,000
534	1,395	980,000	468	926	561,000	580	1,588	692,000
567	1,377	1,301,000	491	1,147	1,248,000	585	1,814	908,000
583	1,799	827,000	528	1,362	1,074,000	664	2,583	1,491,000
616	2,126	1,272,000	545	1,581	1,062,000			
617	2,045	919,000	570	1,748	1,461,000			
640	1,477	1,299,000	587	1,907	1,463,000			
			626	2,415	2,113,000			
			629	2,469	1,615,000			

Finucane and Collins (1986) suggested a spawning period of May through September, indicating that a few fish may spawn as early as April and as late as October. They also suggest that gonad maturation data from south Florida may indicate some spawning throughout the year.

e) Spawning Areas

The prolonged spawning season of individual Spanish mackerel may allow spawning to be distributed over a wide area, which should reduce the chances of fluctuations in year class strength due to environmental variations caused by nature or man.

Indirect evidence of spawning areas comes from larval studies. Wollam (1970) found Spanish mackerel larvae in the Gulf of Mexico along the west coast of Florida from Naples to Panama City. Dwinell and Futch (1973) found them widely distributed in the northern gulf from Mobile, Alabama, to Cedar Key, Florida. McEachran et al. (1980) found them off the Texas coast; however, larval abundance of Spanish mackerel appeared to be greatest in the eastern Gulf of Mexico. Their study indicated that spawning of Spanish mackerel takes place in inshore waters as opposed to king mackerel which spawns over the middle to outer continental shelf.

J.H. Finucane (unpub. data, NMFS, Panama City, FL) found that of 1,180 young Spanish mackerel collected in plankton tows, 90.2% were collected in the nearshore coastal waters off Louisiana, Mississippi, and Alabama. He concluded that the major spawning area for Spanish mackerel occurs off the Mississippi delta. McEachran et al. (1980) stated that Spanish mackerel were most frequently caught over the inner continental shelf (less than 34 meters in depth).

Lyczkowski-Shultz et al. (1986) conducted a study during 1979 through 1980 of the waters of Mississippi Sound and the nearshore waters surrounding the barrier islands. Spanish mackerel larvae occurred at locations south of the barrier islands and near or inside island passes. In a 1981 study, Lyczkowski-Shultz (1987) collected plankton from Dog Keys Pass, Horn Island over a 37 hour period in 84 samples. Spanish mackerel larvae occurred in 40% of those samples. In both of these studies, length of the larvae (2.5 mm or less) indicate the possibility of spawning nearby.

Data collected during Southeast Area Monitoring and Assessment Program (SEAMAP) surveys (J. Gartner, pers. comm. 1987 and 1988) recorded collections of Spanish mackerel larvae from plankton samples from 1982 through 1985. In 1982, a total of 87 Spanish mackerel larvae was collected, with 86 (99%) of those occurring near or inside of the 10 fathom curve. Collections for 1983 resulted in 193 larvae with 95% near or inside the 10 fathom curve, while those for 1984 showed 134 larvae and 96% near or inside the 10 fathom curve. The 1985 collections resulted in 102 larvae with 91 (89%) near or inside the 10 fathom curve. Total figures from 1982 through 1985 resulted in 189 larvae with 177 (93%) collected near or inside the 10 fathom curve.

3.5 Larvae

a) Identification

Embryonic and early larval stages of S. maculatus were described by Ryder (1887) and later stages were described by Wollam (1970). Richardson and McEachran (1981) also provided descriptions of larval Spanish mackerel caught off the Texas coast.

b) Distribution

Spanish mackerel larvae have been found in nearshore environments of the Gulf of Mexico from Florida to south Texas (Wollam 1970, Dwinell and Futch 1973, McEachran et al. 1980). Abundance appears to be greatest in the northeastern gulf (McEachran et al. 1980). The earlier section discussing spawning areas (Section 3.4 e) provides information related to larval distribution.

3.6 Juveniles

a) Identification

Juvenile stages of Spanish mackerel were described by Hildebrand and Cable (1938) and were later verified by Wollam (1970). Shaw and Drullinger (1986), surmising from Hildebrand and Cable (1938) and Wollam (1970), place the size range of juveniles from 13.5 mm to 225 mm. This concurs with Finucane and Collins (1986) who indicate that some fish have been found to mature at around 225 mm.

b) Distribution

A total of 393 juvenile Spanish mackerel was collected during standardized monthly surveys from February 1974 through February 1986 by the Fisheries Assessment and Monitoring Program conducted by the Gulf Coast Research Laboratory in Ocean Springs, Mississippi (J. Warren, pers. comm. 1987). Juveniles were found from lower river outflows to bays to the barrier island passes, covering the full extent of Mississippi Sound. A total of 322 (82%) of those was collected at stations located at or near one of the barrier island passes off Mississippi.

Data obtained during monthly standardized surveys from the Alabama Assessment and Monitoring Program from October 1980 through June 1987 indicated collection of 82 juvenile Spanish mackerel

ranging in standard length from 18 mm to 147 mm (M. Van Hoose, pers. comm. 1987). Of thes juveniles 52% were collected at or near Dauphin Island, an offshore barrier island. Temperatur measurements taken concurrently with juvenile collections ranged from 23°C to 33.5°C. Salinit ranged widely from 2 ppt to 32 ppt indicating a large salinity tolerance for juvenile Spanis mackerel.

A study conducted by Modde and Ross (1983) analyzing the surf zone habitat of Horn Islan off Mississippi from 1975 through 1977 found 63 juvenile Spanish mackerel.

3.7 Ecological Relationships

Prey-predator relationships, food chains, and competitive or mutualistic interactions ar the most important factors to consider in developing an understanding of biological relationship of fishery species. A description follows which gives the specific prey and predator organism for Spanish mackerel followed by a general discussion of food chains, including larval foo chains. Competitive and mutualistic interactions are also discussed where information i available.

3.7.1 Prey-Predator Relationships of Spanish Mackerel

a) Prey Species

Klima (1959) collected Spanish mackerel on the east coast of Florida from Palm Beach t Marathon from October 1956 through April 1958. Collections were made by hook and lin recreational fishermen and commercial gill net operations. Based on his analysis of 29 stomachs, 38% of which were empty, the following food items were found: herrings (Clupeidae (78%); shrimp (Penaeus spp.) (6%); mullet (Mugil spp.) (4%); needlefish (Strongylura) and anchov (Engraulidae) (less than 1%). Unidentified fish made up an additional 8% of stomach contents.

Stomachs of trawl-caught juvenile Spanish mackerel contained fish and squid, mostly th former. The samples were taken from off Cape Canaveral, Florida from October 1978 throug October 1979 and from off Galveston Bay, Texas from August 1978 through June 1979 (Naughton an Saloman 1981). Of the fishes, engraulids were the most important; clupeids and sciaenids wer also found. Stomachs of adult Spanish mackerel that were caught by hooks and by net als contained mostly fish, but contained some crustaceans and mollusks (Saloman and Naughton 1983) Prey species and their percentage composition in the stomachs varied by size of Spanish mackere and locality (Figures 3.4 and 3.5).

b) Predator Species

Bottle-nose dolphins (Tursiops truncatus) are thought to be major predators of Spanis mackerel due to their common occurrence around mackerel schools. Bottle-nose dolphins are problem for gill-net mackerel fishermen on the Florida east coast (Cato and Prochaska 1976) because they tear fish out of nets.

Sharks are major predators of Spanish mackerel. The species has been listed among th stomach contents of the dusky shark (Carcharhinus obscurus) in Florida (Clark and von Schmid 1965). According to Bigelow and Schroeder (1948), the smooth hammerhead (Sphyrna zygaena) prey on Spanish mackerel. The mackerels in general are referred to as a component of the diet of bul sharks (Carcharhinus leucas), porbeagles (Lamna nasus), and tiger sharks (Galeocerdo cuvieri (Bigelow and Schroeder 1948). Sharks commonly attack Spanish mackerel gilled in gill net causing considerable damage or total destruction to the nets (R. Williams, pers. comm. 1987).

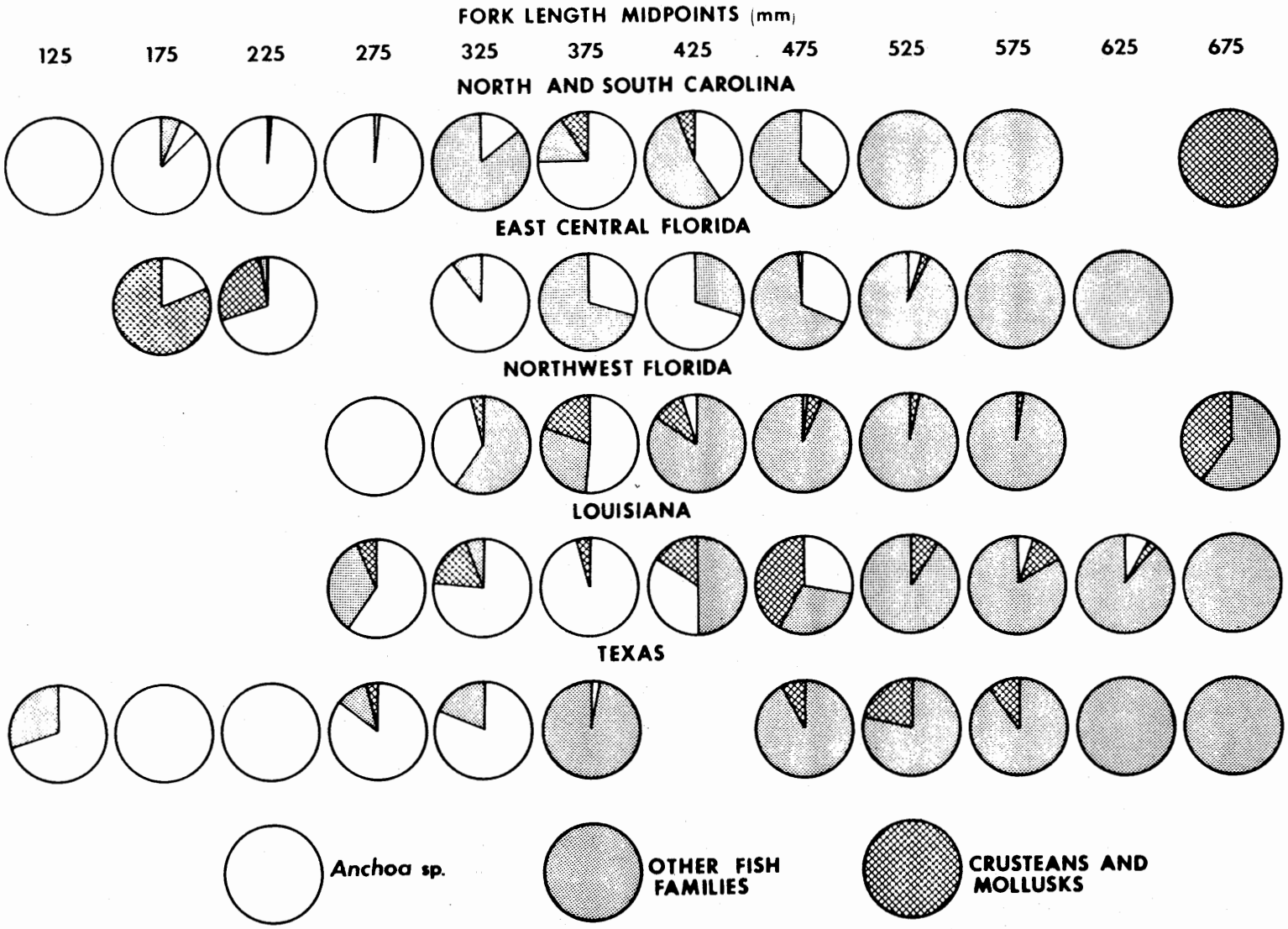


Figure 3.4. Percentage volumes of major identifiable food items in relation to size of Spanish mackerel. Other fish families include all families except Engraulidae (from Saloman and Naughton 1983).

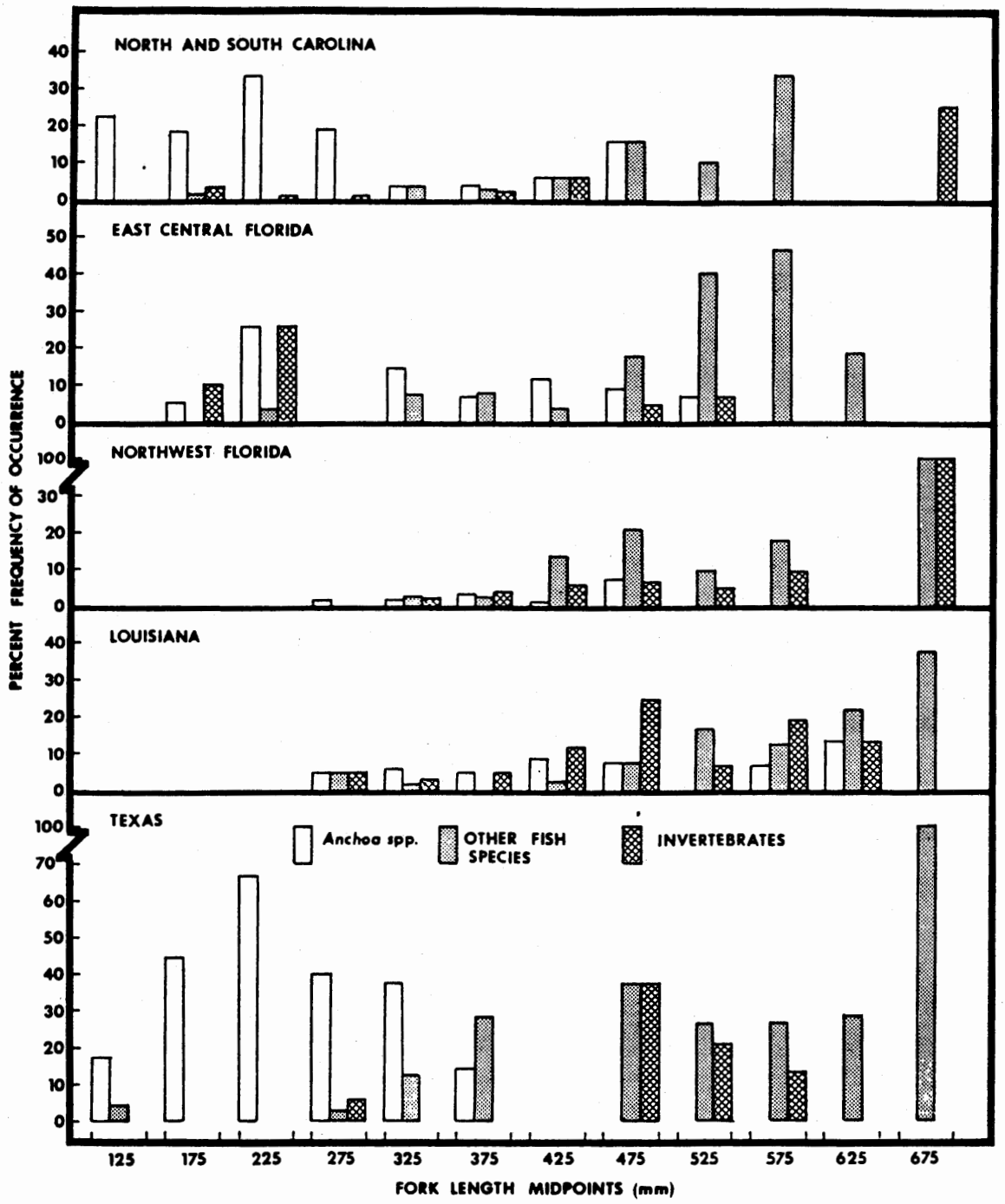


Figure 3.5. Percentage frequency of occurrence of major identifiable food items in relation to size of Spanish mackerel. Other fish families include all families except Engraulidae (from Saloman and Naughton 1983).

3.7.2 Principal Prey Species of Spanish Mackerel and Their Food Habits

Saloman and Naughton (1983) listed engraulids (anchovies) as the principal prey group for Spanish mackerel. The families Clupeidae and Carangidae followed, respectively. Following the fishes, penaeid shrimp and squid were recorded.

Engraulids and clupeids feed on plankton. Zooplankton are especially important to the clupeids (Low 1973, Hildebrand 1963, Bohlke and Chaplin 1968).

Penaeid shrimp are bottom feeders, consuming amphipods, isopods, and some plant material (Eldred et al. 1961). Squid are carnivores feeding on a range of prey items including crustaceans and anchovies depending upon their age and size. Many of the prey species listed depend, either directly or indirectly, on estuarine and nearshore areas for survival.

3.8 Maximum Sustainable Yield

Maximum sustainable yield (MSY) for Spanish mackerel was estimated by Mackerel Stock Assessment Panel (1986) which suggested a range of 15-19 million pounds. Both production model and yield per recruit method were employed. Estimates were reviewed by the Councils' Mackerel Committee, which recommended a range of 15.7 to 19.7 million pounds with 18 million pounds as the best estimate.

The Gulf of Mexico and South Atlantic Fishery Management Councils have adopted 18 million pounds as the best estimate of MSY for the southeast region. The original FMP for coastal pelagics used an estimate of 27 million pounds per year as the estimate of MSY, but it is now considered to be an overestimate. That estimate relied solely on yield per recruit techniques.

3.9 Present Condition

Recent assessments by the Florida Department of Natural Resources (Williams et al. 1985) and by the National Marine Fisheries Service (Mackerel Stock Assessment Panel 1986) have concluded that Spanish mackerel abundance is too low to support harvest at MSY. The FDNR assessment demonstrated that commercial landings had rapidly declined along the gulf coast of Florida after 1977 despite a slight increase in harvest capacity, that the geographical range of the commercial fishery had withdrawn to the Florida Keys, that recreational catches off south Florida had declined, that the fishery was being exploited beyond F (0.1), and that the fishery would benefit from an increase in size at entry to the fishery. The NMFS assessment likewise found that landings had declined, that average size of fish appeared to have declined, but that recruitment indices were inconclusive. The joint Gulf of Mexico and South Atlantic Fishery Management Councils' Stock Assessment Panel reviewed and endorsed these assessments and concluded that there needed to be some regulation of fishing mortality and that an increase in minimum size to about 18 inches would be beneficial.

3.10 Future Condition of Spanish Mackerel

Prior to 1987, about 70% of the gulf Spanish mackerel harvest came from off the Florida coast. Comprehensive management programs for Spanish mackerel were implemented by the Florida Marine Fisheries Commission in late 1986 and by the South Atlantic and Gulf of Mexico Fishery Management Councils in early 1987. Both programs have employed a combination of mesh size regulation, quotas, and bag limits to rebuild Spanish mackerel abundance.

Since the majority of Spanish mackerel harvest comes from within the territorial seas, th future condition of Spanish mackerel is heavily dependent on adequate regulation by all Gul States. However, since about three age classes comprise most of the fishery, recovery of th Spanish mackerel population could be quite rapid.

4.0 HABITAT

4.1 Condition of Habitat

4.1.1 Adult Habitat

The habitat of adult Spanish mackerel is coastal waters out to the edge of the continental shelf in the Gulf of Mexico (Collette and Nauen 1983). Its distribution is governed by temperature and salinity, requiring temperatures of 21 to 27°C (Berrian and Finnan 1977) and salinities of up to 32 ppt (Godcharles and Murphy 1986). Adverse effects of habitat degradation caused by man on adult Spanish mackerel have apparently not been demonstrated.

4.1.2 Larval Habitat

Eggs and larvae are concentrated in the surface waters of 19.6 to 29.8°C and salinities ranging from 28.3 to 37.4 ppt (McEachran et al. 1980). There is, at present, no documented evidence that larval habitats have been degraded by natural or man-made causes to a degree sufficient to affect recruitment; however, man's impact on the habitat has greater potential to affect larvae than adults, and the magnitude of man's impact in the spawning area has been rapidly increasing. Juveniles have been found in salinities as low as 4.7 ppt (Godcharles and Murphy 1986).

Oil pollution from offshore oil spills or chronic leakage or discharge from operating oil wells is a potential danger to the spawning grounds of Spanish mackerel. The water soluble aromatic hydrocarbon component of crude oil is damaging to fish eggs and embryos. A study by Struhsaker et al. (1974) off the California coast showed that pollutants related to oil production in San Francisco Bay caused abnormal development and altered respiration in larval herrings and anchovies. Eggs showed a significantly lower hatching rate than eggs collected from areas free of similar pollutants. According to Struhsaker et al. (1974), other pollutants such as pesticides may act synergistically with oil to produce deleterious effects on larval fish. Wilson (1977) showed that oil dispersants with water soluble aromatic hydrocarbon fractions are also damaging to fish eggs and larvae; however, second generation dispersants have reduced their aromatic hydrocarbon components and are less toxic.

Although there is considerable oil and gas activity in the Gulf of Mexico, there have been no documented adverse impacts on adult fish or eggs and larvae. The potential for adverse impacts, however, does remain.

4.1.3 Habitat of Prey Species

Spanish mackerel move from one area to another and feed on seasonally abundant local resources. Many of the prey species are estuarine dependent, spending all or a portion of their lives in estuaries. Spanish mackerel are to some degree dependent upon estuaries for their source of prey items. Therefore, Spanish mackerel can be expected to be detrimentally affected if the productive capabilities of estuaries are diminished.

4.2 Habitat Areas of Particular Concern

The critical habitats of Spanish mackerel are:

1) Offshore areas of major spawning activities, which are critical to renewing stocks by recruitment
2) All estuaries on their migration routes, which are critical to maintaining stocks by food production.
3) All waters of the Gulf of Mexico along their migratory routes.

Some general statements can be made as to actions that would serve to protect the areas of critical habitat:

1) Locate the centers for spawning activity for Spanish mackerel, evaluate their current habitat quality, and protect them from degradation.
2) Determine whether or not Spanish mackerel hatching or larval development in the western gulf are significantly affected by proximity to operating oil wells (or brine discharges) and if this affects recruitment.
3) Recognize the importance of estuaries to Spanish mackerel and act against damage to estuaries by preventing, controlling, or adequately mitigating dredging, filling, bulkheading, etc.

4.3 Habitat Protection Programs

Spanish mackerel do not occupy any site specific habitat, but rather they are spawned over very large offshore areas, and as adults, migrate over great distances. Comprehensive coastal zone management programs that focus on protecting and enhancing estuarine environments along with other coastal areas are being developed. Indirectly these programs will affect, in a positive manner, the productivity of the management unit. The status of their plans are summarized in Table 5.3.

At the federal level, the importance of habitat to the survival of marine organisms is recognized and expressed in the National Marine Fisheries Service policy on habitat, the U.S. Fish and Wildlife Service series of Habitat Suitability Indices, and the mandate by the Magnuson Fishery Conservation and Management Act that habitat be given critical consideration in fishery management plan development. A marine sanctuary program was established by the Marine Protection, Research, and Sanctuaries Act. It permits the designation of specific marine sanctuaries by the Office of Coastal Zone Management of NOAA. Existing and proposed estuarine sanctuaries may have a positive effect on Spanish mackerel stocks, since their dependence upon estuarine habitats is now recognized.

The National Environmental Policy Act (NEPA) requires that all federal agencies recognize and give appropriate consideration to environmental amenities and values in the course of their decision-making. In an effort to create and maintain conditions under which man and nature can exist in productive harmony, NEPA requires that federal agencies prepare an environmental impact statement (EIS) prior to undertaking major actions which might significantly affect the quality of the human environment. Within these statements, alternatives to the proposed action which may better safeguard environmental values are to be carefully assessed.

5.0 FISHERY MANAGEMENT JURISDICTION, LAWS, AND POLICIES

Management institutions currently regulating Spanish mackerel include the Gulf of Mexico and South Atlantic Fishery Management Councils and the various states within the range of the stocks. Spanish mackerel are caught almost entirely within the Gulf of Mexico and south Atlantic regions, with recent data indicating that the majority of the commercial and recreational harvest is within state jurisdictional waters.

Table 5.1 shows the proportion of the U.S. commercial and recreational catch inside and outside state jurisdictional waters. It is important to remember that the jurisdictional waters

Table 5.1. Commercial and recreational catch in thousands of pounds of Spanish mackerel from the Gulf of Mexico by distance from shore.

Commercial[1]

Year	Jurisdictional Catch	%	EEZ Catch	%	Total catch
1979	2,071	98	51	2	2,122
1980	1,665	94	105	6	1,770
1981	3,329	94	221	6	3,550
1982	3,062	93	225	7	3,287
1983	1,955	94	132	6	2,087
1984	2,952	92	261	8	3,213
1985	2,901	96	122	4	3,023
1986	3,241	98	60	2	3,301
1987	2,124	98	33	2	2,157
Total	23,300	95	1,210	5	24,510

Recreational[2]

Year	Jurisdictional Catch	%	EEZ Catch	%	Total catch
1979	2,244	67	1,099	33	3,343
1980	1,318	42	1,791	58	3,109
1981	1,791	71	742	29	2,533
1982	1,766	72	684	28	2,450
1983	813	33	1,691	67	2,522
1984	250	25	742	75	992
1985	917	50	903	50	1,820
1986	4,156	83	874	17	5,030
1987	1,673	66	871	34	2,544
Total	14,946	61	9,397	39	24,343

[1]Data from State-Federal Cooperative Statistics Program (E. Snell, pers. comm. 1987; G. Davenport, pers. comm. 1988).

[2]Data from Marine Recreational Fishery Statistics Survey, Current Fishery Statistics (J. Witzig, pers. comm. 1988).

of the Florida west coast and the Texas coast extend to three marine leagues, which is nin nautical miles offshore. The remainder of the Gulf States have jurisdiction out to thre nautical miles.

The commercial catches are almost exclusively confined to nearshore waters, with 95% fro state jurisdictional waters and 5% from the EEZ. Recreational catches are 61% from stat jurisdictional waters and 39% from the EEZ. Combined commercial and recreational catches are 78 state jurisdictional waters and 22% EEZ.

5.1 Management Institutions

Table 5.2 summarizes the basic characteristics of the state institutions involved in fisher management. Brief narrative descriptions are presented below for each state. The characteristi of primary importance is the identification of authority for establishing management regulation in the various states. While all states bordering the Gulf of Mexico authorize some degree o authority to administrative bodies, Alabama, Mississippi, Florida, and to a certain degree Texas utilize administrative authorities for establishing substantive management regulations. I Louisiana, statutes contain the specific regulatory measures used to manage fishery resources The embodiment of detailed regulations in statutory law limits the flexibility of managemen programs, because regulatory changes require legislative approval, and those efforts are hampere by the relatively slow pace of the process.

1. Texas -- Texas Parks and Wildlife Department (TPWD), 4200 Smith School Road, Austin Texas 78744.

The Texas Parks and Wildlife Commission is the administrative unit of the state charged wit management of the coastal fishery resources and enforcement of legislative and regulator procedures. The nine members of the commission are appointed by the governor for six-year terms The commission selects an executive director who serves as the chief administrative officer o the department. A director of the Fisheries Division is named by the executive director. Th Coastal Fisheries Branch, headed by a branch chief, is under the supervision of the director o fisheries.

2. Louisiana -- Louisiana Department of Wildlife and Fisheries (LDWF), P.O. Box 98000 Baton Rouge, Louisiana 70898-9000.

The Department of Wildlife and Fisheries is one of 21 major administrative units of th Louisiana state government. A seven-member board, the Louisiana Wildlife and Fisherie Commission, exercises control and supervision of the wildlife of the state, including all aquati life, through its secretary. The Secretary of the Department of Wildlife and Fisheries is "Th executive head and chief administrative officer of the department" and has "sole responsibilit for the policies of the department and for the administration, control and operation of th functions, programs, and affairs of the department." The secretary is appointed by the governo with consent of the senate.

Within the administrative system an assistant secretary is in charge of the Office o Coastal and Marine Resources. In this office the Seafood Division, headed by the division chief performs "the functions of the state relating to the administration, limited enforcement o marine statutes, and operation of programs, including research relating to oysters, waterbottom and seafoods, including but not limited to the regulation of the oyster, shrimp, and marin fishing industries."

Louisiana has a federally approved CZM program.

Table 5.2. State Management Institutions - Gulf of Mexico Region.

	Administrative body and its responsibilities	Administrative policy-making body and decision rule	Legislative involvement in management regulations
TEXAS	PARKS AND WILDLIFE DEPARTMENT • administers management programs • enforcement • conducts research • makes recommendation to legislature	PARKS AND WILDLIFE COMMISSION • nine-member body establishes regulations based on majority vote of quorum (five members constitute a quorum)	• detailed regulations contained in statutes; • licensing requirements and size limits contained in statutes.
LOUISIANA	DEPARTMENT OF WILDLIFE AND FISHERIES • administers management programs • enforcement • conducts research • makes recommendations to legislature	WILDLIFE AND FISHERIES COMMISSION • seven-member board establishes regulations based on majority vote of a quorum (four members constitute a quorum) consistent with statutes.	• detailed regulations contained in statutes; changes require legislative approval.
MISSISSIPPI	DEPARTMENT OF WILDLIFE CONSERVATION • administers management programs • enforcement • conducts research	COMMISSION ON WILDLIFE CONSERVATION • five-member board • establishes ordinances on recommendation of bureau director.	• authority for detailed management regulations delegated to commission • statutes concern licenses and taxes with some specific restrictions on oysters.
ALABAMA	DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES • administers management programs • enforcement • conducts research	• Commissioner of department has authority to establish management regulation. • Conservation Advisory Board is a thirteen member board and advises the commissioner • has authority to amend and promulgate regulations	• authority for detailed management regulations delegated to commissioner • statutes concerned primarily with licensing.
FLORIDA	DEPARTMENT OF NATURAL RESOURCES • makes recommendations to legislature • administers management programs • enforcement • conducts research	FLORIDA MARINE FISHERIES COMMISSION • creates rules which must be approved by the governor and cabinet. • seven member commission	• can override any rule of the commission • responsible for licensing, management of fishing in man-made canals, and limited entry.

3. Mississippi -- Department of Wildlife Conservation, Bureau of Marine Resources, P.O Drawer 959, Long Beach, Mississippi 39560.

The administrative organization of the State of Mississippi with respect to coasta fisheries is the Department of Wildlife Conservation through the Bureau of Marine Resources.

Power and duties related to marine resources are vested in the Mississippi Commission o Wildlife Conservation, the controlling body of the Department of Wildlife Conservation. Th commission consists of five members, all appointed by the governor. The commission has ful power to "manage, control, supervise and direct any matters pertaining to all saltwater aquati life not otherwise delegated to another agency" (Mississippi Code Annotated 49-15-11) and "sai power shall be exercised through the Bureau of Marine Resources of the Mississippi Department o Wildlife Conservation..."

Mississippi has a federally approved CZM program.

4. Alabama -- Department of Conservation and Natural Resources, Marine Resources Divisio (AMRD), P.O. Box 189, Dauphin Island, Alabama 36528.

Management authority of fishery resources in Alabama is held by the Commissioner of th Department of Conservation and Natural Resources. The commissioner may promulgate rules o regulations designed for the protection, propagation, and conservation of all seafoods. He ma prescribe manner of taking, times when fishing may occur, and designate areas where fish may o may not be caught. However, all regulations are to be directed at the best interest of th seafood industry. Most go through the Administrative Procedures Act enacted by the Alabam Legislature in 1983; however, bag limits and seasons are not subject to that act. Th Administrative Procedures Act outlines a series of events which must precede the enaction of an regulations other than those of an emergency nature.

Among this series of events is a) the advertisement of the intent of the regulation; b) a public hearing for the regulation; c) a 35-day waiting period following the public hearing t address comments from the hearing; and d) a final review of the regulation by a joint house an senate review committee.

Within the Department of Conservation and Natural Resources is the Marine Resource Division. It has responsibility for enforcing state laws and regulations, for conducting marin biological research, and for serving as the administrative arm of the commissioner with respect to marine resources. The division recommends regulations to the commissioner.

Alabama has a federally approved CZM program.

5. Florida -- Florida Marine Fisheries Commission, 2540 Executive Center Circle West, Suite 106, Tallahassee, Florida 32301.

The Florida Marine Fisheries Commission, a seven-member board appointed by the governor and confirmed by the senate, was created by the Florida legislature in 1983. This commission was delegated rulemaking authority over marine life in the following areas of concern:

a. gear specification
b. prohibited gear
c. bag limits
d. size limits

e. species that may not be sold
f. protected species
g. closed areas
h. quality control codes
i. seasons
j. special consideration relating to egg bearing females and oyster and clam relaying.

All rules passed by the commission require approval by the governor and cabinet.

The commission does not have authority over endangered species, license fees, or penalty provisions, or over regulation of fishing gear in residential saltwater canals.

The agency charged with the administration, supervision, development, and conservation of natural resources is the Department of Natural Resources headed by the governor and cabinet. The governor and cabinet serve as the seven member board which approves or disapproves all rules and regulations promulgated by the department. The administrative head of the Department of Natural Resources is the Executive Director. Within the department, the Division of Marine Resources, through Section 370.02(2), Florida Statutes, is empowered to conduct research directed toward management of marine and anadromous fisheries in the interest of all people of Florida. The Division of Law Enforcement is responsible for enforcement of all marine resource related laws and all rules and regulations of the department.

Florida has a federally approved CZM program.

5.2 Federal Laws, Regulations, and Policies

The following federal laws, regulations, and policies may directly or indirectly influence the management of Spanish mackerel.

5.2.1 Magnuson Fishery Conservation and Magnuson Act of 1976: 16 U.S.C. 1801-1882

The Magnuson Act mandates the preparation of fishery management plans for important fishery resources within the 200 nautical mile (370 km) EEZ. Each plan aims to establish and maintain the optimum yield for the subject fishery.

5.2.2 Marine Protection, Research, and Sanctuaries Act of 1972, Title III: 16 U.S.C. 1431-1434

This act provides for the establishment of marine sanctuaries and may include regulation of fishery resources within them.

5.2.3 Clean Water Act (CWA): 33 U.S.C. 1251 et seq.

The CWA requires that a National Pollutant Discharge Elimination System (NPDES) permit be obtained before any pollutant is discharged from a point source into waters of the United States, including waters of the contiguous zone and the adjoining ocean. The disposal of drilling effluents and other wastes from drilling platforms is among the activities for which an NPDES permit from EPA is required. Issuance of such a permit is based primarily on the effluent guidelines found in 40 C.F.R. 435. However, additional conditions can be imposed on permit issuance on a case-by-case basis in order to protect valuable resources in the discharge area.

5.2.4 Marine Protection, Research, and Sanctuaries Act, Title 1: 33 U.S.C. 1401-1444

A permit is required for transportation of materials for the purpose of ocean dumping. EPA issues all permits, with the exception of those for transportation of dredged materials issued by the Corps of Engineers. Criteria for issuing such permits include consideration of effects of dumping on the marine environment, ecological systems, and fisheries resources.

5.2.5 Oil Pollution Act of 1961, as amended: 33 U.S.C. 1001-1016

The Oil Pollution Act regulates intentional discharge of oil or oily mixtures from ships registered in the United States, and thus provides some degree of protection to fishery resources. Tankers cannot discharge oil within 50 nm (92 km) of the nearest land. Ships other than tankers must discharge as far as practicable from land. The quantity of oil which can be discharged is also regulated.

5.2.6 Coastal Zone Management Act of 1972, as amended (CZMA): 16 U.S.C. 1451-1464

Under the CZMA, states are encouraged, with federal funding grants, to develop coastal zone management programs which establish unified policies, criteria, and standards for dealing with land and water use issues in their coastal zone, an area which includes the states' territorial sea. Approved coastal programs are thus capable of directing activities away from areas possessing particularly sensitive resources. Guidelines for these areas were published in 15 C.F.R. 921 on June 4, 1974. Table 5.3 provides current status on all state CZM programs. Also, the Marine Mammal Protection Act is indirectly related to the Spanish mackerel fishery.

Table 5.3 Status of Coastal Zone Management Programs in the Gulf of Mexico Region as of December 1986.

	Program status	
State	CZM Program in planning phase	CZM Program in review phase
Florida	completed	completed
Alabama	completed	completed
Mississippi	completed	completed
Louisiana	completed	completed
Texas	completed	not yet submitted

5.2.7 Endangered Species Act of 1973, as amended: 16 U.S.C. 1531-1543

The Endangered Species Act provides for the listing of plant and animal species as threatened or endangered. Once listed as a threatened or endangered species, taking (including harassment) is prohibited, and a process is established which seeks to insure that projects authorized, funded, or carried out by federal agencies do not jeopardize the existence of these species or result in destruction or modification of habitat determined by the Secretary to be critical.

5.2.8 National Environmental Policy Act (NEPA): 42 U.S.C. 4321-4361

NEPA requires that all federal agencies recognize and give appropriate consideration to environmental amenities and values in the course of their decision-making. In an effort to create and maintain conditions under which man and nature can exist in productive harmony, NEPA requires that federal agencies prepare an environmental impact statement (EIS) prior to undertaking major actions which might significantly affect the quality of the human environment. Within these statements, alternatives to the proposed action which may better safeguard environmental values are to be carefully assessed.

5.2.9 Fish and Wildlife Coordination Act: 16 U.S.C. 661-666c

Under the Fish and Wildlife Coordination Act, the FWS and NMFS review and comment on fish and wildlife aspects of proposals for work and activities sanctioned, permitted, assisted, or conducted by federal agencies which take place in or affect navigable waters. The review focuses on potential damage to fish and wildlife and their habitat and may therefore serve to provide some protection to fishery resources from federal activities, particularly in nearshore waters, since federal agencies must give due consideration to recommendations of the two agencies.

5.2.10 Fish Restoration and Management Projects Act: 16 U.S.C. 777-777k

Under this act, the Department of Interior is authorized to apportion funds to state fish and game agencies for fish restoration and management projects. Funds for protection of threatened fish communities located within state waters, including marine areas, could be made available under the act.

5.2.11 National Park Service

National Park Service under the Department of Interior may regulate fishing activities within park boundaries.

Everglades National Park lies within the state of Florida, and park boundaries extend into the territorial sea. Federal regulations [36 C.F.R. Sec. 7.45] prohibit taking, possession, or sale of more than ten fish of a species other than baitfish with the exception of those holding park commercial fishing permits.

Fort Jefferson National Monument lies within the state of Florida, and park boundaries extend into the territorial sea. Federal regulations [36 C.F.R. Sec. 7.27] prohibit commercial fishing or the taking of fish for sale in the area of the monument. Sport fishing is permitted subject to certain area and gear restrictions.

Padre Island National Sea Shore and the **Gulf Islands National Sea Shore** have no special fishing regulations. State regulations apply within the boundaries.

5.2.12 Lacey Act Amendment of 1981 (Public Law 97-79)

This amendment strengthens and improves enforcement of federal fish and wildlife laws and provides federal assistance in enforcement of state laws. The act prohibits import, export, and interstate transport of illegally taken fish or wildlife.

5.2.13 Marine Mammal Protection Act of 1972 (16 U.S.C. 1361-1407)

The Marine Mammal Protection Act makes it unlawful to kill, capture, or harass any marine mammal or attempt to do so.

5.2.14 Federal Water Pollution Control Act

Among the provisions of the Federal Water Pollution Control Act are sections on the protection of estuaries, establishment of standards for marine sanitation, and prohibition of dumping hazardous substances into marine waters. All of the sections have the potential to affect, either directly or indirectly, Spanish mackerel resources by maintaining waters and environmental conditions favorable for survival.

5.2.15 Outer Continental Shelf Lands Act

The Outer Continental Shelf Lands Act requires that the character of fishing shall not be affected by the development of outer continental shelf resources. This clause serves to protect fishery resources.

5.3 State Laws, Regulations, and Policies

The Spanish mackerel fishery is regulated by all states bordering the Gulf of Mexico. Each state has jurisdiction extending three nautical miles from shore except for Texas and the Florida west coast, which have jurisdiction out to three marine leagues (9 nautical miles). The following is a description of the existing laws, regulations, and policies of each Gulf State as of FY 1988.

5.3.1 Texas

1. Licenses and Taxes

Texas has the following licensing requirements for catching, selling, or processing saltwater and freshwater fishes.

A.	Fishing Licenses (Sport or Commercial)	
1.	Combination Hunting and Sport Fishing	15.00
2.	Resident Sport Fishing	8.00
3.	Nonresident Sport Fishing	15.00
4.	Temporary Sport Fishing (14 day)	5.00
5.	Temporary Nonresident Sport Fishing (5 day)	8.00
6.	Saltwater Sport Fishing Stamp	5.00
7.	Resident General Commercial Fishing	15.00
8.	Nonresident General Commercial Fishing	100.00
9.	Resident Commercial Finfish Fishing	65.00
10.	Nonresident Commercial Finfish Fishing	125.00
11.	Fish Guide	50.00
B.	Boat Licenses	
1.	Resident Saltwater Commercial Fishing Boat	10.50
2.	Nonresident Saltwater Commercial Fishing Boat	60.00

C. Equipment Tags

1.	Seine or Net (for each 100 ft or part thereof) Commercial Only	2.00
2.	Saltwater Trotline (for each 300 ft or part thereof) Sport or Commercial	2.00

D. Business Licenses

1.	Wholesale Fish Dealer	400.00
2.	Wholesale Fish Dealer - Truck	250.00
3.	Retail Fish Dealer	30.00
4.	Retail Fish Dealer - Truck	50.00
5.	Finfish Import	50.00

No taxes are levied on fish landed in Texas.

Texas, through reciprocal license agreement with Louisiana, allows resident sport fishermen of either state who are properly licensed or exempt to fish common boundary waters between Louisiana and Texas. There is no statutory authority to enter into reciprocal management agreements.

2. Catch and Possession Limits

There is a three fish per person per trip limit on Spanish mackerel in Texas.

3. Size Limits

There is a minimum possession length of 14 inches total length on Spanish mackerel in Texas.

4. Gear Restrictions

Purse seines may not be used to take Spanish mackerel. Gill nets or trammel nets may not be used in or on the waters of the Gulf of Mexico within the jurisdiction of Texas.

5. Seasons and Quotas

There are no seasons or quotas for Spanish mackerel in Texas.

5.3.2 Louisiana

1. Licenses and Taxes

Louisiana has the following licensing requirements for catching, selling, or processing saltwater and freshwater fishes.

A. Fishing Licenses

1.	Recreational Universal Fishing License (Cane pole/ hook and line license)	2.50
	Resident Basic Fishing License	5.50
	Nonresident Basic Fishing License	15.50

Resident Saltwater Angler's License (Required in addition to basic license)	5.50
Nonresident Season Saltwater Angler's License (Required in addition to basic license)	22.50
Nonresident 7-day Trip Saltwater Angler's License (Required in addition to basic 7-day trip license)	15.50

Louisiana, through reciprocal license agreements with Texas and Mississippi, allows resident sport fishermen of either state who are properly licensed or exempt to fish common boundary waters among the states. The Louisiana Department of Wildlife and Fisheries (LDWF) has the authority to enter into reciprocal fishing license agreements with the authorities of any other state.

2. Commercial

Class	Commercial Fisherman's License	Fees
144011	Resident	55.00
144031	Nonresident	105.00
	Vessel License	
144018	Resident	15.00
144019	Nonresident	60.00
	Gear License	
144015	Resident Gill Net	25.00
144045	Nonresident Gill Net	100.00
144014	Resident Trammel Net	25.00
144017	Nonresident Trammel Net	100.00
144013	Resident Fish Seine	25.00
144034	Nonresident Fish Seine	100.00
144021	Resident Wholesale/Retail Dealer	105.00
144022	Nonresident Wholesale/Retail Dealer	405.00
144023	Resident Wholesale/Retail Dealer/ Restaurants and Retail Grocers only	30.00
144024	Transport	30.00

2. Catch and Possession Limits

There are no catch and possession limits on Spanish mackerel in Louisiana.

3. Size Limits

There is a 12 inch fork length, 14 inch total length limit on Spanish mackerel in Louisiana.

4. Gear Restrictions

The maximum length of all commercial nets is 1,200 feet. Fish seines, gill nets and the inner wall of trammel nets have a minimum mesh size of 3.5 inches stretched. The outer wall of trammel nets have a range of 6-24 inches stretched mesh. Purse seines are illegal for catching fish other than menhaden or herring-like species. Monofilament nets are legal only in outside waters and are regulated by permit.

5. Seasons and Quotas

There are no seasons or quotas for Spanish mackerel in Louisiana.

5.3.3 Mississippi

1. Licenses and Taxes

Mississippi has the following licensing requirements for catching, selling, or processing saltwater and freshwater fishes.

A.	Fishing Licenses	
1.	Resident Fishing	4.00
2.	Temporary (7-day) Nonresident Fishing	7.00
3.	Nonresident Fishing	20.00
4.	Temporary (3-day) Nonresident Fishing	4.00
B.	Boat Licenses	
1.	Gill and Trammel Nets (Resident)	100.00
2.	Gill and Trammel Nets (Nonresident)	300.00
3.	Charter Boat (Resident/Nonresident)	100.00
4.	Hook and Line (Commercial-Resident/Nonresident)	100.00
5.	Menhaden Boat/Net (Resident)	150.00
C.	Business Licenses	
1.	Interstate Commerce (Resident/Nonresident)	20.00
2.	Seafood Dealer (Resident/Nonresident)	100.00
3.	Seafood Processor (Resident/Nonresident)	200.00
4.	Menhaden Processor (Resident)	500.00

All commercial licenses must be purchased between January 1 and April 30 of each calendar year. A nonresident will be charged the same fee for a license as is required of a Mississippi resident as a nonresident in that state, only if the fee charged exceeds the nonresident fees herein listed.

2. Catch and Possession Limits

There are no catch and possession limits on Spanish mackerel in Mississippi.

3. Size Limits

There is a 14 inch fork length size limit on Spanish mackerel in Mississippi for purposes of sale only.

4. Gear Restrictions

All commercial nets must be less than 1,200 feet in length and have a minimum mesh size of three inches stretched. It is illegal to take Spanish mackerel with a purse seine in Mississippi.

5. Seasons and Quotas

There are no seasons or quotas for Spanish mackerel in Mississippi.

5.3.4 Alabama

1. Licenses and Taxes

Alabama has the following licensing requirements for catching, selling, or processing saltwater and freshwater fishes.

A.	Fishing Licenses	
1.	Recreational Fishing	N/C
2.	Gill, Trammel, and Seine Nets	
	Resident 0' - 1,200'	100.00
	Resident 1,201' - 2,400'	150.00
	Nonresident 0' - 1,200'	500.00
	Nonresident 1,201' - 2,400'	750.00
3.	Nonresident Commercial and Recreational - A nonresident will be charged the same fee for a commercial or recreational license as is required of an Alabama resident as a nonresident in that state.	
4.	Commercial Hook and Line	25.00
B.	Business Licenses	
1.	Seafood Dealer	125.00

2. Catch and Possession Limits

There is a bag limit of 10 fish per person per day on Spanish mackerel in Alabama.

3. Size Limits

There is a 12 inch FL and 14 inch TL size limit on Spanish mackerel in Alabama.

4. Gear Restrictions

All commercial nets must be less than 2,400 feet in length. In described inside waters there is a minimum mesh size of 2.75 inches stretched. In outside waters the minimum mesh size is 3.5 inches stretched. Purse seines are not allowed for the harvesting of commercial finfish except menhaden.

5. Seasons and Quotas

There are no seasons or quotas for Spanish mackerel in Alabama.

5.3.5 Florida

1. Licenses and Taxes

Florida requires the following licenses to fish.

A.	Freshwater	
1.	Recreational Fishing	6.00
2.	Nonresident Recreational Fishing	10.00
3.	Temporary Nonresident Recreational Fishing	
	14-day	7.00
	5-day	5.00
B.	Marine	
1.	No Marine Recreational Fishing License	
2.	Commercial Saltwater Products License	
	Resident Individual	25.00
	Resident Boat	50.00
	Nonresident Individual	100.00
	Nonresident Boat	200.00
	Alien Individual	150.00
	Alien Boat	300.00
3.	Wholesale License	
	Resident, Single County	300.00
	Resident, Statewide	450.00
	Nonresident, Single County	500.00
	Nonresident, Statewide	1,000.00
	Alien, Single County	1,000.00
	Alien, Statewide	1,500.00
4.	Retail License	
	Resident, Central Location	25.00
	Resident, Satellite Locations	10.00
	Nonresident, Central Location	200.00
	Nonresident, Satellite Location	25.00
	Alien, Central Location	250.00
	Alien, Satellite Location	50.00
5.	Special License	
	Purse Seine	25.00
	Restricted Species Endorsement	NC

The State of Florida's authorization to enter into reciprocal agreements relates only to fishery access and not to fishery management in general. No license is required for recreational saltwater fishing.

2. Catch and Possession Limits

In Florida there is a four fish per person per day recreational bag and possession limit.

3. Size Limits

Florida has adopted a minimum size of 12 inches fork length for Spanish mackerel.

4. Gear Restrictions

   A. Monofilament Gill Nets (minimum stretched mesh) 3 1/2 in

   B. Power-assisted gill netting is prohibited in Dade and Palm Beach Counties. No gill netting is allowed in Broward County.

   C. Net fishing for Spanish mackerel is prohibited in state waters on weekends.

   D. Purse seining for food fish is not allowed in Florida state waters.

5. Seasons and Quotas

   A. East Coast
      1. Power-assisted Gill Nets
         a. Season opens December 15 of each year
         b. Season closes October 31 of following year or when quota is reached
         c. Quota is 1,850,000 pounds
      2. All Other Forms of Commercial Fishing Gear
         a. Season opens November 1 of each year
         b. Season closes October 31 of following year or when quota is reached
         c. Quota is 205,000 pounds

   B. Southwest Coast
      1. Power-assisted Gill Nets
         a. Season opens July 1 of each year
         b. Season closes June 30 of following year or when quota is reached
         c. Quota is 1,780,000 pounds.
      2. All Other Forms of Commercial Gear
         a. Season opens July 1 of each year
         b. Season closes June 30 of following year or when quota is reached
         c. Quota is 310,000 pounds

   C. Northwest Coast
      1. Power-assisted Gill Nets
         a. Season opens July 1 of each year
         b. Season closes June 30 of following year or when quota is reached
         c. Quota is 392,000 pounds
      2. All Other Forms of Commercial Gear
         a. Season opens July 1 of each year
         b. Season closes June 30 of following year or when quota is reached
         c. Quota is 43,000 pounds.

6.0 DESCRIPTION OF FISHING ACTIVITIES AFFECTING SPANISH MACKEREL

6.1 History of Exploitation

Spanish mackerel has historically been important as a commercial species throughout the Gulf of Mexico. Landings data (L. Collins, pers. comm. 1987) indicate that since the early 1920s all five of the states bordering on the Gulf of Mexico reported commercial landings of Spanish mackerel. In Louisiana, since 1981, the run-around gill net accounted for 44% of the total catch; however, shrimp trawls incidentally caught 38% of the total catch. In Mississippi, since 1981, the two primary commercial fishing modes were the run-around gill net and the purse seine, which is no longer allowed for taking Spanish mackerel. They accounted for 57% and 40% of the total catch, respectively. Alabama, since 1981, reported three significant catch modes. They were the run-around gill net, the shrimp trawl, and the anchored gill net. Those modes accounted for 48%, 38%, and 18% of the total catch, respectively. Those fish caught in the shrimp trawls were taken incidentally. Texas, since 1981, has reported only insignificant commercial landings of Spanish mackerel, the total of which is attributable to incidental catch from the shrimping fleet (H. Osburn, pers. comm. 1987). Florida has long dominated the Gulf of Mexico in commercial landings of Spanish mackerel. Several modes of fishing have been employed in Florida, the most important of which has been the run-around gill net and the haul seine. Since 1981 they accounted for 81% and 10% of the total catch, respectively. Data for the above catches and modes for all states except Texas was provided by Ernest Snell (pers. comm. 1987), and can be found in tabular form in Table 6.11 on page 6-22.

Saltwater sport fishing has been a major recreational activity in the southeastern portion of the nation for many years. Much of the activity was shore-based or took place from boats relatively close to shore until the 1950s. As transportation systems improved and as leisure time increased with affluence, demand for recreational opportunities grew dramatically. With the growth in demand for leisure activity came improvements in recreational equipment. Sales of boats and motors that could be used for offshore fishing climbed, and fishing tackle became more elaborate.

Fishing by private boat for Spanish mackerel has taken place for many years; however, beginning in the late 1950s, small boats capable of catching this species became available to large numbers of people. Beginning in the late 1960s, specialized sportfishing boats in the 20-foot range were developed and became popular with recreational fishermen. These types of craft are capable of venturing into areas where Spanish mackerel can consistently be caught. These boats met a growing demand from recreationalists with growing incomes and increased leisure time and brought the opportunity to fish for Spanish mackerel to large numbers of people. Between 1967 and 1974 the number of private boats of 16-foot length and greater increased at an average annual rate of 10.3%.

6.1.1 Texas

The pattern of exploitation of Spanish mackerel off Texas has appeared to be an inverse of the pattern evidenced off Mexico. Since 1940, Mexican landings have increased from roughly 530 thousand pounds to an annual average of just under 12 million pounds (Quesada 1952). Conversely, Texas landings have declined significantly. Substantial populations of Spanish mackerel which once were an annual occurrence off Texas no longer occur, while a major Mexican fishery is currently extant.

In 1891 Spanish mackerel was one of the principal finfish species taken by commercial fishermen in Texas (Stevenson 1893). Stocks were described as "growing more abundant" with landings increasing from 11,000 lb/year in 1887 to 64,000 lb/year in 1902 (Figure 6.1). Over the next 32 years (1903-1934) reported commercial landings averaged 83,000 lb/year with a range from 41,000 to 174,000 lb/year. Spanish mackerel was described by Higgens and Lord (1926) as a "chief commercial species" which was "one of the most popular fishes with the trade" and which commanded the highest average price per pound. Conservation of the species was not considered a concern since "hundreds of pounds often are caught by a single fisherman [trolling] in one day."

From 1935 to 1951 the average annual commercial landings declined to 14,000 lb. After 1951 commercial landings never exceeded 3,000 lb/year with an annual average of only 500 lb. A limited study in 1978 by the Texas Parks and Wildlife Department using gear and techniques similar to the Florida commercial fishermen (purse seines, gill nets, spotter planes) found Spanish mackerel were not abundant enough to support a commercial fishery off Texas (Rice 1979).

Legal restrictions would not seem to explain the decline in Spanish mackerel commercial landings since the law prohibiting netting in or near bay-to-gulf passes was enacted in 1910 (Texas Game, Fish and Oyster Commission 1912) and the regulation prohibiting gill and trammel nets in gulf waters was not enacted until 1980 (Texas Parks and Wildlife Department 1980). Indeed, nets themselves appear to never have been a dominant gear for capturing Spanish mackerel off Texas. Commercial gear data from the U.S. Bureau of Fisheries documents that 72% of the Spanish mackerel landed in Texas from 1928-1934 (average of 63,500 lb/year) were caught using hand or trolling lines. The largest landings of Spanish mackerel in the last 20 years (3,000 lb in 1968) were caught solely on hand lines.

Recreational landings of Spanish mackerel off Texas are historically less well documented than commercial landings but still indicate a severe decline in abundance. In 1930 the Texas Game, Fish and Oyster Commission described Spanish mackerel as a "welcome migrant" to Texas waters for sport fishermen. It was not unusual for each coastal visitor "to bring back several hundred pounds." In 1935 they described Spanish mackerel as being "caught in the surf extensively." Springer and Pirson (1958) documented the landings of sport fish from the jetties, gulf piers and charter boats at Port Aransas, Texas from 1952 to 1956. Spanish mackerel were the most abundant fish landed in all years with an average of over 25,000 fish/year from this one locale. However, a survey of jetty and gulf pier fishermen coastwide in 1978-79 indicated that Spanish mackerel was only a minor component of the fishery (McEachron 1980). A comprehensive survey of Texas saltwater private and charter boat fishermen from 1983 to 1986 estimated average annual landings of only 5,400 Spanish mackerel despite an average of 6.3 million fishing trip man-hours/year (Osburn and Ferguson 1987).

6.1.2 Louisiana

Louisiana's traditional Spanish mackerel fishery is considered small when compared to other states bordering the Gulf of Mexico. Both commercial landings and estimated recreational catch have fluctuated considerably over the years for which data are available. Recreational catch since 1979 has exceeded commercial landings with the exception of 1981 in which 93% of the total harvest was made of commercially harvested fish.

For the most part, the commercial fishery for Spanish mackerel was and remains an indirect fishery composed of shrimp trawl by-catch and the incidental catch by various other gear types in the fishermen's attempts to harvest spotted seatrout. A limited harvest has also been experienced as a result of the establishment of a hook-and-line king mackerel fishery in 1982. Those fish landed are generally sold as bait at a price of $0.10 - $0.40 per pound. Many are never landed but rather cut up at sea as bait in the snapper or grouper fishery.

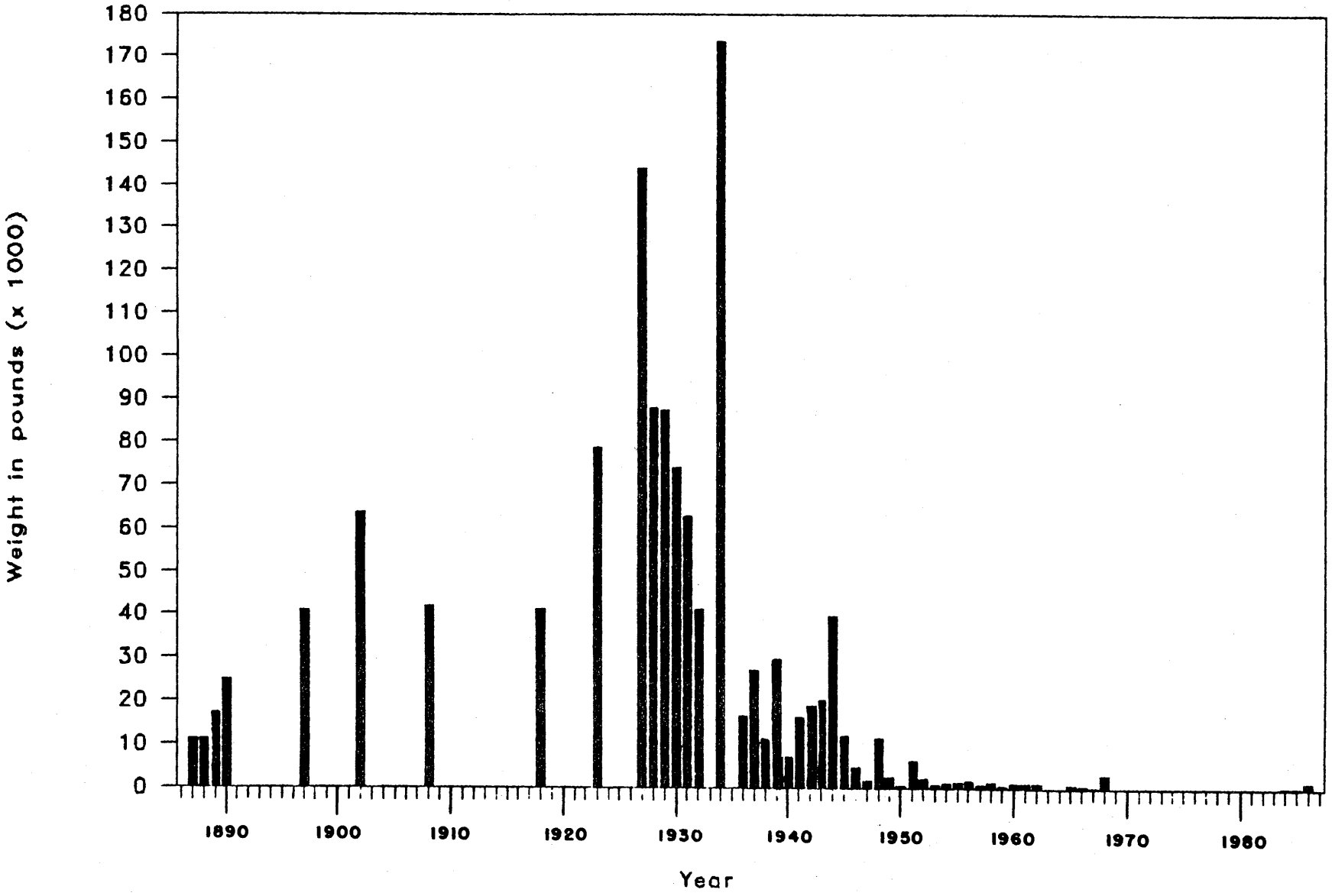


Figure 6.1. Reported commercial landings of Spanish mackerel from Texas marine waters (1887-1986). Data from the U.S. Bureau of Fisheries and the Texas Parks and Wildlife Department.

Harvest of Spanish mackerel increased from 1972 to a peak in 1975 then declined to below mean harvest levels in 1978. The flurry in the fishery in the mid 1970s was a result of the introduction of monofilament gill netting to Louisiana waters by fishermen from other gulf coast states in search of spotted seatrout. As gear restrictions were implemented, such as the prohibition of monofilament, Spanish mackerel landings declined.

Few recreational fishermen actually target Spanish mackerel in a day's fishing as is evidenced by a 1984 creel survey conducted by the Louisiana Department of Wildlife and Fisheries which showed that less than 0.1% of the individuals surveyed indicated a preference for Spanish mackerel. Only 0.2% of the recreational catch was composed of Spanish mackerel and 93.5% of those fish were retained.

6.1.3 Mississippi

Commercial fishing for Spanish mackerel in Mississippi has fluctuated since its apparent inception in 1937 from no catches in the mid 1950s to a high in 1972 of 485 thousand pounds (Tables 6.1 and 6.2). The catches before 1960 were probably incidental to other directed fisheries. Primary gear types used prior to 1960 were trammel nets, hook and line, and trawls. The introduction of the runaround gill net in 1960 greatly enhanced the fishermen's ability to catch Spanish mackerel and aided the formation of a small, sporadic, directed fishery. The value of this fishery has always been quite small, and as late as 1984, ex-vessel prices were as low as $0.20 per pound.

Table 6.1. Commercial Spanish mackerel landings and value for Mississippi from 1933 to 1969 (1,000 pounds and 1,000 dollars).[1]

Year	Volume	Value	Year	Volume	Value
1933	0	0	1951	0.3	0.3
1934	0	0	1952	0.1	0
1935	0	0	1953	0	0
1936	0	0	1954	0	0
1937	0.7	0.1	1955	0	0
1938	2.0	0.2	1956	0	0
1939	0.8	0.1	1957	0	0
1940	3.3	0.2	1958	3.5	0.3
1941	NA	NA	1959	1.9	0.2
1942	NA	NA	1960	8.8	1.0
1943	NA	NA	1961	9.4	1.0
1944	NA	NA	1962	2.5	0.3
1945	7.2	1.5	1963	1.5	0.2
1946	NA	NA	1964	0.7	0.1
1947	NA	NA	1965	3.2	0.3
1948	0.2	0	1966	5.0	0.5
1949	1.2	0.1	1967	75.6	6.9
1950	0.5	0.1	1968	114.2	11.2
			1969	12.0	1.2

[1]Data taken from Fishery Statistics of the United States, 1933-1969. Bureau of Fisheries, Fish and Wildlife Service, Bureau of Commercial Fisheries, and National Marine Fisheries Service.

Table 6.2. Commercial landings by state of Spanish mackerel in the Gulf of Mexico from 1970 through 1986 (1,000 pounds and 1,000 dollars).

Year	Texas	Louisiana	Mississippi	Alabama	W Florida	Total Gulf	$ K Value
1970	0	29	43	126	8,100	8,298	972
1971	-	40	179	56	7,383	7,658	858
1972	-	114	485	91	6,532	7,222	893
1973	-	89	98	76	6,194	6,457	1,027
1974	-	192	41	54	8,268	8,554	1,480
1975	-	200	224	92	5,621	6,137	1,041
1976	-	135	379	45	7,783	8,342	1,467
1977	-	81	146	11	2,393	2,631	499
1978	-	19	58	28	1,601	1,706	356
1979	-	33	30	113	1,946	2,122	537
1980	-	55	76	51	1,170	1,352	521
1981	-	68	34	57	3,550	3,709	1,173
1982	-	15	103	51	3,287	3,456	1,101
1983	-	74	46	58	2,087	2,265	711
1984	0.1	17	3	9	3,476	3,505	1,036
1985	1.3	32	19	57	2,915	3,024	1,007
1986+	0.3	22	42	97	1,228	1,389	458

+Quotas were placed on the Florida fishery starting October 1, 1986.

Spanish mackerel occupy a very large part of the recreational fishery off Mississippi. Catches approached 991,000 fish in 1983 (Table 6.3). The recreational fishery typically begins in April and in some years extends into November. Most catches are made by trolling small spoons from private pleasure craft, concentrated around the offshore barrier islands and near EEZ waters. The species is also highly sought by the charter boat industry.

6.1.4 Alabama

Table 6.4 shows the commercial catch of Spanish mackerel from 1945-1986. During the 5-year period from 1948 to 1952 the average annual catch was around 300,000 lb with an average price/pound of $0.11. Since 1952 (1953-1986), the average annual commercial catch was 52,900 lb with an average price/pound of $0.16.

Table 6.5 shows the distribution of commercial catches of Spanish mackerel by gear type (Swingle 1976). In 1964, the dominant gear type used to take Spanish mackerel was the haul seine. Although Swingle's data do not precede the 1964 time frame, personal discussions with "old time" commercial fishermen in the Gulf Shores area indicate that the majority of Spanish mackerel harvested prior to 1964 was by haul seine (W. Tatum, pers. comm. 1988).

Swingle (1976) demonstrated a growing trend from 1966-1971 on the use of gill nets with haul seines virtually disappearing from the fishery. A significant amount of the commercial harvest reported by Swingle was from shrimp trawls, likely associated with by-catch while fishing for

Table 6.3. Total recreational catch of Spanish mackerel (1,000 fish) by state in the Gulf of Mexico, 1979-1986. (U.S. National Marine Fisheries Service, Current Fishery Statistics 1984-1987.) Numbers in parentheses following catch are standard error (CE) and coefficient of variation (CV)[1], respectively.[2]

Year	Florida (W)	Alabama	Mississippi	Louisiana	Texas
1979	832(361;43)	1,073(222;21)	78(23;29)	171(40;23)	230(51;22)
1980	682(123;18)	584(110;19)	240(62;26)	411(54;13)	360(90;25)
1981[3]	887(214;24)	211(90;43)	927(612;66)	5(2;40)	205(120;59)
1982	686(261;30)	936(311;33)	770(223;29)	70(25;36)	56(24;43)
1983	1,100(460;42)	662(252;38)	991(523;53)	81(31;38)	9(4;44)
1984	221(65;29)	256(86;34)	481(225;47)	7(4;57)	7(3;43)
1985	651(144;22)	141(39;28)	471(185;39)	157(61;39)	32(20;63)
1986	7,816(1213;16)	239(59;25)	160(102;64)	10(6;60)	4[4]
$\bar{X}$	1,609.4	512.8	514.8	114.0	112.9

[1] Data provided by Ron Essig, National Marine Fisheries Service, Washington, DC.
[2] 1982-1985 do not include Texas boat mode data.
[3] Only includes data from March 1981-December 1981.
[4] Data provided by Texas Parks and Wildlife Department.

Table 6.4. Historical Spanish mackerel landings (1,000 pounds) from Alabama ports. Value of landings (1,000 dollars) and price per pound (dollars) from 1945-1986.

Year	Pounds	Value	Price per lb	Year	Pounds	Value	Price per lb
1945	70	13.9	.20	1966	65	6	.09
1946	-	-	-	1967	25.2	2	.08
1947	-	-	-	1968	38.7	3	.08
1948	888	71	.08	1969	85.2	6	.07
1949	423	42	.10	1970	125.9	26	.21
1950	273	33	.12	1971	55.8	5	.09
1951	240	26	.11	1972	90.8	9	.10
1952	151	23	.15	1973	75.9	6	.08
1953	74	11	.15	1974	54	6	.11
1954	37	5	.15	1975	92	11	.12
1955	50	8	.16	1976	45	5	.11
1956	40	6	.15	1977	11	1	.09
1957	38	5	.13	1978	27.8	4	.15
1958	34	5	.15	1979	112.5	25	.22
1959	18	3	.17	1980	50.3	6.7	.13
1960	22	3	.14	1981	57	13.8	.24
1961	15	2	.13	1982	50.5	12.9	.26
1962	38	4	.11	1983	58.3	14.5	.25
1963	39	4	.10	1984	10	3	.30
1964	74	8	.11	1985	56.8	16.8	.30
1965	14.3	2	.14	1986	95	28.2	.30

Table 6.5. Pounds of Spanish mackerel landed in Alabama by each type of gear during the period 1964-1971 (Fisheries Statistics of the United States).

Year	Trawl	Gill net	Trammel net	Haul seine	Hook & line	Total
1964	200	11,300	900	60,900	800	74,100
1965	2,500	2,600	800	6,900	1,500	14,300
1966	2,300	50,900	600	-	200	54,000
1967	11,200	7,100	3,200	3,600	100	25,200
1968	14,000	19,200	5,400	-	100	38,700
1969	29,500	54,600	1,000	-	100	85,200
1970	25,100	34,800	1,200	-	64,800	125,900
1971	28,600	25,200	1,500	-	500	55,800

white shrimp in the nearshore waters. Very little by-catch of Spanish mackerel from shrimp trawlers enters the current Spanish mackerel commercial fishery, the majority of the catch coming from run-around gill nets.

6.1.5 Florida

The following discussion is excerpted from Williams et al. (1985):

> The commercial fishery for Spanish mackerel dates back to at least the middle of the last century. At that time it was centered on the upper east coast and mid-Atlantic areas, and the Florida contribution was quite low. The fishery at that time was described by Trent and Anthony (1979):
>
> 'The commercial fishery for Spanish mackerel in the United States began before 1850 along the Long Island and New Jersey coasts and was well established in the mid-Atlantic and Chesapeake Bay areas by the late 1870s (Earll 1883). Catch statistics for this fishery in 1880 showed that the Chesapeake Bay area produced about 86% of the total catch of about 1.9 million pounds. In 1880, less than 2% of this catch was recorded from the south Atlantic and Gulf of Mexico.
>
> The areas of major production changed during the 1880s, and by 1897 about 64% of the Spanish mackerel produced by commercial fishermen in the United States was landed in the south Atlantic and Gulf States. This trend in greater proportionate landings of Spanish mackerel in the south continued, and in 1945 over 97% of the total production on the Atlantic coast occurred in the south Atlantic and Gulf areas.'

The southward movement of the Spanish mackerel fishery has continued so that presently most U.S. commercial Spanish mackerel landings occur in Florida. Trent and Anthony (1979) reported that during 1950-1976 over 92% of the U.S. production came from Florida. That appears to have increased to about 97% in recent years (Eldridge and Powers 1984). Most production is by gill nets (Trent and Anthony 1979).

During 1950-1959, the east and west coast of Florida produced approximately equal landings of Spanish mackerel averaging 3.6 million pounds and 3.5 million pounds, respectively (Table 4). However, during the 1960s west coast landings began a gradual increase so that by the end of the decade production was exceeding 8 million pounds per year. For unknown reasons the east coast production was about 1,000,000 pounds/year lower in the 1960s than the 1950s. During the 1950s, west coast commercial production averaged 5.9 million pounds, which was over twice the east coast average of 2.6 million pounds. The trend continued through the first half of the 1970s, so that from 1970 to 1974 west coast annual production was 7.3 million pounds, while the east coast averaged 3 million pounds. But during 1975 to 1977 a rapid change occurred on each coast. The change began in 1975 when east coast production increased to over 5 million pounds and then to over 9 million pounds in 1976 and 1977. West coast production held steady until 1977 when it dropped to only 2.4 million pounds. From 1975, when east coast production began its rapid increase, through 1983 the Florida east coast has averaged 6.4 million pounds per year. Since 1977, when the west coast began its decline, through 1984 the Florida west coast has averaged only 2.5 million pounds. Thus, during recent years, the Florida east coast production has been 2 1/2 times greater than west coast production, a reversal of the situation during the 1960s and early 1970s, when west coast production exceeded that of the east coast by a factor of 2.3.

The cause for the reversal is not known, although at least some, and perhaps, all of the increase in east coast production is due to increased effort. Effort figures for each coast are not available, but trends in estimates of the number of boats in the Spanish mackerel fishery can be inferred for most years since 1969, and more precise estimates are available for 1977, 1980, and 1982-83. The Spanish mackerel fleet consists almost entirely of gill net boats, which are generally reported as either small boats (20-22 feet) or large boats (30-60 feet) (Austin et al. 1977; Cato et al. 1978). The small boat fleet has traditionally operated along the southeast coast from Sebastian to Salerno, while the large boat fleet traditionally operated around Naples, the Florida Keys, and the southeast coast from Palm Beach to Cape Canaveral (Anonymous 1982: p. 8-4). The large scale net fleet rapidly expanded during the past decade, while the small boat fleet has apparently declined somewhat statewide.

Table 6.6. (Table 4 from Williams et al. 1985) Annual commercial landings of Spanish mackerel on east and west coasts of Florida in thousands of pounds. (Landings for 1950-1982 from Eldridge and Powers 1984. Landings for 1983, 1984, and 1985 from Ernest Snell, NMFS, Miami).

Year	East coast Florida	West coast Florida
1950	3,577	2,313
1951	1,977	6,267
1952	3,435	4,361
1953	3,580	2,939
1954	2,101	2,848
1955	3,238	1,576
1956	4,578	2,887
1957	4,221	3,610
1958	7,308	3,830
1959	2,352	4,670
1960	2,282	5,435
1961	3,158	3,988
1962	2,578	6,869
1963	2,123	5,405
1964	2,002	3,880
1965	2,901	4,883
1966	2,181	7,004
1967	1,802	5,867
1968	4,406	7,066
1969	2,359	8,175
1970	3,574	8,100
1971	2,582	7,383
1972	3,369	6,532
1973	3,203	6,194
1974	2,346	8,267
1975	5,145	5,621
1976	9,589	7,783
1977	10,987	2,393
1978	3,424	1,478
1979	4,886	1,946
1980	9,811	1,770
1981	4,174	3,550
1982	3,759	3,287
1983	5,947	2,087
1984	2,397	3,476
1985	3,245	2,915

6.1.6 Mexico

The fishery for Spanish mackerel has grown substantially since the early 1900s. In 1940, landings were 529,000 pounds. That amount increased to 1.6 million pounds in 1945, and then to slightly over 3 million pounds in 1949, representing roughly a six-fold increase in landings in 10 years (Quesada 1952). The National Marine Fisheries Service (L. Collins, pers. comm. 1987) and Mote Marine Laboratory (Burns and Fortune 1987) reported average annual Spanish mackerel landings of 11.7 million pounds from 1968 to 1985. This extensive fishery is centered primarily off the state of Veracruz (Figure 6.2) representing more than 61% of the reported landings (Table 6.7).

Four types of gear are used in the Mexican fishery (K. Burns, pers. comm. 1988). They are commercial hook and line, a fish-trap called an almadraba, the beach seine, and the gill net. Figures 6.3 and 6.4 provide length-frequency data from gill net caught Spanish mackerel from Veracruz and Campeche, Mexico (Burns and Fortune 1987 and 1988). Those data indicate that 68% of those fish ranged between 14 inches and 17 inches (fork length).

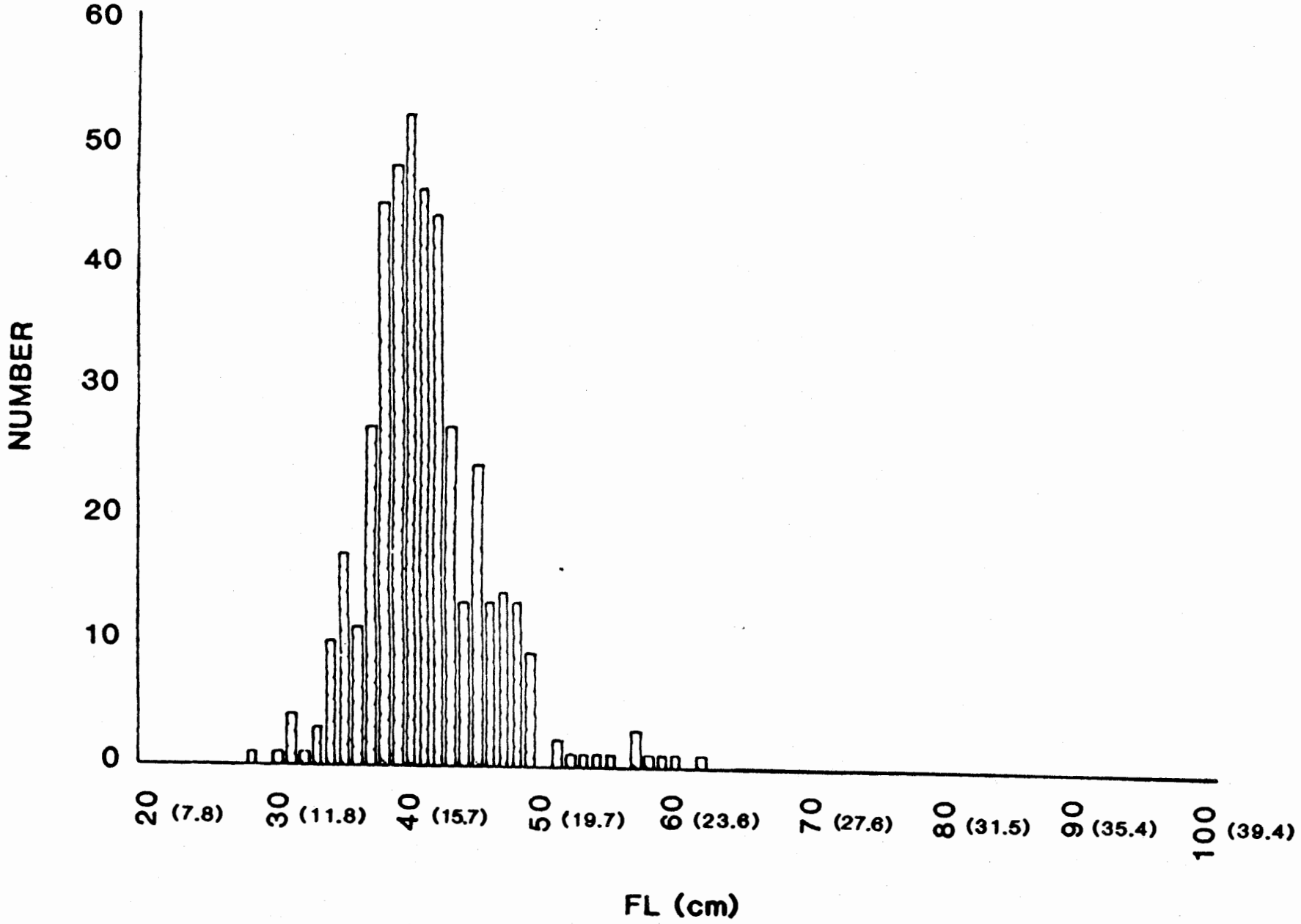
Table 6.7. Commercial landings of Spanish mackerel (1,000 pounds) by state in Mexico, 1968-1986. (This table was taken from a draft manuscript by Naughton, Collins, Barger and Trent; original data sources are Bane and Bane 1984, and Mote Marine Laboratory 1986 and 1987 Final Report to NMFS).

Year	Tamaulipas	Veracruz	Tabasco	Campeche	Yucatan	Quintana Roo	Total
1968	6	11,012	40	1,236	282	-	12,577
1969	3	10,102	85	1,192	127	*	11,510
1970	5	9,120	42	1,232	167	-	10,566
1971	*	5,876	55	945	413	4	7,292
1972	11	9,403	116	1,263	851	178	11,762
1973	9	10,763	85	2,076	1,494	27	14,454
1974	39	9,119	201	1,715	393	51	11,517
1975	11	7,536	354	2,231	282	8	10,422
1976	3	4,315	240	2,448	365	25	7,395
1977	12	4,887	547	3,810	360	20	9,637
1978	65	4,062	600	5,908	628	64	11,327
1979	77	4,835	1,002	6,515	166	83	12,679
1980	133	4,305	942	5,319	331	67	11,097
1981	348	7,745	999	3,340	425	168	13,025
1982	747	10,828	1,407	3,379	524	317	17,203
1983	476	6,086	885	4,804	370	192	12,813
1984	882	4,331	1,721	5,409	167	223	12,733
1985	842	4,604	2,115	4,731	90	365	12,748
1986[1]	961	6,834	3,332	4,501	272	47	15,948
1987[1]	1,820	3,434	2,102	3,698	239	13	11,306

[1]Data provided by E. Nakamura, National Marine Fisheries Service, Panama City, FL.

*Less than 500 pounds.

Figure 6.2. Mexican States which border on the Gulf of Mexico (from Burns and Fortune 1987).


NUMBER
60
50
40
30
20
10
0
20 (7.8)
30 (11.8)
40 (15.7)
50 (19.7)
60 (23.6)
70 (27.6)
80 (31.5)
90 (35.4)
100 (39.4)
FL (cm)

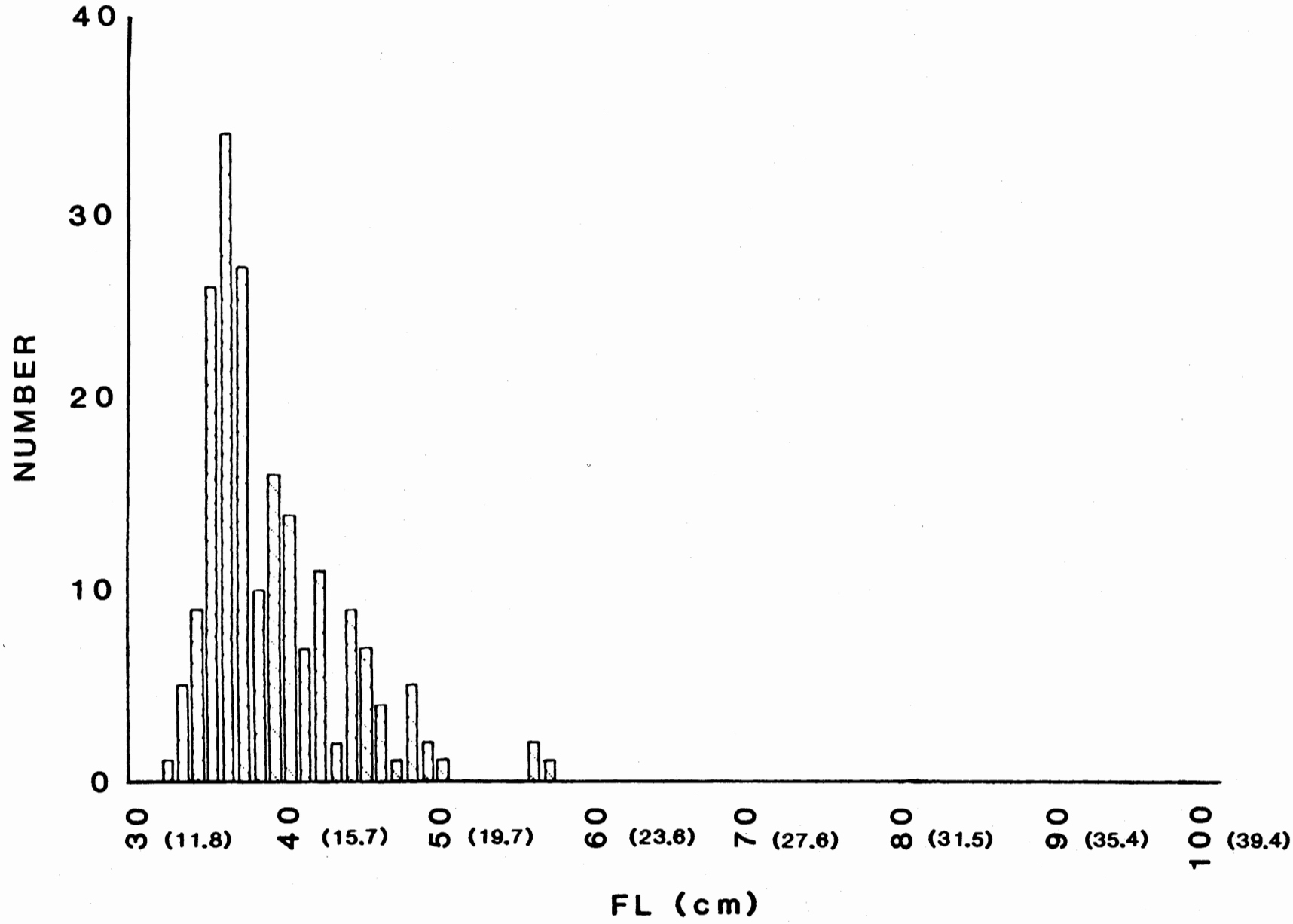


Figure 6.4. Length-frequency of Spanish mackerel caught by gill net off Veracruz during March through May, 1986 (Nos. in parentheses are inches) (from Burns and Fortune 1987).

The following description of the king and Spanish mackerel fishery in Mexico is provided by the Mote Marine Laboratory (K. Burns, pers. comm. 1988). For location of all Mexican states referenced, see Figure 6.2).

> King and Spanish mackerel are fished in all six Mexican states which border the Gulf of Mexico. The abundance of Spanish mackerel cannot always be judged by the landings. For example, in the state of Quintana Roo, the only area where king and Spanish mackerel support an active fishery is around the island of Holbox. Mackerel are also abundant off the island of Contoy, but fishermen do not live on the island as it is reserved as a laboratory field station and bird preserve. Many Cuban boats fish this area. Off the Caribbean coast, lobsters are the big catch and are worth far more than any fish, so the commercial fishermen only turn to other species during the closed season.
>
> The king and Spanish mackerel fishery is more important in the state of Yucatan. The most important landing areas for mackerel in Yucatan include Celestun, Sisal, Progreso, Rio Lagartos and el Cuyo. There are also fishing cooperatives for mackerel in Chuburna, Telchac, Dzilam de Bravo and San Felipe.
>
> Spanish mackerel have a lower market value than king mackerel, so most fishermen prefer to catch kings. Off Yucatan mackerel are primarily caught by gill net with some hook and line harvest. Best fishing using gill nets occurs during the new moon when it is very dark.
>
> Off Yucatan, many fishermen prefer to fish for shark rather than mackerel. Sharks bring better prices in the market. Also off Yucatan, because of the wide platform, it takes 2.5 hours to get to the good king mackerel fishing grounds and 2 hours to get to the reefs where Spanish mackerel are abundant.
>
> Of all the Mexican states bordering the Gulf of Mexico, Campeche is the place for Spanish mackerel. In fact, in Campeche, Spanish mackerel (sierra) are far more important than king mackerel (carito). Important ports for Spanish mackerel in Campeche include, Campeche, Seybaplaya, Champoton, Sabancy and Ciudad del Carmen.
>
> Results from a study conducted by Dr. Kimberly Smith of the CRIP - Cuidad del Carmen have shown that Spanish mackerel (sierra) ranks as the eighth most abundant species found in the Cuidad del Carmen market place. It is interesting to note that as you travel down the state of Campeche from Campeche to Ciudad del Carmen, catches of king mackerel become rarer and in Ciudad del Carmen, carito are not considered an important species.
>
> The Spanish mackerel fishery is also important in the state of Tabasco, and many Spanish mackerel from Tabasco find their way to the Ciudad del Carmen market.
>
> In the state of Veracruz, both king (peto) and Spanish mackerel are abundant. The Continental Shelf is narrow and the

currents swift and close to shore. Fishing here is done by hook and line, gill net, beach seine, and almadraba. Important fishing areas in Veracruz include Barrancas, Anton Lizardo, Mocombo, Chachalacas, and Alvarado.

In the state of Tamaulipas (see map), an almadraba is currently being deployed off La Pesca which may then prove to be an important site for king and Spanish mackerel capture.

As I mentioned previously, of all the Mexican states, the area where sierra are most abundant and important is the state of Campeche. They are not the most important fishery in the state. Shrimp is the most important species in Campeche. In Quintana Roo, the lobster fishery is the most important fishery. In Yucatan, red grouper (mero), and red snapper (huachinango), are the most important fisheries. One interesting fact is that most of the king and Spanish mackerel from Yucatan is exported to the U.S.

The decline of the Spanish mackerel fishery off the Texas coast (see 6.1.1) and the increase in the Mexican Spanish mackerel fishery described above may represent cause and effect if the fish off Texas are principally migrants from Mexican waters. The Texas Game, Fish, and Oyster Commission (1930) reported that Spanish mackerel "travel up the coast from southern waters in the early summer." Sutherland and Fable (1980) and Burns and Fortune (1988) suggest migration of Spanish mackerel between Texas and Mexico based on two recaptures from Veracruz, Mexico of fish tagged off Texas. Currently, the Mote Marine Laboratory is continuing their investigations into the Mexican Spanish mackerel fishery. Greater research efforts will be required to explore fully the stock situation of this fish in the Gulf of Mexico, an effort that will rely on continued cooperation with the Mexican government.

6.2 Domestic Commercial and Recreational Fishing Activities

6.2.1 Participating User Groups

Spanish mackerel is a major target species of an important commercial fishery in south Florida as well as a major target species for private and charter boat recreational fishing along widespread areas in the Gulf of Mexico. Small amounts, though increasing in past years, of Spanish mackerel are caught as an incidental catch or supplemental commercial target species off Alabama, Mississippi, and Louisiana, and Texas. According to Poffenberger (1987), those four states have reported average combined annual landings of 138,000 pounds per year.

Recreational users have increased in numbers over time. Many come from outside the gulf area; however, most are residents of states bordering the Gulf of Mexico. Increased income, leisure time, and a wide variety of supplies have served to increase participation. The following sections are in no way intended as a comparison of the commercial and recreational users of the Spanish mackerel resources, but rather represent the most recent information available for both groups.

6.2.1.1 Primary Commercial User Groups

The primary commercial user groups for Spanish mackerel include:

1. the Florida small boat (20-35 ft) gill-net fleet
2. the Florida large boat (greater than 36 ft) gill-net fleet.

Some secondary commercial use includes the Florida haul seine fleet.

Small Boat Spanish Mackerel Gill-net Fleet

The Florida small boat Spanish mackerel gill-net fleet has traditionally operated along t east coast from about Port Salerno (Martin County) to about Sebastian (Indian River County There are other small boat gill-net fishermen scattered along the Florida panhandle and the we coast though no data currently exists to describe that fleet.

Typically, the small boat gill-net fleet was comprised of boats 20-35 feet in length, and a of 1978 obtained roughly 40% of their value of landings from Spanish mackerel (Cato et al. 1978) although that percentage has decreased significantly in the 1980s (R. Williams, pers. comm 1987). In addition to Spanish mackerel, these boats also harvest king mackerel, bluefish pompano, and mullet.

Large Boat Spanish Mackerel Gill-net Fleet

The Florida large boat Spanish mackerel gill-net fleet traditionally operated in three mai areas of Florida: the Naples area on the west coast, the Florida Keys, and on the east coas between Palm Beach and Cape Canaveral. By the late 1970s production in the Naples area ha declined and as of 1987 is nearly inactive. The large vessels are typically greater than 35 fee and are equipped with power rollers; however, power-assisted equipment can no longer be used of Palm Beach and Dade counties.

As of the late 1970s about 80% of their value of landings came from Spanish mackerel (Anonymous 1982); however, that percentage has probably decreased in the 1980s (R. Williams, pers. comm. 1987). This fleet also harvests bluefish, king mackerel, and spiny lobster (only in the Keys).

6.2.1.2 Recreational User Groups

Estimated Number of Anglers

Table 6.8 provides estimates for the number of recreational anglers and the number of fishing trips in the Gulf of Mexico from 1980 through 1985. Since recreational fishing efforts are frequently opportunistic, it is impossible to estimate the number of participants and fishing trips related solely to Spanish mackerel; consequently, total participants and total trips are reported herein.

In 1980 an estimated 4.0 million anglers fished in the Gulf of Mexico. Estimates for 1982, 1983, and 1984 (estimates for 1981 are for March through December only) were below the 1980 figure; however, the 1985 estimate was just under the figure at 3.9 million anglers. Estimated number of fishing trips followed the same pattern as estimated number of anglers. A high in 1980 of 24.5 million trips was reported with decreases in 1982, 1983, and 1984 (estimates for 1981 are for March through December only) and an increase in 1985 to 24.2 million trips (Poffenberger 1987).

Type of Fishing

Table 6.9 provides the estimated number of Spanish mackerel caught by different modes of fishing from 1979 through 1985. Poffenberger (1987), summarizing data from the U.S. National Marine Fisheries Service, Current Fishery Statistics, stated that for 1980, 1982, and 1985, more Spanish mackerel were caught from private or rental boats than from man-made structures or charter and party boats. Charter and party boat catches dominated in 1981 (data from March through December only) and 1984, and in 1983 man-made mode dominated.

Table 6.8. Estimated number (1,000) of participants, fishing trips and participants who sought Spanish mackerel in the recreational fishery in the Gulf of Mexico, 1979-1987. (From U.S. National Marine Fisheries Service, Current Fishery Statistics, 1984-1987.)

Year	Number of anglers	Number of fishing trips	Number of anglers who primarily sought Spanish mackerel
1979	3,460	21,273	88
1980	4,035	24,471	72
1981[1]	2,212	19,089	68
1982[2]	2,404	20,520	69
1983[2]	2,838	20,500	41
1984[2]	2,272	16,397	42
1985	3,959	24,227	57
1986[3]	2,208	17,897	70
1987[3,4]	2,301	18,486	93

[1]Only includes data from March 1981-December 1981.
[2]Excludes data from Texas boat modes.
[3]Excludes Texas landings and party boat landings; also, man-made and beach-bank modes were combined into the "shore" mode.
[4]Preliminary data.

Table 6.9. Estimated number (1,000) of Spanish mackerel caught by recreational fishermen by mode of fishing in the Gulf of Mexico, 1979-1987. (From U.S. National Marine Fisheries Service, Current Fishery Statistics, 1984-1987.)

Year	Man-made structures	Party/charter boats	Private/rental boats	All modes
1979	153	191	2,029	2,384
1980	324	63	1,886	2,278
1981[1]	396	1,188	651	2,236
1982[2]	651	779	1,243	2,700
1983[2]	1,013	917	900	2,843
1984[2]	163	580	227	972
1985	304	492	656	1,452
1986[3]	4,405	264	3,604	7,914
1987[3,4]	806	122	1,217	2,145

[1]Only includes data from March 1981-December 1981.
[2]Excludes data from Texas boat modes.
[3]Excludes Texas landings and party boat landings; also, man-made and beach-bank modes were combined into the "shore" mode.
[4]Preliminary data.

Commercial Charter Fishing Boat Fleet

According to Palko et al. (1987), 25% of Spanish mackerel caught in the Gulf of Mexico from 1980 through 1985 were caught by party or charter boats. The greatest landings by charter boats occurred in west Florida, Alabama, and Mississippi, accounting for 62% of the landings from the south Atlantic and gulf.

Private Boats

A wide range of types of private boats are used by recreational fishermen to pursue Spanish mackerel, ranging from open outboards 16 feet in length to sportfishing boats of 60 feet or more. Typically, however, fishing for Spanish mackerel tends to be from boats of 18 to 20 feet or larger because the boats must be capable of venturing into near offshore waters.

According to recreational boating registration in the five Gulf States, boats from 16 to 65 feet in length increased from just under 1.4 million in 1976 to just over 1.7 million in 1985, an increase of 24%. Those same data for boats in the 16 to 26 foot range indicate an increase of 44%, with 454 thousand in 1976 to 652 thousand in 1985 (Table 6.10). This significant growth in the number of recreational boats (16-26 feet) has made it possible for a much larger number of recreational fishermen to fish in areas where Spanish mackerel occur, and has doubtless been a factor in increasing recreational fishing pressure on stocks in the Gulf of Mexico.

Table 6.10. Total number of registered recreational boats by state from 1976 through 1985 for the five Gulf States (Anonymous 1980 and 1985b).

Year	Texas	Louisiana	Mississippi	Alabama	Florida*	Total
			16 - 65 feet			
1976	482,992	224,783	84,965	161,200	430,061	1,384,001
1977	502,631	248,576	70,185	170,360	440,575	1,432,327
1978	532,673	255,283	93,990	172,868	452,754	1,507,568
1979	533,103	247,504	108,501	174,949	474,022	1,538,079
1980	532,642	254,951	100,959	216,791	490,598	1,895,941
1981	550,655	269,573	115,578	220,851	505,051	1,661,708
1982	562,861	298,333	-	-	461,981	Incomplete
1983	572,383	270,777	121,401	221,154	486,438	1,672,153
1984	573,396	281,348	120,343	221,396	473,927	1,670,410
1985	572,673	287,019	129,110	224,854	508,892	1,722,848
			16 - 26 feet			
1976	167,682	64,104	19,920	37,400	165,061	454,167
1977	179,877	70,507	16,912	41,766	171,370	480,432
1978	199,466	73,775	23,412	44,928	179,940	521,521
1979	207,595	74,803	27,439	47,042	188,849	545,728
1980	214,044	76,922	25,377	56,212	193,610	566,168
1981	222,835	81,418	29,114	57,387	199,190	589,944
1982	233,625	92,047	-	-	184,756	Incomplete
1983	241,340	86,161	30,788	57,457	197,102	612,848
1984	249,747	91,323	30,793	59,626	183,226	614,715
1985	255,296	96,415	32,562	61,473	206,715	652,461

*East and West coasts.

6.3 Landings/Catch

6.3.1 Commercial Landings

Table 6.2 presents commercial landings and value of Spanish mackerel in the Gulf of Mexico from 1970 through 1986 (L. Collins, pers. comm. 1987). Over the 17-year period, Florida produced 88-99% of the total gulf landings, averaging 94%. On the average, Alabama, Mississippi, and Louisiana landed about 6% of the total. For the years 1984, 1985, and 1986, Texas had commercial landings of approximately 100 lbs, 1,300 lbs, and 300 lbs, respectively (Osburn, pers. comm. 1987).

6.3.2 Recreational Catch

Table 6.3 presents the recreational catch of Spanish mackerel in the U.S. Gulf of Mexico from 1979 through 1986. These data indicate that the Florida west coast led the catch with an average of 35% of the total during the reporting period. Mississippi follows with 33% and Alabama is third with 22%. Together these three states accounted for an average of 90% of the recreational catch of Spanish mackerel in the U.S. Gulf of Mexico.

6.3.3 Fish Caught Recreationally and Sold Commercially

In addition to the expenditures associated with purchase of goods and services for recreational fishing, some fish caught by anglers are sold in commercial markets. Very little is known about the final disposition of the recreational catch. Existing evidence is too limited to approximate the value of fish sold; however, information from several local areas provides some insight into the amount of recreational catch sold commercially.

Preliminary results from a study of Florida gulf coast charter boats revealed that 53% of the operators responding to the survey sold recreationally caught fish to commercial markets (Browder et al. 1978). Of the fish sold, 70% went to wholesale fish houses; 13% was sold directly to the public, 12% went to restaurants, and 5% went to other retail establishments.

In Dade County, Florida, an estimated 12.5% of all fish caught from charter boats in 1976 were sold (Gentle 1977). Other fish caught were used for bait (24.8%), consumed by customers (19.6%), mounted (14.8%), and released (1.5%). The disposition of the remaining 26.8% of the catch was unknown. The researcher also found that king mackerel and cero were generally consumed by customers or used for bait.

6.3.4 Fishing and Landing Areas

6.3.4.1 Commercial

Total U.S. commercial landings of Spanish mackerel occur almost entirely in Florida, averaging 93% of the total gulf catch since 1980. The Spanish mackerel fishery is a local fishery in the sense that the catch is generally landed at ports within a few hours run of where the fish are caught. Typical one-way trip lengths between fishing and landing areas average about 20 miles on the Florida east coast. In the Florida Keys these distances may be about 40 miles. However during the winter, some Spanish mackerel boats may travel around the coast of Florida and temporarily operate out of ports closest to where the fish are currently available.

The three main traditional Florida landing areas for Spanish mackerel have been:

- o Collier and Lee Counties on the west coast of south Florida
- o Monroe County in the Florida Keys
- o Indian River, St. Lucie, Martin, and Palm Beach Counties on the east coast of south Florida.

In recent years, however, this pattern has changed. The Collier and Lee County areas are no longer landing significant amounts of Spanish mackerel, and as of 1986, power-assist gill nets are prohibited off Palm Beach County, which significantly reduce landings in that area.

In the Florida Keys, major landing ports for Spanish mackerel include Key West and Marathon, while on the Florida east coast they are Port Salerno and Ft. Pierce.

In northwest Florida there is a small catch of Spanish mackerel taken by haul seines and gill nets. This generally occurs in the spring and fall. In addition small amounts of Spanish mackerel are caught commercially off Alabama, Mississippi, and Louisiana. According to Texas Parks and Wildlife Department (TPWD) personnel (H. Osburn, pers. comm. 1987) directed commercial fishing for Spanish mackerel off Texas is virtually nonexistent. A relatively small incidental catch does occur in conjunction with other fisheries.

6.3.4.2 Recreational

Unlike the commercial harvesting of Spanish mackerel, the recreational fishing activity is widely distributed throughout both the south Atlantic and Gulf of Mexico regions. Fishing occurs out of virtually all marinas and boat docks that have access to coastal waters. Similarly, anglers can be found on most accessible beaches and shore-based locations such as bridges, piers, or jetties. The following discussion mentions those locations that are generally thought to be heavily frequented by anglers catching Spanish mackerel.

In the U.S. Gulf of Mexico, Spanish mackerel represent an important factor in the recreational fishery of all five Gulf States. The MRFSS conducted by NMFS reported substantial declines in the recreational harvests from Texas and Alabama (Table 6.3). No such trend is apparent for the remaining states. A recreational creel survey conducted by the Texas Parks and Wildlife Department (Osburn and Ferguson 1987) indicates relatively stable landings from 1983 to 1986 ranging from 4,100 to 7,000 fish, with preliminary results indicating a substantial increase in 1987 over the previous four years.

On the west coast of Florida, major fishing areas include the Keys, the Fort Myers-Naples area, the Clearwater-St. Petersburg area and the Panama City-Destin area. These areas are popular for charterboat fishing as well as fishing from private boats, although charter fishing is most concentrated in the Keys and Panama City-Destin locations. Florida, unlike the other Gulf States, also has a significant amount of shore-based fishing effort which produces Spanish mackerel. Table 6.9 indicates that in 1983 fishing for Spanish mackerel from man-made structures (shore-based) dominated recreational production. Biloxi and Ocean Springs are major areas for coastal recreational fishing in Mississippi, and in Louisiana anglers seeking to fish offshore often depart from areas such as Port Eades, South Pass, or Grande Isle. The long and diverse Texas coastline provides many access points from which to fish for Spanish mackerel, such as Freeport, Port O'Connor, Rockport, Port Aransas, South Padre, and Port Isabel; however, as stated above recreational harvest has significantly declined off Texas. As indicated by Table 6.3, recreational harvest of Spanish mackerel for Mississippi and Louisiana does not appear to have declined as dramatically as Texas.

6.4 Vessels and Gear

6.4.1 Commercial

Spanish mackerel are caught primarily with run-around gill nets. Small amounts are taken by haul seine, other gill nets, trammel nets, hook and line, and as by-catch in shrimp trawls. Table 6.11 presents catch by gear type for the Florida west coast, Alabama, Mississippi, and Louisiana. As noted in Table 6.2, commercial landings for Texas have been relatively insignificant for a number of years, and thus are not included in Table 6.11. As stated earlier, Florida landings have accounted for an average of 93% of the total gulf catch since 1980. From 1981 through 1985 the run-around gill net has accounted for an average of 81% of the commercial harvest of Spanish mackerel. During that same period haul seines accounted for approximately 10% of the total Florida west coast catch. Other gear types made up the remaining 9%. Though the catch in the outer Gulf States is significantly lower, the run-around gill net still accounts for the majority of the commercial harvest of Spanish mackerel in those states (Table 6.11).

Section 6.2.1.1 describes the commercial gill net boats that are typically used to harvest Spanish mackerel commercially. The smaller boats have a capacity of about 2,500 to 6,000 pounds (Cato et al. 1978), and some of those typically used a spotter plane to locate fish. These boats are frequently operated by one man although they may have one or two crewmen on board for some trips during the year. Both strike or run-around gill nets and drift gill nets are used by these boats.

According to the survey of Cato et al. (1978), the average capacity of the larger gill net boats was 29,000 pounds, ranging from 15,000 to 50,000 pounds. A large number of these boats typically use a spotter plane to locate fish. Typically these boats are manned by a captain and from one to five crewmen.

6.4.2 Recreational

Recreational fishermen use rod and reel when they angle for Spanish mackerel. Both natural and artificial baits are used, and three different fishing methods are generally employed. Trolling is the most commonly used technique by charter and private boat fishermen. Charter boats often use four lines, two unweighted lines for fishing at the surface and two weighted lines at some depth below. Private boats generally troll with fewer lines and remain closer to shore. Boats troll in a straight line or in a random pattern until fish are hooked, and then trolling continues in circles until fish are no longer being caught. Trolling often is used when circling surface structures or underwater reefs. A second technique, jigging, involves casting a lure or bait into the water and retrieving it with a jerking motion. This method is often used from fixed platforms such as bridges or piers. Jigging is also employed from boats when the boat is near a surface or underwater structure. The third method is float fishing and is usually done from a drifting or anchored boat, although it can be employed from a fixed platform. Hooks are baited and suspended below the surface in the water column with a float. Frequently chum is used to attract the fish (Manooch 1979, Brusher et al. 1978).

Section 6.2.1.2 presents a discussion of the types of private boats used by recreational fishermen for Spanish mackerel. Studies of charter boats from Florida and Texas provide a more detailed description of these boats than is available for private boats.

Table 6.11. Commercial catch of Spanish mackerel by gear type from Louisiana, Mississippi, Alabama, and Florida from 1981 through 1985. - = non reported (from State-Federal Cooperative Statistics Program, E. Snell, pers. comm. 1987).

	Run-around gill net	Anchored gill net	Drift gill net	Haul seine	Purse seine	Shrimp trawl	Trammel net	Hook & line[1]	Trolling[1]	Total
					LOUISIANA					
1981	49,806	-	-	-	-	14,060	4,268	-	-	68,134
1982	1,708	159	-	-	-	12,655	88	-	-	14,610
1983	29,908	-	-	-	-	23,913	-	20,319	-	74,140
1984	4,704	-	-	-	-	12,094	-	694	-	17,492
1985	3,627	-	-	-	4,080	13,717	-	49	3,494	27,203
					MISSISSIPPI					
1981	30,200	-	-	-	3,900	-	-	-	-	34,100
1982	26,400	-	-	-	75,600	700	-	-	-	102,700
1983	45,300	-	-	-	400	450	-	-	-	46,150
1984	1,550	-	-	-	170	146	-	265	-	2,671
1985	13,630	-	-	-	1,200	-	-	-	3,980	18,810
					ALABAMA					
1981	9,477	22,688	-	-	-	23,392	1,356	-	-	56,913
1982	30,809	3,523	-	-	-	16,005	3	198	-	50,538
1983	19,109	16,573	-	-	-	18,721	1,060	2,801	-	58,264
1984	4,945	335	-	-	-	3,982	-	201	-	9,463
1985	48,062	123	-	-	-	8,555	-	-	59	56,799
					FLORIDA					
1981	2,660,601	-	-	633,272	-	-	98,679	98,105	59,241	3,549,898
1982	2,760,799	-	-	281,575	-	-	89,892	97,284	57,776	3,287,326
1983	1,641,422	-	-	294,135	-	-	51,260	59,624	40,980	2,087,421
1984	2,944,969	-	325,256	136,478	-	-	20,964	31,918	16,155	3,475,740
1985	2,407,106	-	232,920	203,549	-	-	19,186	33,631	18,860	2,915,162

[1]Trolling refers to hook and line fishing aboard a vessel under power. Hook and line fishing refers to hook and line other than by trolling, [illegible] fishing, drift fishing, etc.

According to Ditton et al. (1977), almost all of the recreational fishing boats sampled had VHF and CB radios and fathometers. Only 28% were equipped with Loran; however, due to greater availability and lower cost of Loran units, it is believed that that figure has increased significantly.

6.5 Employment

6.5.1 Associated with Commercial Harvest

In 1987, there were about 517 fishermen working on approximately 148 gill net boats in the U.S. Gulf of Mexico (E. Snell, pers. comm. 1987). There is a considerable cross-over between fishing for king and Spanish mackerel. Employment is seasonal, occurring in south Florida predominantly in the winter months. In the off-season Spanish mackerel gill net fishermen target such species as grouper, spiny lobster, bluefish, and others.

There is also a portion of the commercial fishery that fishes for Spanish mackerel on a part-time basis and can be considered secondary users. There is a distinction between full-time seasonal Spanish mackerel fishermen and part-time fishermen. The term "secondary users" does not imply that Spanish mackerel are of less importance to that group than to "primary users", but rather that "secondary users" probably impact the stocks of Spanish mackerel to a lesser degree than "primary users", and that economic activity solely attributable to "secondary Spanish mackerel users" is less than that of "primary users". Precise quantification of the number of such fishermen is not possible; however, in a survey of Florida commercial fishermen, Prochaska and Cato (1977) reported that 10.6% caught Spanish mackerel, correlating to roughly 1,000 fishermen. This part-time participation may have been minimized by recent regulations requiring commercial fishermen to obtain special permits to catch Spanish mackerel for sale in the EEZ (coastal pelagics permit) and Florida jurisdictional waters (restricted species endorsement). In order to obtain either or both permits, fishermen must be able to prove that they derive a certain percentage of their income from commercial fishing.

In addition to employment in the direct fish harvesting, the fishery can be associated with employment generated in industries providing inputs to fish harvesting (i.e., gear manufacture, boat building, gear repair, fishing supplies, etc.).

The amount of additional employment generated in these sectors was estimated at approximately 25 person-years for Spanish mackerel. Note that the actual number of people involved may be considerably greater than this; the above estimates were produced by prorating the time actually devoted to producing goods and services used in the Spanish mackerel fishery. Also in certain years when a number of boats are built for use in the fishery, the above estimates (which are long-term averages) would be greatly increased. These estimates were derived using the economic impact ratios to determine average expenses for the boats and vessels in the fisheries. The results of a national input/output study of the impacts of the U.S. commercial fishing industry (Centaur Management Consultants, Inc. 1975) were then used to estimate employment in the direct economic sectors supplying inputs to fish harvesting.

In addition to the above employment, there is employment associated with the processing and distribution of the products from the fishery. Using techniques similar to those described above, employment associated with the processing and distribution of Spanish mackerel was estimated to be approximately 230 person-years. The above employment estimates include employment in processing as well as wholesale and retail trade.

6.5.2 Associated with Recreational Angling

Employment related to marine recreational fishing in the Gulf of Mexico in 1980 was estimated to have been 21,258 person-years with wages and salaries over $260.5 million. This includes estimates of employment related to purchases of equipment such as boats, motors, trailers, and fishing gear; non-durable goods such as fuel and live bait; and services such as charter boat fees, use of marine facilities, food, lodging and travel. Due to the difficulty of designating target species for recreational fishermen, specific portions of the above figures were not attributed to recreational harvest of Spanish mackerel (Centaur Management Consultants, Inc. 1980). Total employment related to marine recreational fishing is greater than that solely attributable to fishing for Spanish mackerel.

The estimates represent employment benefits which accrue to the nation and not just the Gulf of Mexico. For example, fishing equipment purchased in Florida for use in mackerel fishing may be manufactured in New England and distributed through a mid-Atlantic state. This non-local manufacturing and wholesale distribution employment is included in the estimates presented above.

As discussed earlier, Spanish mackerel is an important species to the charterboat fleet. Charterboat fishing is often not a full-time occupation for the boat operators. For some it provides seasonal employment. Peak season for recreational fishing for Spanish mackerel in south Florida is in the winter months. Peak season varies for other areas in the Gulf of Mexico. Other operators may charter these boats only on weekends. For example only 34% of Texas operators surveyed in 1975 said that charter fishing was their only occupation. Nearly 60% of the operators earned less than 50% of their income from charter fishing (Ditton et al. 1977). Because of the seasonal and intermittent characteristics of charterboating activity, it is not possible to provide an estimate of related employment in terms of person-years; however, the estimated number of persons involved in providing charterboating services is presented below.

Estimates place the number of charter boats operating in the Gulf of Mexico in 1977 at 569. Each boat requires a captain and most use a mate. In Texas, 60% of the boats used mates (Ditton et al. 1977). On the west coast of Florida, over 90% of the boats used mates (Anonymous 1985, p. 8-33). Assuming then that 75% of all charter operators employed a mate for their trips in 1977, the total number of persons directly involved in providing charter fishing services in the Gulf of Mexico was 996. By 1987, the number of charter boats (vessels for hire that are longer than 25 feet and carry no more than 15 people) in the Gulf of Mexico was approximately 925. Adhering to the same assumptions made above, the total number of persons directly involved in charter fishing services in 1987 was about 1,620.

6.6 User Group Conflicts

Historically, there have been conflicts, primarily commercial versus recreational fishermen, over various fishery resources. Any time commercial and recreational fishermen are targeting the same fishery stocks in the same arena the potential for conflict exists. In the Gulf of Mexico charterboat fishermen have complained that Spanish mackerel net fishermen made sets in front of them requiring them to change course while trolling, thereby missing the school of mackerel for their clients. Private boat recreational fishermen have complained that they were displaced from fishing a school when it was encircled by run-around gill net gear. The Florida Marine Fisheries Commission has addressed this problem by prohibiting net fishing for Spanish mackerel on weekends when recreational fishing is intense. Other complaints from recreational fishermen center around a perceived waste of fish in the Spanish mackerel net fishery when observations of net boats being trailered out of public water access areas revealed Spanish mackerel still entangled in the webbing with no visible means of preventing spoilage of the fish. Net fishermen have voiced complaints that the vast and still growing numbers of recreational fishermen are catching the majority of Spanish mackerel thereby interfering with their livelihood. Another complaint is that recreational fishermen scatter the fish in the schools making it more difficult for them to make a successful net set.

There have also been conflicts between small and large gill net boats, generally on the Florida east coast. Prior to 1975, that fishery was entirely a small boat fishery. Development of deep-water gill netting in the mid 1970s led to conflict and competition for the Spanish mackerel resource. The fishery is now dominated by the large boats. To minimize these problems, the Florida Marine Fisheries Commission reserved a small portion of the commercial quota to small scale fishermen by requiring the large scale boats to stop fishing when 90% of the commercial quota was filled.

In a discussion paper developed by the National Fisheries Institute (Anonymous 1987b), the perspective of the commercial fishing industry is discussed, indicating a concern that many fishery resources are being allocated largely to the recreational fishing sector. Spanish mackerel is listed as one of those resources. Manning (1987) discussed fishery management from the perspective of sport fishing. In this discussion, there is a recognition that recreational fishing is an equal partner with commercial fishing with respect to fishery management.

In some cases resources have been allocated to the recreational sector by being designated a game species. Though the reciprocal has never occurred, some species are only harvested by the commercial sector, such as menhaden, butterfish, and coastal herrings. In each of the discussion papers referenced above, concern for protection of the resource was a high priority. Conflict arises over the issue of allocation.

Fishery conflict is not confined to the United States as evidenced by Ruello and Henry (1977) who discussed the issue concerning commercial and recreational fishermen in Australia.

6.7 Assessment of U.S. Harvesting Capacity

Table 6.12 presents a lower bound estimate of harvesting capacity for Spanish mackerel in the Gulf of Mexico. Estimates for the commercial gill net fleets are based on the estimated

Table 6.12. Spanish mackerel harvesting capacity (pounds) in the Gulf of Mexico.

Florida Large Vessel Gill Net Fleet[1,2]	30 vessels @ 425,000	12,750,000
Florida Small Boat Gill Net Fleet[1,2]	118 boats @ 58,360	6,886,480
Florida Haul Seine Fleet[3]	1985 landings	203,549
Florida Hook and Line Fleet[3]	1985 landings	33,631
Commercial Fleet in states in the Gulf Region[3]	1985 landings	107,234
Recreational Fishing Capacity (Total)[4]	1985 landings	2,003,760
Total		21,984,654

[1] Estimated number of boats from E. Snell, NMFS, pers. comm. 1987.
[2] Vessel capacity from Coastal Pelagics Fishery Management Plan (Anonymous 1982).
[3] 1985 landings from E. Snell, NMFS, pers. comm. 1987.
[4] U.S. National Marine Fisheries Service, Current Fishery Statistics, 1986.

number of boats in each fleet in 1985 multiplied by the average harvest during 1976 as estimated by Cato et al. (1978) for small boats and the Coastal Pelagics Fishery Management Plan (Anonymous 1982) for large boats. Since harvesting was unrestricted except by natural causes, those estimates provide a good indication of the harvesting capacity of those vessels.

Current Spanish mackerel harvesting capacity is considerably greater than current catch estimates. As seen in Table 6.12, the U.S. is capable of harvesting nearly 22 million pounds for the Gulf of Mexico; however, the 1987-88 total allowable catch (TAC) established by the councils is only 2.5 million pounds.

While these estimates of capacity for Spanish mackerel would seem to indicate overcapitalization, the fact that these boats and vessels participate in two or more other fisheries precludes such an obvious conclusion. There have been no direct studies of this issue for this fishery, and methodology until very recently has been lacking to deal with capacity for multispecies craft. In addition, the catch rates used to compute commercial capacity were for years of near perfect weather conditions and high availability. The effective capacity is less under average conditions.

6.8 Assessment and Specification of the Extent to Which U.S. Vessels Will Harvest Optimum Yield

The Fishery Management Councils have determined that U.S. fishing vessels will harvest the entire optimum yield (OY) specified for Spanish mackerel by the councils. Therefore the total allowable level of foreign fishing is zero.

6.9 Foreign Fishing Activities

There are no foreign fishing participants operating in the EEZ or in any state jurisdictional waters for Spanish mackerel. Since the vast majority of Spanish mackerel are caught within state jurisdictional waters, and since the species is currently being harvested at OY as set by the Gulf of Mexico Fishery Management Council, it is unlikely that any foreign fishing activities for Spanish mackerel will occur in the future.

There are extensive Mexican fisheries for Spanish mackerel. These are centered off the States of Veracruz and Campeche. From 1968 through 1984 reported landings on the Mexican Gulf coast varied between 7.3 and 14.4 million pounds for Spanish mackerel (E. Nakamura, pers. comm. 1987). Tag returns indicate some interaction between these and the U.S. stocks (Sutherland and Fable 1980).

6.10 Interactions Between Foreign and Domestic Participants

6.10.1 Harvesting Interactions

There are currently no interactions between domestic and foreign participants in the fishery.

6.10.2 Transfers at Sea to Foreign Vessels

Transfers of Spanish mackerel from U.S. harvesters to foreign vessels are unknown. None have been proposed or are anticipated.

6.11 Domestic Processing Capacity

Current processing capacity is sufficient to handle the commercial harvest of Spanish mackerel. The domestic processing industry has handled as much as 17 million pounds annually, which far exceeds recent commercial production and total allowable catch (TAC).

Three processors fillet and freeze Spanish mackerel. All are located in Florida, two in the Tampa Bay area and the third in the Florida panhandle. The structure of these processors is variable, ranging from filleting and freezing only to combination fish house and processor.

Since the major commercial production is in Florida, the fish houses and processors have organized an efficient system to accommodate the migratory patterns of these fish. The organizational systems follow three basic patterns. First, some fish houses have established themselves in the most highly productive areas and are highly dependent on locally caught fish. Other fish houses around Florida may also own vessels which "follow" the fish. Trucks are then sent to the seasonal landing locations and the fish are transported to the fish house or point of handling or sale by the trucks. The third method has seen some processors set up handling locations along the coast to handle the fish as they are harvested near these locations. These techniques have insured adequate refrigeration and freezing capability near harvest areas.

Availability and capacity of labor force, processing machinery, freezers, etc. are adequate. Secondary handlers presently use machines for filleting Spanish mackerel; therefore, there is no constraint by available labor supply in this segment of the total industry.

Seasonal schedules fluctuate due to the variability in seasonal landings for Spanish mackerel. During record production year for Spanish mackerel, fishermen were placed on a 15,000 pound per day limit. This gives an indication of the capacity which is approximately 18 million pounds, considerably above the average or expected commercial harvest.

7.0 SOCIOECONOMICS

7.1 Domestic Harvesting Sector

The economic discussions of commercial and recreational fishing presented here employ different methods of analyzing the value of the two sectors. Commercial fishing is measured in economic benefits of vessels targeting Spanish mackerel while the recreational sector is discussed in terms of economic impacts of marine recreational fishing for Spanish mackerel. Using two different economic models and applying them to different activities can present a misleading picture. The following discussions represent the most recent information available for both groups and do not imply comparability.

7.1.1 Commercial

7.1.1.1 Value of Landing

About 95% of the Gulf of Mexico Spanish mackerel commercial landings occur in Florida, although at least some landings occur in all five Gulf States. The ex-vessel value of Spanish mackerel is relatively low, with the 1987 freezer price ranging from $.30 to $.32 per pound. Fish going to market often bring a higher price, and in 1987 reached as high as $.60 per pound. Complete data on the value and amount of total U.S. landings for Spanish mackerel are found in Table 6.2.

7.1.1.2 Economic Characteristics of the Fleet

Recent estimates of costs and returns in the Spanish mackerel fishery have not been made. However, Morris et al. (1977 and 1978) provided cost and return data for the mid 1970s. At that time, the average small Spanish mackerel net boat in the survey had a total revenue of $26,700, $10,500 of which was due to Spanish mackerel. The average large net boat for Spanish mackerel totaled $96,400, $76,000 of which was directly due to Spanish mackerel. Net returns to the captain/owner were $15,900 for small Spanish mackerel net boats and $21,800 for large Spanish mackerel net boats. Overall yearly profit for vessels and boats in the Spanish mackerel fishery is the remainder of total revenue after fixed and variable costs are paid. Variable costs, which include fuel, crew shares, gear repair, and maintenance, must be paid to continue fishing during one season. Fixed costs, which include boat payments, insurance, and depreciation, could be postponed temporarily either totally or in part if total income is inadequate. Vessels and boats such as these that do participate in several fisheries have their fixed costs spread over several activities. Therefore, analysis of the financial performance of a boat or vessel in only one fishery is incomplete or would be biased if it included all fixed costs.

Data from these surveys were used to calculate economic ratios of investment, costs, and personal income to value of the catch for these fleets. These ratios were then applied to estimate the economic characteristics for the respective commercial fisheries as a whole. Catch was estimated as the 1976-77 average. Then the current (1977) price was applied to determine the value of landings. To estimate personal income, the ratio of personal income/value of catch from the surveys was applied to the value of landings. A similar procedure was used to estimate investment in the fishery. The total personal income in the commercial fishery derived from the Spanish mackerel fishery in the gulf and south Atlantic regions was estimated to be $1,888,000.

7.1.2 Recreational Fishing

The following sections present a description of the direct economic contribution to the nation associated with recreational fishing for Spanish mackerel. The estimates are presented in the context of impacts associated with all marine recreational fishing in the southeast to illustrate the relative importance of the fisheries. Presented first are estimates of total expenditures by recreational fishermen and the associated employment, wages and salaries generated by their purchases.

Identification of economic effects associated with a particular species of fish is conceptually difficult to determine. Often fishermen seek multiple species. Similarly, those fishermen who do direct their effort at particular fish often catch other fish incidentally. These confounding characteristics of recreational fishing activity make it difficult to clearly delineate activity attributable to a particular species. Fully recognizing these conceptual difficulties, species specific estimates were determined by prorating total economic activity using an indicator of participation such as catch or effort. The indicators chosen were largely dictated by the limits of available data. In all instances where prorating procedures were used, the method has been described.

Thus, while the estimates presented may not fully represent the economic impacts within the desired accuracy range, they do provide a reasonable perspective of the relative magnitude of the Spanish mackerel fishery vis a vis other saltwater sportfishing.

7.1.2.1 Total Direct Economic Impacts

Participation in marine recreational fishing results in substantial purchases of goods and services. The proportion of the total direct economic impact of marine recreational fishing attributable to Spanish mackerel was derived by calculating the proportion of combined Spanish mackerel catches reported in 1979 and 1980 in the MRFSS to the total combined recreational finfish catches reported in 1979 and 1980 in the MRFSS. That proportion is approximately 2%. Table 7.1 presents estimates of direct economic impacts associated with marine recreational fishing in the Gulf of Mexico in 1980.

Anglers' purchases create and sustain employment and personal income in the production, distribution, and retail sale of the goods and services bought. From Table 7.1, of the estimated 21,258 person-years of employment generated by expenditures of all anglers in the Gulf of Mexico in 1980, approximately 425 person-years of employment can be attributed to Spanish mackerel. Wages and salaries generated were just over $260 million. Approximately $5.2 million were attributed to Spanish mackerel. With an estimated total value of retail sales of $1.3 billion, Spanish mackerel activities accounted for approximately $26 million.

These direct economic impact estimates represent benefits that accrue to the entire nation and not just to the gulf region. Included in the estimates are impacts associated with purchases of durable goods such as boats, motors, boat trailers, and fishing tackle; non-durable goods such as boat fuel, car fuel, or live bait; and services such as charter and head boat fees, use of marine facilities, equipment rental, and food, travel, and lodging.

Many purchases made by anglers are not made for the singular purpose of fishing. This is particularly true of durable goods. For example, a boat may be purchased for fishing as well as for cruising or water skiing. Moreover, a boat used solely for fishing is rarely (if ever) used for seeking one species of fish. On the other hand, it would be inappropriate to completely discount purchases that are not wholly attributable to a particular activity (e.g., angling for Spanish mackerel). Here it is assumed that the expenditures for the purchase of equipment are

Table 7.1. Estimated economic impacts associated with marine recreational fishing in the Gulf of Mexico in 1980 (From Economic activity associated with marine recreational fishing in 1980. Centaur Management Consultants, Inc. 1980).

	Value of retail sales ($1,000)	Employment (Person-years)	Wages and salaries ($1,000)
All species	$1,320,805	21,258	$260,589
Spanish mackerel*	26,416	425	5,212

*See section 7.1.2.1 for an explanation of the derivation of these figures.

attributable to a particular activity in proportion to the amount of time the equipment is used for that activity.

7.1.2.2 Charter Boats

In 1977, total expenditures associated with all marine recreational fishing in the Gulf of Mexico were estimated to be $644 million (Centaur Management Consultants, Inc. 1977). Of that figure an estimated $14.1 million were for charter boat fees. The 1977 figure for total expenditures was used because more current data to describe the charter industry were not available. Estimates of charter revenues and personal income illustrating the relative importance of Spanish mackerel are presented in Table 7.2. Charter fees associated with fishing for Spanish mackerel in the Gulf of Mexico in 1977 were estimated at $365,000 representing around 3% of the total estimated charter fees.

Table 7.2. Estimated gross revenue and operators' income for charter boats in the Gulf of Mexico, 1977.

Estimated Gross Revenue	
Total	Spanish Mackerel
$14,081,000	365,000
Charter Operators' Income	
4,928,000	138,000

Personal income of charter boat operators in the Gulf of Mexico for 1977 totaled $4.9 million. That portion attributable to Spanish mackerel was estimated to be $138,000 or 3% of the total. These estimates were determined by using studies of charter operations on the Florida gulf coast (Browder et al. 1978) and Texas (Ditton et al. 1977). These studies provided estimates of the average annual gross revenues for a boat operating in the area studied. These estimates were assumed to be typical of the proximal geographic region. Data from the northwestern Florida charter boats were assumed to be representative of Alabama charter operations, and data from the Texas fleet were assumed to be similar to activities in Louisiana and Mississippi. While revenues may vary from year to year because of weather conditions, availability of fish or other reasons, the studies (which were conducted in different years) were assumed to represent typical fishing years. Revenue estimates were normalized only for inflation. To obtain the total revenue estimates, the number of boats in each area was multiplied by the respective average annual revenue per boat.

Personal income earned by the operators was estimated through an analysis of cost and revenue data of charter boats presented in studies of the Texas charter fleet (Ditton et al. 1977). Operators' income as a percent of gross revenues was 39% in Texas. Personal income figures include all profit remaining after fixed expenses (excluding depreciation) and variable expenses have been paid, but before payment of interest and taxes.

7.1.3 Tourism

Tourism is a significant aspect of the marine recreational fisheries of the southeast. Recent regional surveys conducted by the NMFS show that a substantial number of anglers in the eastern United States do at least some of their fishing in the coastal states of the south Atlantic and Gulf of Mexico, most of them traveling to Florida (Ridgely and Deuel 1975). Comprehensive tourism data specific to the Spanish mackerel fishery are not available, but studies of charter boat operations (the importance of Spanish mackerel to the charter fleet is discussed earlier) show that tourism is very important to the charter fishery.

A study of charter boat fishermen in Mississippi revealed that only 17% of the participants live in the coastal counties of that state, and that 57% of the participants were from outside Mississippi (Etzold et al. 1977). A study of Texas charter boat fishing in 1976 shows that only 2% of the participants were from Texas coastal counties, while 92% were from inland areas of the state (Ditton et al. 1977). In Dade County, Florida, 81% of the participants in charter fishing surveyed were non-residents of the county, and 77% were from outside of Florida (Gentle 1977). Also, charter boat operators in Bay County, Florida have estimated that 98% of their customers are non-residents of the county (Brusher et al. 1978). Clearly, the charter boat fleet is heavily dependent on tourism for its business.

In addition to the business that tourists bring to the charter boat operators, they spend considerable sums of money in the local economy for other items such as food, lodging and travel. It is estimated that approximately 456,000 tourists are estimated to have participated in charter fishing in 1977 in the south Atlantic and Gulf of Mexico. In addition to the $23.9 million they spent for charter fees (see previous section), an estimated $17.9 million was spent on food, lodging, transportation and miscellaneous items for the days they fished. Approximately $8.2 million of that total was spent in southern Florida.

Tourist expenditures attributable to Spanish mackerel were estimated using a prorating procedure similar to that applied in the analysis of charter boat revenues and income (i.e., based on the proportion of Spanish mackerel that were caught while charter fishing to total fish caught). Accordingly, expenditures by tourist for food, lodging and travel attributable to Spanish mackerel were approximately $850,000. While tourists engage in charter fishing likely

comprise the majority of non-local participants, other tourists also fish for recreation. Many persons trailer their boats to the southeast for long winter vacations. Also, non-local anglers catch Spanish mackerel from shore-based locations such as beaches, piers or jetties. These tourists are not included in the estimates presented above. Therefore, the above expenditure estimates should be viewed as a lower bound of total tourist expenditures associated with Spanish mackerel resources.

7.2 Domestic Processing Sector

Major product forms for Spanish mackerel include frozen fillets and fresh whole fish. Currently, the great bulk of Spanish mackerel is sold as frozen fillets with over 1.0 million pounds processed in 1986 valued at $1.3 million (Anonymous 1988). Most of this was processed in Florida.

Spanish mackerel also go to the local Florida fresh fish market. Spanish mackerel are also sold as marine mammal food to aquarium-type attractions. A certain amount is also sold for bait.

Processing capacity for Spanish mackerel appeared to be reached in the 1975-76 winter season, when boats were placed on 15,000 pound limits. The landings during that season were approximately 18 million pounds, which represents an approximation of market/processing capacity at that time based on the earlier definition. Processors indicate that the market is continuing to expand.

7.3 International Trade

International trade of Spanish mackerel appears to occur on a relatively small scale in comparison to domestic trade for these fish. Trade with Puerto Rico, a major market for Spanish mackerel is not included in the analysis of international trade. Imports originate from Mexico (E. Berry, pers. comm. cited in Anonymous 1982). Austin et al. (1977) reported major foreign markets to include Canada and Venezuela. However, the Venezuelan export market collapsed in 1982 due to a decline in the petroleum industry (W. Antozzi, pers. comm. 1987). Records of international trade in Spanish mackerel are generally aggregated with all mackerel, making international activity difficult to trace.

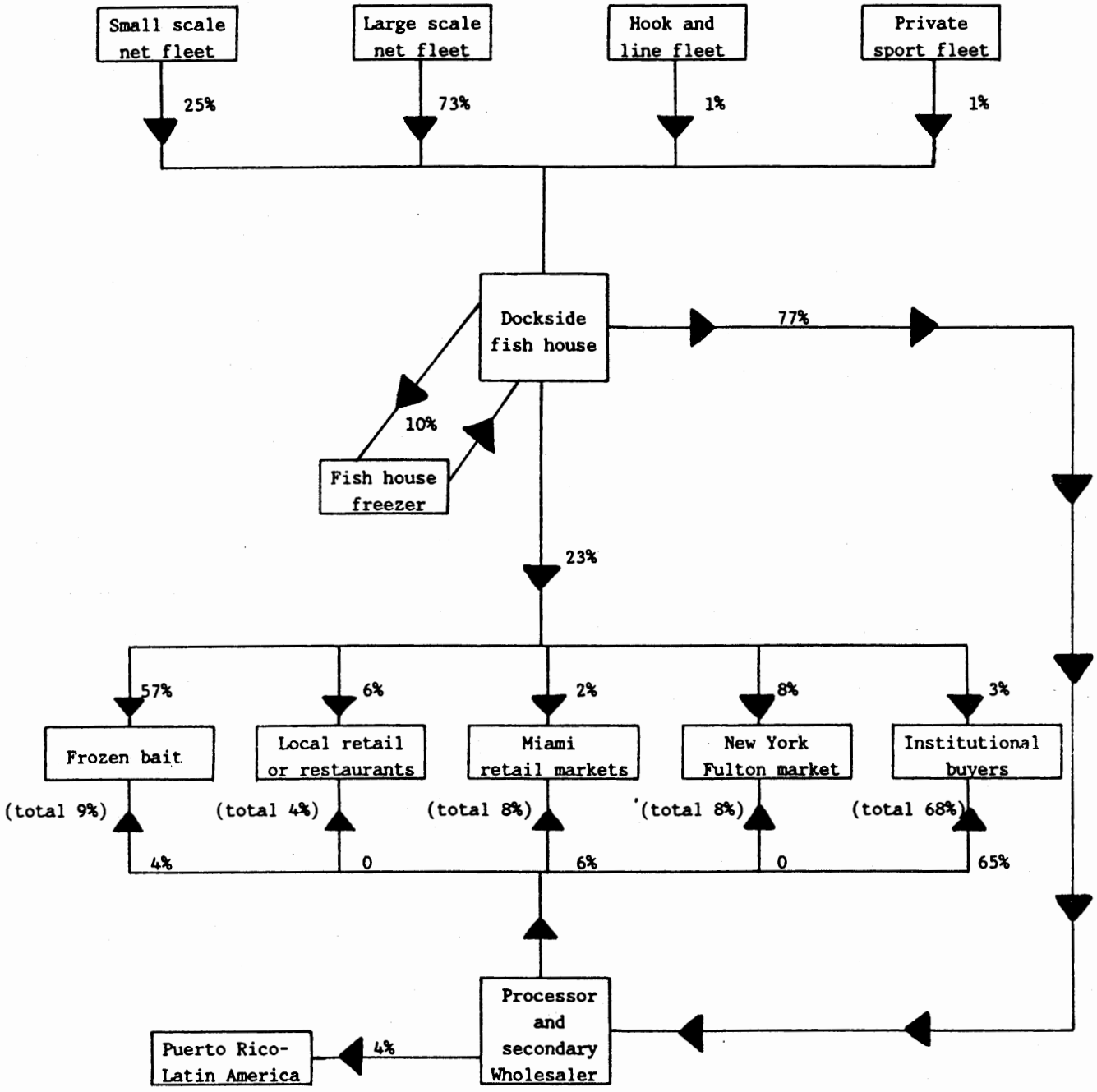
7.4 Description of the Business, Markets, and Organizations Associated with the Spanish Mackerel Fishery

7.4.1 Relationship Among Harvesting, Brokering, and Processing Sectors

Historically, Spanish mackerel have been sold by fishermen to local fish dealers. These primary wholesalers in turn sell to fresh fish markets and restaurants, freezer companies, and secondary wholesalers. The industry structure and markets for Spanish mackerel are described below.

7.4.2 Spanish Mackerel Industry Structure and Markets

Figure 7.1 provides a product flow diagram for Spanish mackerel. Sizeable markets exist for both fresh and frozen Spanish mackerel. Traditionally, this species has been an important product in the fresh fish market. Geographically, the major market for fresh Spanish mackerel is the southeast United States.



Totals may not add due to rounding.

Source: Centaur Associates, Inc., "Socio-Economic Study of the Mackerel Purse Seine Fishery, Task I Report." Prepared for the National Marine Fisheries Service, Miami, Florida, Contract No. FSE-43-12-119, 1981.

Figure 7.1. Spanish mackerel product flow.

Approximately 77% of Spanish mackerel were sold as frozen fillets, most going to institutions (Centaur Management Consultants, Inc. 1981). Product forms are determined in part by the size of the fish. Fish over 1 1/4 pounds are preferable for fillets. Some companies ship whole frozen fish three pounds or greater to Puerto Rico, though this represents a very small amount.

There are three major markets for Spanish mackerel. By far the most important market outlet is the approximately 15-20 cafeteria chains in the southeast that purchase frozen Spanish mackerel fillets. About 75% of Spanish mackerel landings are sold to cafeteria chains. The second largest outlet is to retailers who service home consumers. Products sold to retailers consist primarily of fresh and frozen fillets and whole drawn, the latter being both fresh and frozen. The third market outlet consists of two major user groups, i.e., for animal feeding in zoos, aquariums, etc., and for bait by both commercial and recreational fishermen. Spanish mackerel sold to these outlets consists primarily of the smaller sized fish that have limited acceptance in the restaurant and retail outlets.

7.4.3 Labor Organizations

Labor organizations are not included in the harvesting or processing sectors of the fishery.

7.4.4 Foreign Investments

Foreign investment in the domestic sectors of the industry is unknown.

7.5 Social and Cultural Framework of Domestic Fishermen

7.5.1 Ethnic Character, Family Structure, and Community Organizations

Commercial fishermen who fish for Spanish mackerel, in general, have an ethnic and social character similar to the cross section of people in the states and counties in which they reside. The boat captains in the fisheries for the Spanish mackerel are predominantly owner/operator entrepreneurs although there are a few cases of company-owned boats or vessels or a captain owning more than one boat or vessel, in which case captains may work on an employee basis.

The small scale Spanish mackerel net fishery typically consists of an owner/operator who may fish alone or who may have one or possibly more crew members for at least part of the year. In these cases, the crew member frequently is a relative. The larger net boats operating in the Spanish mackerel net fisheries usually consist of an owner/captain and three to five paid crew members. Many of the captains try to work with the same crew year after year. In other cases boats may be operated with one or more itinerant crew members.

There is a considerable number of instances where fishermen in this fishery have come from families where the father was a fisherman operating in the same or other local fisheries. Currently, a number of father/son combinations are commercially fishing for Spanish mackerel. Many of these fishermen appear to express a desire that their sons may be able to continue with a family tradition of commercial fishing.

The predominant portion of the fishermen reside in those coastal communities surrounding the ports from which they operate. Certain of the communities in which the commercial fishermen live such as Monroe County (Florida Keys), Port Salerno, Fort Pierce and Sebastian (Florida east coast) have a large proportion of the total population involved in the fishing community.

7.5.2 Age, Education, and Experience of Commercial Fishermen

Specific data on age and years of fishing experience for Spanish mackerel fishermen are available only from surveys describing Florida east coast large and small boat Spanish mackerel fishermen (Cato et al. 1978). The Spanish mackerel fishermen in the surveys are about the same age as Florida fishermen as a whole, but they have considerably more years of fishing experience than other Florida commercial fishermen. In 1974, the average age of Florida commercial fishermen was 48 years with a range of 16 to 85 years. Spanish mackerel fishermen on the Atlantic coast averaged 45.6 years of age.

With respect to years of experience in commercial fishing, Florida fishermen as a whole, averaged 16.5 years in 1974. In contrast, small boat Spanish mackerel fishermen had 27.3 years of experience and large boat Spanish mackerel fishermen had 33.7 years.

It should be noted that the fishermen in the survey were boat captains and so the survey may be skewed toward the more experienced persons in the fishery. However, contact with people in the fishery indicates that Florida Spanish mackerel fishermen have demographic characteristics similar to those of Florida fishermen as a whole. The majority (52%) of all Florida fishermen was between 41 and 60 years of age with only 11% less than 31 years old and 19% over 61 years of age (Prochaska and Cato 1977). The average Florida fisherman has fished for approximately 16 years and most have fished between 7 and 30 years. Educational attainment averaged 11.3 years for Florida fishermen surveyed in 1974. Years of schooling declined with the age of the fishermen. Data on educational attainment specific to mackerel fishermen are not available.

7.5.3 Employment Opportunities and Unemployment Rates

Unemployment has risen sharply in the Florida counties (Martin, Indian River, St. Lucie, Palm Beach, Monroe, and Collier) where most commercial fishing of Spanish mackerel occurs.[1] Despite relatively high rates of unemployment in the local economies, overall employment opportunities in commercial fishing appear to have remained favorable as have opportunities in the mackerel fisheries.

In all six counties the 1977 unemployment rate was more than double the 1973 rate. With the exception of Martin County, all areas had rates well above the 7.7% rate for all of Florida in 1977. In Martin and Monroe counties the unemployment rate dropped between 1975 and 1977 while in Indian River and St. Lucie counties the rate continued to climb during that period. Thus opportunities for employment in the local economies have generally declined since the early part of the decade.

No directly comparable unemployment data are available specifically for fishermen, but estimates of the number of fishermen in all types of fishing activity by county between 1970 and 1975 do provide an indication of the employment opportunities in fishing.[2] The total number of

---

[1] Source of all unemployment estimates: FL Dept. of Commerce, Div. of Employment Security

[2] Source of number of fishermen employed: NMFS, unpublished data.

fishermen in the six counties increased from nearly 3,150 in 1970 to just over 3,900 in 1975, indicating that employment opportunities in fishing increased during the time when unemployment rates for the local economies also increased. Not all counties gained in fishing employment, however. The number of fishermen in Monroe County increased by more than 50% from 1970 to 1975. During that period the county unemployment rate tripled. On the east coast of Florida a similar pattern occurred in St. Lucie and Indian River counties although the percent increase in the number of fishermen was not as large. In contrast, the total number of fishermen in Martin, Palm Beach and Collier counties decreased between 1970 and 1975. There is no clear reason for the declining trend there. The statistics on number of fishermen are gathered at the location where fish are landed. The temporary migration of fishermen to other fishing areas (i.e., Monroe County) may partly explain the decline. Employment opportunities in the mackerel fisheries have increased as demonstrated by the increase in number of boats participating in the fishery.

In Monroe County, fishing is an extremely important industry to the local economy. The number of fishermen reported for the county is nearly 15% of total county employment. Major participants in both the king and Spanish mackerel fisheries comprise about 8% of total fishermen. Unemployment is high in the area, being nearly ten times the number of major participants in either the king or Spanish mackerel fisheries.

On the southern Florida west coast (Collier and Lee counties), employment in the king mackerel fishery is relatively low. However, major participants in the Spanish mackerel fishery are about 15% of total fishermen. Again, the total county unemployment rate is several times the employment in the fishery.

Still many fishermen are not employed full time in fishing. A recent survey of Florida fishermen showed that those with income from non-fishing activities had widely varied employment. Based on those who specifically reported type of employment, 28% were in residential or commercial construction, 17% in marine related jobs such as tug boat captains, marina operators and boat builders, 10% in agriculture, 9% in security type jobs, 7% in jobs as mechanics and repairmen, and 22% in other occupations such as teachers, chemists, optometrists, broadcasters, and flight inspectors. Only 21% of the respondents said that their non-fishing employment was seasonal (Prochaska and Cato 1977).

Spanish mackerel fishing in the major commercial areas in south Florida takes place primarily in the months of December through February. In Monroe County participants in the Spanish mackerel fishery gain additional income from the spiny lobster fishery. Spiny lobster fishing takes place predominantly from August through November; thus the two fisheries are seasonal complements to one another. Mackerel fishermen also fish for other species such as snapper, grouper, stone crab, mullet, spiny lobsters, and pompano.

7.6 Recreational Fishing

The motivations and cultural characteristics of anglers seeking Spanish mackerel are diverse. Many seek the excitement of the sport, the chance to relax and socialize with their friends, or the opportunity to be in a natural environment. A discussion of the demographic characteristics of marine recreational fishermen and their values in participation is presented below.

7.6.1 Demographic Characteristics of Recreational Fishermen

Basic demographic characteristics of marine recreational fishermen in the south Atlantic and Gulf of Mexico were determined by the U.S. Department of Interior (1972, 1977a, 1977b). Over 51% of participants were between the ages of 25 and 54 in 1975. Anglers under 25 accounted for

32.4% of the participants, and anglers 55 years old or older accounted for 16.3% of the fishermen. Saltwater anglers are predominantly male. Nearly one-third of the participants were female in 1975. Forty-three percent of the recreational fishermen had incomes between $10,000 and $25,000 (U.S. Department of Interior 1977b). A 1971 study of southeastern wildlife recreation suggests that of the surveyed anglers, there was no heavy concentration of participation from any particular occupational group, although professionals, management, and skilled crafts persons tend to participate more often than members of other occupational groups (Horvath 1974).

These characteristics apply to anglers in general from the southeast. Data specific to anglers that seek or catch Spanish mackerel are not available; however, they are caught predominantly by private or charter boats. Because of the widespread and growing popularity of smaller boats in the 18-22 foot category capable of fishing for Spanish mackerel and other pelagic species, they tend to be highly sought by middle income fishermen as well as fishermen owning the larger sportfishing craft.

Research on charter boat fishing in the Gulf of Mexico, the other important component of the coastal pelagic recreational fishery, suggests that charter fishermen are of higher socioeconomic status than anglers as an entire group. Mississippi charter fishermen tend to have higher incomes than anglers overall. Eighty percent of the charter fishermen had incomes over $15,000 and 36% had incomes over $25,000. Occupationally, charter fishermen in Mississippi were much more often employed in professional and managerial positions than the general population of southeastern anglers (Etzold et al. 1977). A study of Texas charter fishermen yielded similar results. There, 78% of charter fishermen surveyed had incomes over $20,000 and 34% had incomes over $40,000 (Ditton et al. 1977).

7.6.2 Social Benefits of Recreational Fishing

Recreational fishing yields significant benefits over and above those measured by the value of expenditures. Researchers have found that participants pursue angling opportunities for multiple reasons. Among the benefits are the fulfillment of a desire for solitude; to be outdoors in a natural environment; to have companionship; to explore and have an adventurous experience; for the scenery; to get away from it all and reduce tension; to experience achievement in catching fish or obtaining a trophy; or for the opportunity to "think things through". These, of course, are in addition to the satisfaction gained from the feeling of sporting accomplishment in successfully catching fish (Bryan 1976). There is general agreement that the great majority of persons go fishing with at least the expectation that fish will be caught.

In efforts to estimate how fishermen value these benefits of recreational fishing, researchers have devised methodologies for expressing them in monetary terms. For example, a 1971 study of the southeast indicated that saltwater fishermen received benefits valued at $59.80 for each day of fishing (Horvath 1974). In contrast, a 1970 national study showed that saltwater anglers spent an average of only $10.77 per day (U.S. Department of Interior 1972). Although the valuation procedure used by Horvath is not necessarily precise because of its subjective nature, the results of such a methodology provide a benchmark of the value of the social benefits associated with recreational fishing.

7.7 Economic Dependence on Commercial or Marine Recreational Fishing and Related Activities

In many instances persons employed in both commercial and recreational fishing activities are not wholly dependent on fishing for their entire income. Often the seasonality of fishing

activity makes it necessary to find other employment. For example, the North Carolina charter fishing season generally begins in April and runs through part of November, but the heavy season includes only the summer months. Most charter boat operators there must find alternate sources of income to support themselves during the off-season. There are also a significant number of part-time fishermen, persons who fish to supplement the income of their essentially full-time jobs. A survey of Florida commercial fishermen found that a number of respondents were employed in occupations such as chemistry, optometry, education, or broadcasting (Prochaska and Cato 1977). Research on commercial fishermen in Florida and charter fishermen in Texas and Florida provides a picture of the importance of fishing as a source of income.

In 1974, 48% of surveyed Florida commercial fishermen fished full time, while 52% of the fishermen reported that some of their income was earned from employment outside of fishing. Approximately 30% of the fishermen earn over 50% of their income from non-fishing employment. On average, all fishermen (excluding shrimping operations) earned about 38% of their income from outside sources (Prochaska and Cato 1977).

Spanish mackerel fishermen are more dependent on fishing for a livelihood than are the average Florida commercial fishermen. Small boat Spanish mackerel gill-net fishermen earned 71.2% of their income in 1976 from fishing. Large boat Spanish mackerel gill-net fishermen earned 91.7% of their income from fishing (Cato et al. 1978).

Two studies of charter fishing, one in Texas (Ditton 1976) and one in Florida (Browder et al. 1978) also include information on the operator's dependence on the commercial sport fishing business as a source of income. Of those operators surveyed in Texas, 66% responded that charter fishing was not their only source of income. On average, 61.5% of an operator's working time was devoted to charter fishing. When asked what percent of their income comes from charter fishing, 59% said that less than 50% of their earnings came from charter fishing (Ditton 1976). In Florida the situation differs. Preliminary results of a study of charter fishermen on Florida's west coast reveal that 60% of the operators surveyed had other income, but less than 28% of the operators had a second job. Additionally, 90.4% of the operators fished full time in season.

In short, while fishing is often not a full-time occupation, it is a substantial source of income for those who are directly employed in commercial harvesting and commercial sportfishing.

Very little is known about the economic dependence of those employed in the processing, distribution, and retail sale of fishery products and of those involved in producing and selling recreational fishing goods and services. It is reasonable to assume though that where fishing activity is seasonal, some employment is also affected. For example, this would likely be true for employment in processing commercially harvested fish, and for recreational fishing, those employed in activities such as selling bait would also be affected. It is unclear though to what extent these persons are dependent on Spanish mackerel or other coastal pelagic fish. With respect to the production of recreational fishing gear (e.g., tackle, boats, etc.), most gear is not made specifically for use in one fishery. Boats and boat related items are used for activities other than fishing, and most fishing tackle can be used to catch many kinds of fish.

8.0 MANAGEMENT GOALS, OBJECTIVES, AND RECOMMENDATIONS

8.1 Management Goals

8.1.1 Immediate Management Goal

The immediate goal of this FMP is to manage Gulf of Mexico Spanish mackerel stock(s) to rebuild the stock(s) to a level which could support harvest at MSY.

8.1.2 Long-term Management Goal

The long-term management goal of this FMP is to manage Gulf of Mexico Spanish mackerel stock(s) at optimum yield (OY), which is defined as maximum sustainable yield (MSY) as modified by any relevant economic, social, or ecological factors.

8.2 Management Objectives

The two management objectives of this FMP are a) population restoration and b) coordinated fishery management.

8.3 Management Unit

The management unit to be managed by this FMP is the Spanish mackerel stock(s) within the Gulf of Mexico.

8.4 Problems in the Fishery

The following is a list of problems that have been identified within the Gulf of Mexico Spanish mackerel fishery:

a) The Gulf of Mexico Spanish mackerel stock(s) has been reduced to an unacceptable level because of overfishing.

b) Management programs for Spanish mackerel are not coordinated among all the states of the Gulf of Mexico.

c) Migratory patterns of Spanish mackerel in the Gulf of Mexico are not well known.

d) There is evidence that there is more than one stock of Spanish mackerel in the Gulf of Mexico. However, that evidence is inconclusive.

e) It is not known to what extent Spanish mackerel harvest outside U.S. waters affects Spanish mackerel abundance in U.S. waters.

f) Current fishing technology can result in reaching a commercial quota in a short time.

g) There is a need for sufficient social and economic data and analysis of those data from which to make more accurate estimates of OY and allocation decisions for the Gulf of Mexico Spanish mackerel fishery.

8.5 Fishing Year

The fishing year for the Gulf of Mexico Spanish mackerel fishery begins April 1 and ends the following March 31.

8.6 Management Area

The area of management authority of this FMP for Gulf of Mexico Spanish mackerel is state territorial waters within the Gulf of Mexico.

8.7 Total Allowable Catch (TAC)

The TAC for any fishing year is based on the most current stock assessment. Currently, the TAC for the 1989-90 fishing year is set at 5.25 million pounds.

8.8 Commercial Fishing Gear

8.8.1 Purse Seines

The use of purse seines to harvest Spanish mackerel within the state territorial waters of the Gulf of Mexico is prohibited.

8.8.2 Gill and Trammel Nets

8.8.2.1 Mesh Size

In those states which allow the use of nets in the commercial harvest of Spanish mackerel, any net used in the directed fishery for Spanish mackerel must be of a 3 1/2 inch stretched mesh size or larger.

8.8.2.2 Net Length

In those states which allow the use of nets in the commercial harvest of Spanish mackerel, the total length of any net involved in the fishery should not exceed 1800 feet.

8.9 Allocation

Based on current shares of Spanish mackerel, the commercial fishery is allocated 2.73 million pounds, while the recreational allocation is 2.52 million pounds. As growth of the stock(s) occurs, the commercial allocation will remain at 2.73 million pounds, while the recreational allocation will increase concomitant with the growth in the stock(s) until an equal share is attained. If the stock(s) declines below a TAC of 5.25 million pounds, an allocation of the TAC of 48% recreational and 52% commercial will be used based on historical landings from 1979-1986.

8.10 Quotas and Closures

8.10.1 Commercial Fishery

The commercial allocation of 2.73 million pounds for fishing year 1989-1990 represents the commercial quota. The commercial fishery for Spanish mackerel in the state territorial waters of the Gulf of Mexico will close when it is determined that the quota has been reached or exceeded.

8.10.2 Recreational Fishery

The recreational allocation of 2.52 million pounds for fishing year 1989-1990 represents the recreational quota. The recreational fishery will not close, but will be regulated by bag limits which will be set to allow the fishery to remain open.

8.11 Recreational Fishery Bag Limits

Bag limits will be set by each state for the recreational fishery. Each state will consider all factors which affect bag limits throughout the Gulf of Mexico (ie. effort, seasonal occurrence of the fish, etc.) when setting state bag limits.

8.12 Size Limits

A size limit of 12 inches fork length (14 inches total length) for recreationally caught Spanish mackerel in state territorial waters of the Gulf of Mexico is established.

8.13 Statistical Reporting and Monitoring

The stock assessment panel which provides annual stock assessments and allowable biological catch (ABC) ranges to the Gulf of Mexico and South Atlantic Fishery Management Councils will be used to monitor the fishery and set ABC ranges.

The GSMFC Fishery Management Committee will meet as required to reassess all regulatory measures regarding Spanish mackerel in the state territorial waters of the Gulf of Mexico. Recommendations of the Fishery Management Committee will then be considered by the GSMFC Executive Committee. If adopted by the Executive Committee, individual states will be asked to adopt the recommendations or any other recommendations which will meet the immediate and long-term goals of this Spanish Mackerel FMP.

8.14 Research and Data Needs

8.14.1 Collection of Vital Statistics

A. Length frequencies
B. Otoliths for aging
C. Sex ratios
D. Tissue samples for stock identification

8.14.2 Tagging Studies

A. Migration
B. Stock identification
C. Growth

8.14.3 Mortality Studies

A. Fishing mortality
B. Natural mortality
C. Catch and release mortality
D. Tagging mortality

8.14.4 Stock Identification

8.14.5 Fishing Effort Studies

8.14.6 Improved Collection of Landings Data

8.14.7 Social and Economic Studies

8.14.8 Mesh Size Selectivity Studies

8.14.9 Collection of Fishery Independent Data

A. Distribution and abundance of adults
B. Distribution and abundance of pre-recruits
C. Distribution and abundance of larvae
D. Reproduction and spawning stock biomass estimates

9.0 LITERATURE CITED

Anonymous. 1980. Boating registration statistics 1980. National Marine Manufacturers Association. Chicago, IL and New York, NY.

Anonymous. 1982. Coastal Pelagic Fishery Management Plan. Gulf of Mexico and South Atlantic Fishery Management Councils, Tampa, FL and Charleston, SC.

Anonymous. 1985a. Coastal Pelagic Fishery Management Plan, Amendment I. Gulf of Mexico and South Atlantic Fishery Management Councils, Tampa, FL and Charleston, SC.

Anonymous. 1985b. Boating registration statistics 1985. National Marine Manufacturers Association. Chicago, IL and New York, NY.

Anonymous. 1987a. Coastal Pelagic Fishery Management Plan, Amendment II. Gulf of Mexico and South Atlantic Fishery Management Councils, Tampa, FL and Charleston, SC.

Anonymous. 1987b. User group conflict report. A report prepared for the National Fisheries Institute. Washington, DC.

Anonymous. 1988. Processed fishery products: annual summary, 1986. U.S. NMFS, Washington, DC.

Austin, C.B., R.D. Brugger, J.C. Davis, and L. Siefert. 1977. Recreational boating in Dade County. Univ. Miami Sea Grant. Special report No. 9. Coral Gables, FL.

Bane, G.W. and Bane, A.W. 1984. A fisheries related visit to PESCA, Mexico. CWR Report, various pagination. LSU Center for Wetlands Resources, Baton Rouge, LA 70803.

Beaumariage, D.S. 1970. Current status of biological investigations of Florida's mackerel fisheries. In: Proc. Gulf and Caribb. Fish. Inst. 22nd Annual Meeting, 1969:79-86.

Berrien, P. and D. Finan. 1977. Biological and fisheries data on king mackerel, Scomberomorus cavalla (Cuvier). NMFS, Sandy Hook Laboratory, Highlands, NJ, Tech. Serv. Rept. No. 8. 42 pp.

Bigelow, H.B. and W.C. Schroeder. 1948. Fishes of the western North Atlantic. Part 1. Sharks. Sears Found. Mar. Res. Mem. 1(1):104-172.

Bohlke, J.E. and C.G. Chaplin. 1968. Fishes of the Bahamas and adjacent tropical waters. Livingston Publ. Co., Wynnewood, PA. 771 pp.

Browder, J.A., J.C. Davis, and C.B. Austin. 1978. Study of the structure and economies of the recreational paying-passenger fisheries of the Florida Gulf Coast and Keys, from Pensacola to Key West. Univ. Miami Contract Final Rep. to NMFS, Southeast Fish. Cent., Contract No. NOAA/03/7/042/35142.

Brusher, H.A., L. Trent, and M.L. Williams. 1978. Recreational fishing for king mackerel in Bay County, Florida during 1975. In: [C.B. Austin, et al.] Mackerel Workshop Report. Univ. Miami Sea Grant Spec. Rep. No. 14. Coral Gables, FL:117-139.

Bryan, H. 1976. The sociology of fishing: a review and critique. In: [R. Stroud and H. Clepper] marine recreational fisheries. Sport Fishing Institute, Washington, DC.

Burns, K.M. and B.D. Fortune. 1987. Mackerel tagging and length frequency report. Final report from Mote Marine Lab submitted to NMFS, Contract No. 50-WCNF-6-06014. NMFS, Panama City, FL. 75 pp.

Burns, K.M. and B.D. Fortune. 1988. King mackerel migration and stock assessment study in southern Gulf of Mexico. Final report from Mote Marine Laboratory to NMFS, Contract No. NA-86-WC-H-06115. NMFS, Panama City, FL.

Cato, J.C. and F.J. Prochaska. 1976. Porpoise attacking hooked fish irk and injure Florida fishermen. National Fishermen 56(9).

Cato, J.C., R.A. Morris, and F.J. Prochaska. 1978. Production, costs, and earnings by boat size: Florida Spanish mackerel fishery. Univ. FL Sea Grant Program, Marine Advisory Program Report No. 4. 16 pp.

Centaur Management Consultants, Inc. 1975. Economic impacts of the U.S. commercial fishing industry. A report prepared for the U.S. Dept. Comm., NMFS, 307 pp.

Centaur Management Consultants, Inc. 1977. Economic activity associated with marine recreational fishing. A report prepared for the U.S. Dept. Comm., NMFS, 205 p. Centaur Associates, Inc. 1120 Connecticut Ave., NW, Washington, DC.

Centaur Management Consultants, Inc. 1980. Economic activity associated with marine recreational fishing in 1980. A report prepared for Sport Fishing Institute, Contract No. NA82AA-H-00054.

Centaur Management Consultants, Inc. 1981. Socioeconomic study of mackerel purse fishery. Two vols. Contract rep. to the U.S. Dept. Comm., NMFS·Contract No. NA79-GA-C-0049. 445 pp.

Clark, E. and von Schmidt. 1965. Shark of the central gulf coast of Florida. Bull. Mar. Sci. 15:13-83.

Collette, B.B. and C.E. Nauen. 1983. An annotated and illustrated catalogue of tunas, mackerels, bonitos, and related species known to date. FAO Fisheries Synopsis, 2(125).

Collette, B.B. and J.L. Russo. 1979. An introduction to the Spanish mackerels, genus Scomberomorus. In: Nakamura and Bullis (eds.), Proceedings: Colloquium on the Spanish and king mackerel resources of the Gulf of Mexico. Gulf States Marine Fisheries Commission, No. 4:3-16.

Collette, B.B., J.L. Russo, and L.A. Zavala-Camin. 1978. Scomberomorus brasiliensis, a new species of Spanish mackerel from the western Atlantic. U.S. NMFS, Fish. Bull. 76:273-280.

Ditton, R.B. 1976. Texas charter fishing survey: summary highlights. Dept. Rec. and Parks, TAMU. 5 pp.

Ditton, R.B., N.J. Jarman, T.J. Mertens, M.P. Schwartz, and S.A. Woods. 1977. Charter fishing on the Texas Gulf Coast. Texas Agricultural Exp. Sta. (Rec. and Parks), TAMU. 195 pp.

Dwinell, S.E. and C.R. Futch. 1973. Spanish mackerel and king mackerel larvae and juveniles in the northeastern Gulf of Mexico, June through October, 1969. FL Dept. Nat. Res. Mar. Res. Lab. Leafl. Ser. Vol. 4, Pt. 1, No. 24. 14 pp.

Earll, R.E. 1883. The Spanish mackerel, Cybium maculatum (Mitchell); its natural history and artificial propagation, with an account of the origin and development of the fishery. U.S. Commissioner of Fish and Fisheries, Report for 1880, 395-426.

Eldred, B., R.M. Ingle, K.D. Woodburn, R.F. Hutton, and H. Jones. 1961. Biological observations on the commercial shrimp, Penaeus duorarum (Burkenroad), in Florida waters. FL Mar. Lab. Prof. Pap. Ser. 3. 139 pp.

Eldridge, P. and J.E. Powers. 1984. Commercial and recreational fishery statistics for Spanish mackerel in the southeast United States. Stock Assessment Workshop Document No. SAW/84/GCP/7, Miami, June 1984.

Etzold, D.J., N.O. Murray, and C.D. Veal. 1977. Charterboat fishing on the Mississippi Gulf Coast. A report prepared for the Mississippi-Alabama Sea Grant Consortium, Univ. Southern MS MASGC-T-002. 15 pp.

Fable, W.A., Jr. and E.L. Nakamura. 1986. Observations on purse-seined king mackerel (Scomberomorus cavalla) and Spanish mackerel (Scomberomorus maculatus), March 1983-March 1986. U.S. Dept. Comm., NOAA Tech. Memo. NMFS-SEFC-183. 44 pp.

Fable, W.A., Jr., A.G. Johnson, and L.E. Barger. 1987. Age and growth of Spanish mackerel, Scomberomorus maculatus, from Florida and the Gulf of Mexico. Fish. Bull. 85(4):777-784.

Finucane, J.H. Unpublished data. National Marine Fisheries Service. Panama City, FL.

Finucane, J.H. and L.A. Collins. 1986. Reproduction of Spanish mackerel, Scomberomorus maculatus, from the southeastern United States. Northeast Gulf Sci. 8(2):97-106.

Gentle, E.C., III. 1977. The charterboat sport fishery of Dade County, Florida, March, 1976 to February, 1977. M.S. Thesis, Univ. Miami, Coral Gables, FL.

Godcharles, M.F. and L.H. Bullock. Unpublished report. Spanish mackerel pilot tagging project, Brief synopsis: December 1984-December 1986.

Godcharles, M.F. and M.D. Murphy. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (south Florida) -- king mackerel and Spanish mackerel. U.S. Fish and Wildl. Serv. Biol. Rep. 82(11.58). U.S. Army Corps of Engineers, TR EL-82-4. 18 pp.

Helser, T.E. and S.T. Malvestuto. In press. Age and growth of Spanish mackerel (Scomberomorus maculatus) in the northern Gulf of Mexico. In: Transactions of the Southern Division of Amer. Fish. Soc.

Higgins, E. and R. Lord. 1926. Preliminary report on the marine fisheries of Texas. Appendix IV to the Report of the U.S. Commissioner of Fisheries for 1926. U.S. Bur. of Fisheries. Washington, DC.

Hildebrand, S.F. 1963. Family Clupeidae. In: Fishes of the western North Atlantic. Sears Found. Mar. Res. Mem. No. 1, Part 3:257-454.

Hildebrand, S.F. and L.E. Cable. 1938. Further notes on the development and life history of some teleosts at Beaufort, NC. U.S. Bur. Fish., Bull. 48:505-642.

Horvath, J.C. 1974. Southeastern economic survey of wildlife recreation, executive summary. Georgia St. Univ., Atlanta, GA. 68 pp.

Johnson, A.G. In preparation. Investigation of electrophoretic and morphometric characteristics of Spanish mackerel from the southeastern United States and Mexico.

Klima, E.F. 1959. Aspects of the biology and the fishery for Spanish mackerel, Scomberomorus maculatus (Mitchell), of southern Florida. FL St. Conserv. Tech. Ser., No. 27. 39 pp.

Low, R.A., Jr. 1973. Shoreline grassbed fishes in Biscayne Bay, Florida, with notes on the availability of clupeid fishes. M.S. Thesis, Univ. Miami, Coral Gables, FL. 145 pp.

Lyczkowski-Shultz, J. 1987. Fisheries independent data on abundance and distribution of Spanish and king mackerel larvae in the northcentral Gulf of Mexico (August-November, 1983-1986). Unpub. rep. Louisiana State Univ., Contract No. 173285. 19 pp.

Lyczkowski-Shultz, J., D.L. Ruple, and S.L. Richardson. 1986. Factors influencing the movement of fish larva into Mississippi Sound through a barrier island pass. Final Technical Report, MS-AL Sea Grant Consort., Ocean Springs, MS. 57 pp.

Mackerel Stock Assessment Panel. 1986. Report of the Mackerel Stock Assessment Panel Meeting, March 5-6, 1986, Miami, FL. Gulf and South Atlantic Fishery Management Councils. 11 pp.

Mackerel Stock Assessment Panel. 1987. Report of the Mackerel Stock Assessment Panel Meeting, March 18-20, 1987, Miami, FL. Gulf and South Atlantic Fishery Management Councils. 17 pp.

Mackerel Stock Assessment Panel. 1988. Report of the Mackerel Stock Assessment Panel Meeting, April 6-8, 1988, Miami, FL. Gulf and South Atlantic Fishery Management Councils. 17 pp.

McEachran, J.D., J.H. Finucane, and L.S. Hall. 1980. Distribution, seasonality and abundance of king and Spanish mackerel larvae in the northwestern Gulf of Mexico (Pices: Scombridae). Northeast Gulf Sci. 4(1):1-16.

McEachron, L.W. 1980. Gulf pier and jetty finfish catch statistics for the Gulf waters of Texas, September 1978-August 1979. Management Data Series No. 11. Texas Parks and Wildl. Dept., Coastal Fisheries Branch. Austin, TX.

Manning, L.L. 1987. Rethinking the Magnuson Fisheries Conservation and Management Act from a sport fishing perspective. A report prepared for Sport Fishing Institute. Washington, DC.

Manooch, C.S., III. 1979. Recreational and commercial fisheries for king mackerel, Scomberomorus cavalla, in the south Atlantic Bight and Gulf of Mexico, USA. In: Nakamura and Bullis (eds.), Proceedings: Colloquium on the Spanish and king mackerel resources of the Gulf of Mexico. Gulf States Marine Fisheries Commission, No. 4:33-41.

Modde, T. and S.T. Ross. 1983. Trophic relationships of fishes occurring within a surf zone habitat in the northern Gulf of Mexico. Northeast Gulf Sci. 6(2):109-120.

Morris, R.A., F.J. Prochaska and J.C. Cato. 1977. An economic analysis of king mackerel production by hook and line on the Florida Atlantic coasts. Univ. FL Sea Grant, Marine Advisory Program Report No. 1. 8 pp.

Morris, R.A., F.J. Prochaska, and J.C. Cato. 1978. Production costs and earnings by boat size: Florida Spanish mackerel fishery. Univ. FL Sea Grant.

Naughton, S.P. and C.H. Saloman. 1981. Stomach contents of juveniles of king mackerel (Scomberomorus cavalla) and Spanish mackerel (S. maculatus). Northeast Gulf Sci., 5(1):71-74.

Osburn, H.R. and M.O. Ferguson. 1987. Trends in finfish landings by sportboat fishermen in Texas marine waters, May 1974-May 1986. Texas Parks and Wildl. Dept., Coastal Fish. Branch, Management Data Series No. 119.

Palko, B.J., L. Trent, and H.A. Brusher. 1987. Abundance of Spanish mackerel, Scomberomorus maculatus, in the southeast United States based on charterboat CPUE data, 1982-1985. Marine Fish. Rev., 49(2):67-77.

Poffenberger, J.R. 1987. An economic assessment of the fisheries for king and Spanish mackerel. U.S. Dept. Comm., NOAA, NMFS, NOAA-SEFC, Miami, FL. 66 pp.

Powell, D. 1975. Age, growth, and reproduction in Florida stocks of Spanish mackerel, Scomberomorus maculatus. FL Mar. Res. Publ. No. 5. 21 pp.

Prochaska, F.J. and J.C. Cato. 1977. An economic profile of Florida commercial fishing firms: fishermen, commercial activities, and financial considerations. Univ. FL Sea Grant. Report No. 19. 22 pp.

Quesada, A. 1952. Estrustura economica y social de Mexico: La Pesca. (The economic structure and society of Mexico: The fisheries. Mexico, Buenos Aires.

Rice, K. 1979. An investigation of the Spanish mackerel, Scomberomorus maculatus (Mitchell). Management Data Series No. 3. Texas Parks and Wildl. Dept., Coastal Fisheries Branch. Austin, TX.

Richardson, S.L. and J.D. McEachran. 1981. Identification of small (<3 mm) larvae of king and Spanish mackerel, Scomberomorus cavalla and S. maculatus. Northeast Gulf Sci. 5(1):75-79.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fish. Res. Board of Canada. No. 191.

Ridgely, J.E. and D.G. Deuel. 1975. Participation in marine recreational fishing northeastern United States, 1973-74. U.S. NMFS Current Fish. Statistics. No. 6236. 8 pp.

Robins, C.R., R.M. Bailey, C.E. Bond, J.R. Brooker, E.A. Lachner, R.N. Lea, and W.B. Scott. 1980. A list of common and scientific names of fishes from the United States and Canada. Amer. Fish. Soc. Special Pub. No. 12, 4th Ed.

Ruello, N.V. and G.W. Henry. 1977. Conflict between commercial and amateur fishermen. Australian Fisheries, March, p. 4-10.

Ryder, J.A. 1887. On the development of osseus fishes, including marine and freshwater forms. Rep. U.S. Fish. Comm. 13(1885):489-605.

Saloman, C.H. and S.P. Naughton. 1983. Food of Spanish mackerel, Scomberomorus maculatus, from the Gulf of Mexico and southeastern seaboard of the United States. U.S. Dept. Comm., NOAA Tech. Mem. NMFS-SEFC-128. 22 pp.

Scott, G.P. and D.M. Burn. 1987. Updated assessment information on the status of the Spanish mackerel resource in the southeastern United States. A report prepared for U.S. Dept. Comm., NOAA, NMFS ML-CRD-86/87-17.

Shaw, R.F. and D.L. Drullinger. 1986. Early life history of coastal pelagic finfish in Louisiana. Final report to Coastal Fish. Inst., Center for Wetlands Res., Louisiana State U. p. 244-263.

Skow, L.C. and M.E. Chittenden, Jr. 1981. Differences in hemoglobin phenotypes among Spanish mackerel, Scomberomorus maculatus. Northeast Gulf Sci. 5(1):67-70.

Springer, V.G. and J. Pirson. 1958. Fluctuations in the relative abundance of sport fishes as indicated by the catch at Port Aransas, Texas 1952-1956. Pub. Inst. Mar. Sci. 5:169-185.

Stevenson, C.H. 1893. Report on the coast fisheries of Texas. Report of the Commissioner for 1889 to 1891. Part xvii. U.S. Commission of Fish and Fisheries. Washington, DC.

Struhsaker, J.W., M.B. Eldridge, and T. Echeverria. 1974. Effects of benzene (a water-soluble component of crude oil) on eggs and larvae of Pacific herring and northern anchovy. p. 253-284. Vernberg and Vernberg, eds. Academic Press, New York.

Sutherland, D.F. and W.A. Fable, Jr. 1980. Results of a king mackerel (Scomberomorus cavalla) and Atlantic Spanish mackerel (Scomberomorus maculatus) migration study, 1975-79. U.S. Dept. Comm. NOAA, NMFS, NOAA Tech. Memo., NMFS-SEFC-12. 18 pp.

Swingle, W.E. 1976. Analysis of commercial fisheries catch data for Alabama. AL Mar. Res. Bull. No. 11, p. 26-50.

Texas Game, Fish and Oyster Commission. 1912. Annual report of the Game, Fish and Oyster Commission for 1912. Texas Game, Fish and Oyster Commission. Austin, TX.

Texas Game, Fish and Oyster Commission. 1930. Year book on Texas conservation of wildlife, 1929-30. Texas Game, Fish and Oyster Commission. Austin, TX.

Texas Parks and Wildlife Department. 1980. Statewide hunting and fishing proclamation 1980-81. Texas Parks and Wildl. Dept. Austin, TX.

Trent, L. and E.A. Anthony. 1979. Commercial and recreational fisheries for Spanish mackerel, Scomberomorus maculatus. In: Nakamura and Bullis (eds.), Proceedings: Colloquium on the Spanish and king mackerel resources in the Gulf of Mexico. Gulf States Marine Fisheries Commission, No. 4, p. 17-32.

U.S. Department of Interior, Fish and Wildlife Service. 1972. 1970 national survey of fishing and hunting. U.S. Government Printing Office, Washington, DC.

U.S. Department of Interior, Fish and Wildlife Service. 1977a. 1975 survey of hunting, fishing, and wildlife-associated recreation; state technical reports. Individual state reports prepared by National Analysts, division of Booz, Allen, and Hamilton.

U.S. Department of Interior, Fish and Wildlife Service. 1977b. 1975 survey of hunting, fishing, and wildlife-associated recreation. A study conducted by National Analysis, division of Booz, Allen, and Hamilton, Inc. 91 pp.

U.S. National Marine Fisheries Service. 1984. Current Fishery Statistics Number 8322, Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1979 (Revised) - 1980. September 1984.

U.S. National Marine Fisheries Service. 1985a. Current Fishery Statistics Number 8324, Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1981 - 1982. April 1985.

U.S. National Marine Fisheries Service. 1985b. Current Fishery Statistics Number 8326, Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1983 - 1984. August 1985.

U.S. National Marine Fisheries Service. 1986. Current Fishery Statistics Number 8327, Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1985. June 1986.

U.S. National Marine Fisheries Service. 1987. Current Fishery Statistics Number 8327, Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1986. September 1987.

Williams, R.O., M.D. Murphy, and R.G. Muller. 1985. A stock assessment of the Spanish mackerel (Scomberomorus maculatus) in Florida. FL Mar. Fish. Comm. FL Dept. Nat. Res.

Wilson, K.W. 1977. Acute toxicity of oil dispersants to marine fish larvae. Mar. Biol. 40:65-74.

Wollam, M.B. 1970. Description and distribution of larvae and early juveniles of king mackerel, Scomberomorus cavalla (Cuvier), and Spanish mackerel, Scomberomorus maculatus (Mitchell); (Pices: Scombridae): in the western North Atlantic. FL Dept. Nat. Res., Mar. Research Lab., Tech. Series, No. 61. 35 pp.

9.1 Personal Communications

Antozzi, William. 1987. National Marine Fisheries Service. St. Petersburg, FL.

Burns, K.M. 1988. Mote Marine Laboratory. Sarasota, FL.

Collins, L.A. 1987. National Marine Fisheries Service. Panama City, FL.

Davenport, G. 1988. National Marine Fisheries Service. Miami, FL

Essig, Ronald J. 1988. National Marine Fisheries Service. Washington, DC.

Fable, William. 1988. National Marine Fisheries Service. Panama City, FL.

Gartner, J.V. 1987. Florida Department of Natural Resources. St. Petersburg, FL.

Gartner, J.V. 1988. Florida Department of Natural Resources. St. Petersburg, FL.

Nakamura, E. 1987. National Marine Fisheries Service. Panama City, FL

Osburn, H.R. 1987. Texas Parks and Wildlife Department. Rockport, TX.

Snell, Ernest. 1987. National Marine Fisheries Service. Miami, FL.

Tatum, Walter (from Callaway 1983 personal communication). 1988. Alabama Department of Conservation and Natural Resources. Gulf Shores, AL.

Van Hoose, Mark. 1987. Alabama Department of Conservation and Natural Resources. Dauphin Island, AL.

Warren, James. 1987. Gulf Coast Research Laboratory. Ocean Springs, MS.

Williams, Roy. 1987. Florida Marine Fisheries Commission. Tallahassee, FL.

Witzig, J. 1988. National Marine Fisheries Service. Washington, DC.