PROCEEDINGS:

COLLOQUIUM ON SNAPPER-GROUPER FISHERY RESOURCES OF THE WESTERN CENTRAL ATLANTIC OCEAN

Edited by

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Hosted by
Gulf States Marine Fisheries Commission
New Orleans, Louisiana

NOTE

The Colloquium on Snapper-Grouper Fishery Resources of the Western Central Atlantic Ocean was held October 16, 1975, at the Gulf States Marine Fisheries Commission meeting in Pensacola Beach, FL.

The purpose of the Colloquium was to assemble information on the snapper and grouper resources in the region and to provide a forum to discuss the problems of the fishing industries. Although the Colloquium was received with favor, we believe its accomplishments can best be judged by the extent to which it stimulates future consideration and research. We recommend to other persons the colloquium technique of addressing fishery resource problems, especially when the available information is unrecorded or scattered among many individuals.

We wish to express our appreciation to Mr. Charles H. Lyles, Chairman of the Gulf States Marine Fisheries Commission, at whose invitation the Colloquium was held. The success of the colloquium is due primarily to the scientists, administrators, and commercial and recreational fishermen who prepared the papers and participated in the discussions. In many cases, these individuals contributed their own time and funds to prepare for and participate in the Colloquium. Susan E. Coleman, National Marine Fisheries Service, provided the editorial assistance, and the State University System of Florida Sea Grant College Program printed the Proceedings under a cooperative funding arrangement with the Texas A&M Sea Grant College Program and the Mississippi/Alabama Sea Grant Consortium, Mississippi Cooperative Extension Service, Sea Grant Advisory Service. We express our special appreciation to each of them.

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INTRODUCTION[1/]

Chairman of the Colloquium
Harvey R. Bullis, Jr.
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The snappers and groupers of the Gulf of Mexico and Caribbean region have been the basis for a large, wide ranging fishery for more than a century. But interestingly, the stocks and the fisheries have received very little study proportionate to their economic importance. In recent years, we have begun to see an increasing interest, and several important biological studies have been reported. However, over the past 50 years not more than three or four technical reviews of the fishery have been conducted, and these are most incomplete and badly out of date.

There appear to be several problems developing in the snapper and grouper stocks on the Gulf. We must give these some consideration right now. We know that the total effort has been increasing rapidly in recent years. Can we measure the effect?

Extended jurisdiction is on everyone's mind. What will this do to our wide-ranging commercial fleet? What will we be protecting, or perhaps reserving, for our own use off the coast of the United States?

We need to recognize that the United States is but one of some three dozen countries in the western central Atlantic marine ecosystem. All of the other countries have interest in these stocks as well. Eventually, and perhaps sooner than anyone believes, we may need to look at the prospects of an international management regime. At that time, we will need to have developed some kind of consensus position for the United States.

In Trinidad next week, the inaugural meeting of the Western Central Atlantic Fisheries Commission is going to take place. This is a new commission that has been organized under the sponsorship of FAO. Ours is the last region in the world to be represented by a fisheries commission. Approximately 25 nations have joined to date. The United States is a member. And we know that one of the principal interests is going to be in "reef fish communities," which include the snapper-grouper resources. This means that 25 nations are going to start formal considerations on research requirements, statistical requirements, possible management needs, conservation, and, eventually, to questions of allocation. As will emerge from our discussions this morning, we'll see that the United States fisheries, both commercial and

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1/ Introductory comments, statements, and discussions have been edited only to achieve clarity, continuity, and relevance.

recreational, have the largest stake in this resource. If we are going to meaningfully participate in this international forum, we need to do it from a solid home base. It will be difficult for those representing the United States to do a good job if the overall user-community fails to provide them with a rational perspective of U. S. needs and interests.

This doesn't mean that we need a total consensus amongst all users. We can recognize the fact that we do have problems with allocation; we do have growing conflicts between user groups; we do see recreational fisheries displacing commercial fisheries; we see some of the traditional conflicts between commercial and recreational fishermen in localized areas. But, I don't believe that this Colloquium is in a position to solve these problems this morning. It is important that they be brought out in the most constructive spirit that we are able to present them. We will then have a documented basis for developing a rational approach to these problems.

My first meeting with the Gulf States Marine Fisheries Commission took place here 25 years ago. Those of you who knew Pensacola then will remember the dock area studded with snapper schooner masts. There was a large fleet of snapper vessels operating out of this port. In the fish business, "red snapper" and "Pensacola" were synonymous words. Today the single survivor of that fleet is a museum piece, tied to the dock in downtown Pensacola -- the snapper schooner BUCCANEER, which, by the way, I helped pull off Alacran Reef 23 years ago with the exploratory fishing vessel OREGON. It is the only memento of an era that has disappeared in our lifetime. The changes that have occurred in this fishery are the basis for this Colloquium. We hope it will provide a compendium of existing knowledge of the fishery, the resources, and all there is to know of importance about snapper-grouper resources as they affect United States interests.

There are only four hours to complete all the presentations at hand. We must stay on schedule to get through everything on the agenda. If there are contentious issues, they will have to be saved for after the banquet this evening.

The organization of the Colloquium has been summarized in the agenda. Everyone should have received copies at the registration desk. I would like to give you the rationale for the organization of the program. In Panel 1, we have a group of five speakers who have prepared Review Papers on the broader aspects of factors affecting the resource and its fisheries. In addition to these five papers, seven Contributed Papers have been prepared that will also appear in the published proceedings of this Colloquium. I would like to express our appreciation to these authors, who will not have a chance to stand up and take bows for their input this morning. You can see the subject content of these papers in the list of abstracts that was also handed out at the desk.

Panel 2 members will strive to develop a list of problem areas as seen by the principal user groups: the producers, the sportsmen and recreational industry, and even the marine supply business. We have provided them with list of provocative questions; and, hopefully, their frank answers will develop new and better understanding of the user needs.

Panel 3 is composed of a representative of each of the Gulf States fisheries agencies. It will be their task to identify the problems of state and possible interstate management. Hopefully, they will also discuss, when appropriate and applicable, some of the pertinent questions raised in Panel 2. We should be particularly interested in the problems of dialogue and communication between state agencies and the National Marine Fisheries Service in respect to international matters that are developing in this region.

Finally, the chairman of the Gulf States Marine Fisheries Commission will provide a summation of the important elements that will be highlighted in these panels.

I would like to introduce the moderator of Panel 1, Dr. Albert C. Jones. Dr. Jones is Program Manager of the Commercial Fisheries Program at the Southeast Fisheries Center. His team has done much of the legwork of putting this Colloquium together and deserves full credit for their diligence. Further, Dr. Jones' program at Miami has been building background profiles on Southeastern U. S. flag fisheries that are operating in international waters and along foreign coasts.

PANEL 1

SNAPPER-GROUPER RESOURCES AND THEIR UTILIZATION

Moderator
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The purpose of Panel 1 of the Colloquium is to review the snapper-grouper resources and their utilization and to provide a common base of information that can be used for the discussions to follow. The information base is contained in 12 papers. Five Review Papers were prepared on general subjects: the resource base, the commercial fishery, the recreational fishery, biological research, and the economics of the industry.

The Review Papers will be summarized verbally by Edward F. Klima, Donald M. Allen, Eugene L. Nakamura, Charles R. Futch,[2] and James C. Cato.

In addition, seven authors prepared Contributed Papers on various specialized topics. We will not have verbal summaries of these. The panel members and authors will participate in the discussion and answer questions.

I want to thank the state fishery administrators and the other agency directors who allowed and encouraged their staffs to participate in the Colloquium. We received, without reservation, enthusiastic response from them when we asked for participation. The preparation of these papers took several months of work, and, in many cases, this was done on time taken from more pressing duties.

2/ Charles R. Futch summarized the Review Paper by D. S. Beaumariage and Lewis H. Bullock.

SNAPPER AND GROUPER RESOURCES OF THE WESTERN CENTRAL ATLANTIC OCEAN 1/

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ABSTRACT

Estimates of the standing stock and potential yields of snappers, groupers, and related species are provided for the Caribbean Sea and Campeche Bank area of the Gulf of Mexico. Handline fishing explorations by the United Nations Food and Agriculture Organization (FAO) Caribbean Project provided the basic data for assessment of the resources in the Caribbean Sea. Exploratory trawl surveys by the Pascagoula Laboratory of the National Marine Fisheries Service (NMFS), NOAA and catch and effort data from the Cuban and Mexican snapper fisheries provided the basis for the Campeche Bank assessments. Present production of snappers and groupers can probably be significantly increased in many areas of the Caribbean, notably along the Continental Shelf of northeast South America off the Guianas and the Central American Shelf. One problem hampering increased production in some island communities is the occurrence of ciguatera in the fish in the northern Leeward Islands. Production for both snappers and groupers can be increased in the Campeche Bank area. Increased red grouper production can be realized by altering the age at entry into the fishery from 3 to about 5 years of age and increasing fishing effort.

INTRODUCTION

The western central Atlantic Ocean is one of the under-exploited areas of the world, even though it supports some important fisheries. Numerous authors have reported on the potential of the available fish resources of this vast region. Unfortunately, reliable estimates are lacking for most species groups with a high potential for development. Bullis and Carpenter (1968) reported on the abundance of finfish resources in the Gulf of Mexico and off the southeastern coast of the United States. They indicated that considerable underutilized stocks of snappers, groupers, and other demersal species occurred in the Gulf of Mexico and the Shelf area off northeast South America. Kawaguchi (1974) estimated that annual production of snappers in the Caribbean Sea could be increased from two to four times by utilizing under

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1/ MARMAP Contribution No. 113.

fished or unfished grounds. However, development of the snapper-grouper resources encounters difficulty because of the presence of ciguatera or toxic fish in some areas.

This report analyzes existing information and crudely estimates the snapper and grouper potential of the western central Atlantic Ocean.

BACKGROUND

DISTRIBUTION

Snappers (Lutjanidae) occur in the waters between Massachusetts and Brazil, with large concentrations of the Gulf red snapper (*Lutjanus campechanus*) off the Yucatan Peninsula and the Texas and Louisiana coasts. There are also large concentrations of snappers in the Caribbean. Snappers are abundant on irregular bottom of hard limestone that is covered with live corals, although large catches also have been reported over mud bottoms. Red snapper often congregate in "gullies" and around rocks or coral outcrops.

The Atlantic groupers are generally tropical in distribution,with the 21° C isotherm as their northern limit. They occur mostly in waters of less than 183 m depth,in hard bottom reef areas.

The groupers live a solitary life and often require crevices and holes in which to hide. They spawn throughout the year, with a spawning peak in the spring.

THE FISHERY

Although about 20 species of snappers and groupers are included in the fishery, the Gulf red snapper is the main one exploited. The fishing grounds for snappers and groupers include: (1) oceanic banks, (2) coastal and insular waters up to a depth of 219 m in the Gulf of Mexico and the western Caribbean, and (3) the southeastern coast of the United States (North Carolina to the Bahamas Bank). Fishing is carried out mainly with handlines bearing several baited hooks retrieved by mechanical reels.

Presently, total production of snappers, groupers, grunts, jacks, and porgies in the western central Atlantic is between 64,000 and 126,000 metric tons (Table 1).

Total production of snappers in 1973 was over 31,000 tons and almost 24,000 tons of groupers were harvested; probably most of this comes from the Campeche Bank. The Campeche Bank area produces about 75% of the total grouper production and about 10% of the total snapper production (Table 2). Total production was stable from 1966 to 1971, at around 60,000 tons. In 1972 the U.S.S.R. caught close to 60,000 tons of grunts and porgies, thereby doubling total production to over 120,000 tons. The U.S.S.R. did not maintain this fishing intensity in 1973, 1974, or 1975. Perhaps an additional 5,000 - 10,000 tons of snappers are caught incidentally to the grunts and porgies. Cuba increased production of

Table 1. Catch Statistics for Snappers, Groupers, Grunts, Porgies, and Jacks (in Thousand Metric Tons) from the Western Central Atlantic Ocean, 1970-73.

Catch of Major Species					
Species		Catch (1,000 mt)			
		1970	1971	1972	1973
Snappers	Total	18.2	21.8	20.0	31.6
red		7.8	9.6	8.2	7.8
lane		3.2	4.1	3.8	13.9
yellowtail		1.6	1.9	1.4	2.0
n.e.i. 1/		5.6	6.2	6.6	7.9
Groupers	Total	23.4	22.2	26.3	23.9
Nassau		0.9	1.1	1.0	1.0
red		17.3	15.9	19.7	17.6
n.e.i.		5.2	5.2	5.6	5.3
Grunts	Total	16.1	12.6	65.3	20.4
Caribbean		16.0	12.5	65.2	20.3
n.e.i.		0.1	0.1	0.1	0.1
Jacks	Total	5.4	6.5	5.6	7.9
Porgies	Total	1.4	3.6	8.9	3.6
TOTAL		64.5	66.7	126.1	87.4

1/ n.e.i. = not elsewhere included.

Table 1. (Continued).

Snapper Catch by Country					
Country	Species	Catch (1,000 mt)			
		1970	1971	1972	1973
Cuba	Total	5.8	8.0	6.9	16.9
	Caribbean red	1.4	2.5	1.5	1.5 * 2/
	lane	3.1	4.0	3.7	13.7 *
	yellowtail	0.7	0.8	0.9	0.9 *
	n.e.i. 1/	0.6	0.7	0.8	0.8 *
Mexico	Total	2.9	2.9	3.5	3.5
	red	2.3	2.0	2.8	2.3
	lane	0.1	0.1	0.1	0.2
	yellowtail	0.3	0.4	0.3	0.5
	n.e.i.	0.2	0.4	0.3	0.5
U.S.	Total	5.1	6.1	3.9	4.6
	red	4.1	5.1	3.9	4.0
	lane	0.5	0.5	0.0	0.1
	n.e.i.	0.5	0.5	0.0	0.5
Venezuela	Total	3.1	3.3	4.2	5.0
	yellowtail	0.1	0.2	0.2	0.5
	n.e.i.	3.0	3.1	4.0	4.5
Colombia	n.e.i.	0.4	0.5	0.5	0.5 *
Dominican Rep.	n.e.i.	0.1	0.1 *	0.1 *	0.2
Grenada	n.e.i.	0.0	0.1	0.1	0.1 *
Guadeloupe	n.e.i.	0.8 *	0.8 *	0.8 *	0.8 *

1/ n.e.i. = not elsewhere included.
2/ * = data estimated or calculated by FAO.

Table 1. (Continued).

Grouper Catch by Country					
Country	Species	Catch (1,000 mt)			
		1970	1971	1972	1973
Cuba	Total	9.5	6.7	6.8	6.8
	Nassau	0.9	1.1	1.0	1.0 * 2/
	red	8.6	5.6	5.8	5.8 *
Mexico	Total	9.0	10.7	14.2	12.3
	red	8.7	10.3	13.8	11.7
	n.e.i. 1/	0.3	0.4	0.4	0.6
U.S.	Total	3.7	3.5	3.5	3.2
	red	- - - - - - - no data - - - - - - - -			
	n.e.i.	3.7	3.5	3.5	3.2
Venezuela	Total	1.1	1.2	1.2	1.3
	red	- - - - - - - no data - - - - - - - -			
	n.e.i.	1.1	1.2	1.2	1.3
Dominican Rep.	n.e.i.	0.1	0.1 *	0.1 *	0.2
Colombia	red	0.0	- - 3/	0.1	0.1 *
U.S.S.R.	n.e.i.	- -	0.0	0.4	0.0

1/ n.e.i. = not elsewhere included.
2/ * = data estimated or calculated by FAO.
3/ - - = negligible catch.

Table 1. (Continued).

Grunt Catch by Country

Country	Species	Catch (1,000 mt) 1970	1971	1972	1973
Cuba	Caribbean	12.4	6.8	6.2	6.2 * 2/
Mexico	Caribbean	0.3	0.4	0.2	0.4
U.S.S.R.	Caribbean	- - 3/	1.4	53.5	7.9
U.S.	Total	0.3	0.3	0.2	0.3
	Caribbean	0.2	0.2	0.1	0.2
	n.e.i. 1/	0.1	0.1	0.1	0.1
Venezuela	Caribbean	3.1	3.7	5.2	5.6

Porgy Catch by Country

Country	Species	Catch (1,000 mt) 1970	1971	1972	1973
Cuba		0.4	2.0	1.9	1.9
U.S.S.R.		- -	0.4	6.0	0.3
Mexico		0.5	0.6	0.6	0.8

1/ n.e.i. = not elsewhere included.
2/ * = data estimated or calculated by FAO.
3/ - - = negligible catch.

Table 1. (Continued).

Jack Catch by Country

Country	Species	Catch (1,000 mt) 1970	1971	1972	1973
Colombia		0.2	0.3	0.3 * 2/	0.3 *
Cuba		0.4	0.4	0.4	0.4 *
Dominican Republic		0.1	0.3	0.3	0.2
Mexico		1.2	1.3	1.3	1.7
U.S.		1.8	2.2	1.3	2.2
U.S.S.R.		- - 3/	- -	- -	- -
Venezuela		1.7	2.0	2.0	3.1

2/ * = data estimated or calculated by FAO.
3/ - - = negligible catch.

Source: FAO (1974).

Table 2. Estimated Catch (in Metric Tons) on Campeche Bank, 1966-74.

Year	Trawl Catch 1/ U.S.S.R., Cuba	Snappers Cuba, U.S., Mexico	Groupers Mexico, Cuba	Other Finfishes Mexico (East Coast) 2/	Total
1966	32,252	2,136 3/	7,399 4/	18,133	59,909
1967	30,197	2,669 3/	9,484	20,575	62,925
1968	16,541	2,899	10,914	22,915	53,269
1969	18,156	2,626	12,487	24,933	58,202
1970	7,901	2,756	14,979	26,461	52,097
1971	11,449	2,080	15,033	33,157	61,719
1972	71,415	3,037	18,667	29,677	122,796
1973	16,807				
1974	26,850				

1/ All species.

2/ Most fish were caught from an area south of Veracruz to the eastern tip of Yucatan.

3/ Does not include U.S. catch.

4/ Does not include Cuban catch.

lane snapper (Lutjanus synagris) from around 4,000 to almost 14,000 tons in 1973 (Table 1).

The Snapper-Grouper Fisheries in the Gulf of Mexico off the United States

The snapper-grouper fisheries began in the 1830's with the New England fishermen operating in Key West; and by the 1850's, the fishery had extended to northwest Florida. Today, the U.S. fleet in the area consists of over 300 vessels and numerous boats. This is a hook-and-line fishery and the fishermen use line reels operated by hand or electricity. The fishing vessels are diesel-powered and the fishermen employ sails for stabilization of the vessel while fishing. The red snapper vessels are based in Florida, Mississippi, and Alabama and range from about 20 to 24 m in length. The U.S. landings from the Gulf of Mexico are shown in Table 3.

The Snapper-Grouper Fisheries in the Gulf of Mexico off Mexico

Carpenter (1965) gave the history of the U.S. snapper-grouper fishery off Mexico. Between 1900 and 1960 the average annual catch by the U.S. fleet was over 1,600 metric tons. The snapper catch includes the Gulf red snapper (the most important single species) and a few others of the family Lutjanidae. The grouper catch includes the red grouper (Epinephelus morio), black grouper (Mycteroperca bonaci), Warsaw grouper (Epinephelus nigritus), and jewfish (Epinephelus itajara). Incidental catches of flounders and porgies are obtained by the snapper-grouper handline fishery.

The Mexican handline vessels have fished on Campeche Bank for many years. The current Cuban and Mexican production of grouper on the Campeche Banks is almost 19,000 tons (Table 4). In recent years, Mexico has produced well over 10,000 tons annually, but Cuba's catch has decreased from around 5,000 to less than 3,000 tons in 1974. The red grouper is the major species for these two fisheries and, according to Moe (1969), is probably the most abundant and commercially important grouper in the Gulf of Mexico. Martin Contreras (pers. comm.) 2/ informed me that red grouper made up over 87% of the Mexican catch. Progreso, Yucatan, the major grouper fishing port, produces over 75% of the total Mexican grouper landings (Table 5).

Basically, there are three types of Mexican grouper fishing vessels in the Yucatan district. The first and most important type is the offshore grouper vessel, which is similar to the snapper vessel but slightly smaller. It also uses from 7 to 10 dories which deploy longlines for fishing, and it fishes almost the entire bank (Fig. 1). The second type of grouper vessel, referred to as an inshore boat, does not exceed 10 m in length and usually makes short trips of 1 or 2 days. This type carries from 2 to 4 dories which deploy longlines, and it generally fishes the inshore waters close to the

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2/ Martin Contreras, Instituto Nacional de Pesca, Progreso, Mexico, pers. comm.

Table 3. The U.S. Snapper-Grouper Fishery Total Landings and Value, 1949-73.

Year	Snappers		Groupers		Total	
	Metric Tons	Thousand Dollars	Metric Tons	Thousand Dollars	Metric Tons	Thousand Dollars
1949	4,130	2,090	4,634	1,012	8,765	3,102
1950	3,605	1,851	3,102	629	6,707	2,480
1951	3,743	2,047	4,334	767	7,177	2,814
1952	4,475	2,312	2,707	714	7,181	3,026
1953	4,061	2,430	2,552	569	6,614	2,999
1954	4,447	2,495	2,756	668	7,203	3,163
1955	4,650	2,574	2,526	568	7,176	3,142
1956	4,498	2,449	3,064	669	7,562	3,118
1957	4,737	2,678	3,471	769	8,208	3,447
1958	5,214	2,919	2,251	544	7,465	3,463
1959	5,363	3,012	3,020	758	8,382	3,770
1960	5,441	3,039	3,111	774	8,552	3,813
1961	6,323	3,518	3,354	745	9,677	4,263
1962	6,455	3,509	3,744	840	10,199	4,349
1963	6,658	3,835	3,579	784	10,237	4,619
1964	7,089	4,456	4,130	979	11,219	5,435
1965	7,195	4,550	4,513	1,072	11,708	5,622
1966	6,664	4,627	3,852	1,055	10,516	5,682
1967	6,609	4,693	3,549	1,093	10,158	5,786
1968	6,285	4,746	3,697	1,318	9,983	6,064
1969	5,507	5,067	3,899	1,596	9,405	6,663
1970	5,181	5,071	3,918	1,573	9,099	6,644
1971	5,127	5,334	3,665	1,555	8,792	6,889
1972	5,151	6,097	3,661	2,037	8,811	8,134
1973	4,999	6,561	3,003	1,896	8,002	8,457

Source : Allen and Tashiro (1976).

Table 4. Catches of Snappers and Groupers (in Metric Tons) on Campeche Bank, 1963-74.

Year	Groupers			Snappers			
	Cuba	Mexico	Total	U.S.	Mexico	Cuba	Total
1963	- -	6,256	6,256	2,676	1,493	- -	4,169
1964	- -	6,876	6,876	- -	1,868	- -	1,868
1965	- -	6,976	6,976	- -	2,102	- -	2,102
1966	- -	7,399	7,399	- -	2,136	- -	2,136
1967	5,135	4,349	9,484	- -	2,669	- -	2,669
1968	5,373	5,541	10,914	688	2,211	- -	2,899
1969	4,956	7,531	12,487	408	2,218	- -	2,626
1970	6,393	8,586	14,979	400	2,356	- -	2,756
1971	4,819	10,214	15,033	288	1,757	35	2,080
1972	4,920	13,747	18,667	- -	3,014	23	3,037
1973	3,253	- -	- -	- -	- -	- -	- -
1974	2,668	- -	- -	- -	- -	- -	- -

Sources: Allen and Tashiro (1976); Centro de Investigaciones Pesqueras, Havana, Cuba; and Instituto Nacional de Pesca, Mexico City, Mexico.

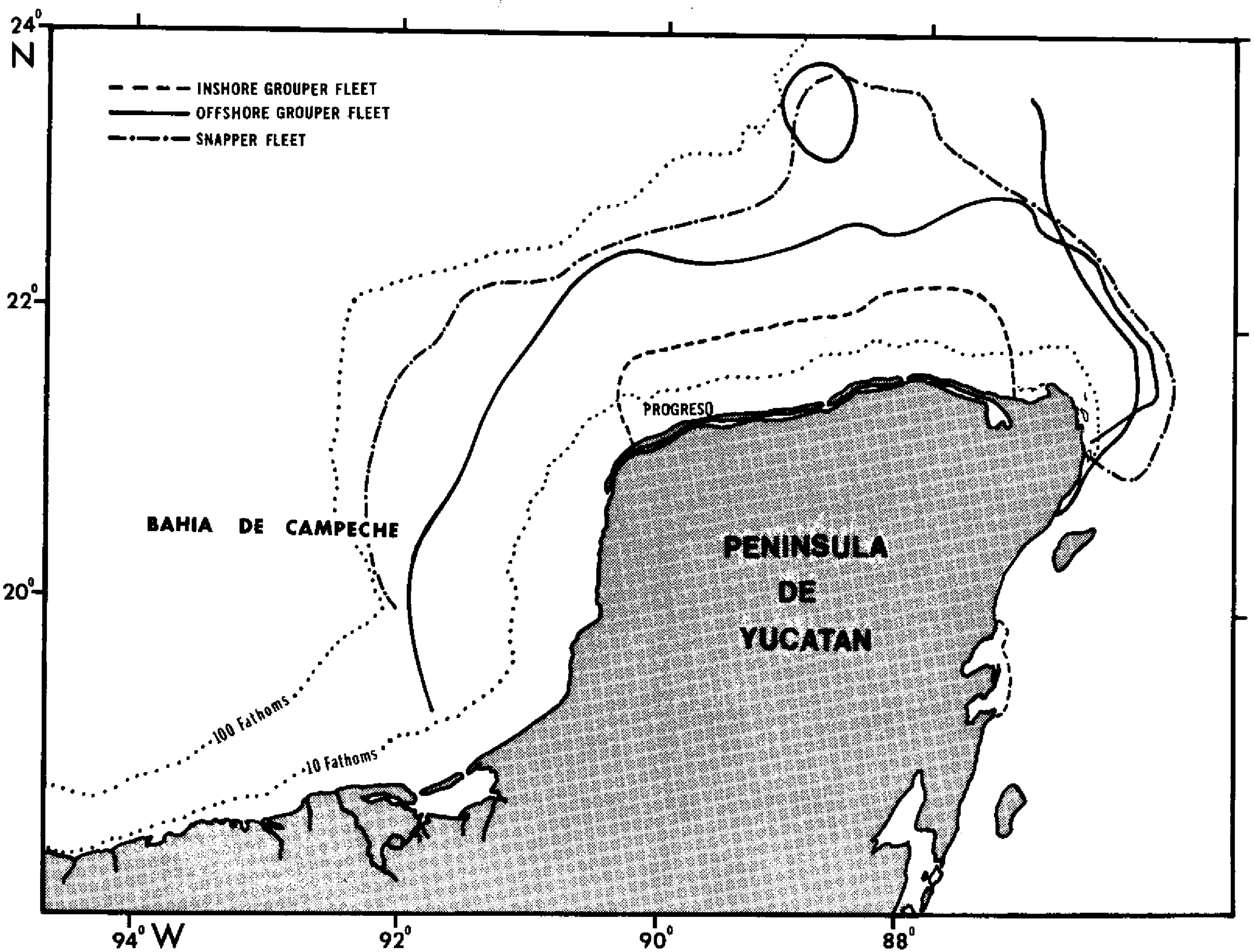
Table 5. Mexican Catch of Groupers (in Metric Tons) by District, 1963-74.

Year	Tamaulipas	Veracruz	Tabasco	Campeche	Yucatan	Quintana Roo	Total
1963	--	--	--	283	5,982	- -	6,256
1964	--	--	--	188	6,670	18	6,876
1965	--	--	--	193	6,732	51	6,976
1966	--	--	--	148	7,175	65	7,388
1967	--	--	--	83	4,178	88	4,349
1968	--	--	--	46	5,415	80	5,541
1969	--	--	--	33	7,426	72	7,531
1970	--	--	--	21	8,495	70	8,586
1971	--	--	--	81	10,081	52	10,214
1972	--	--	--	66	13,443	283	13,792
1973	--	--	--	--	8,615 1/	--	--
1974	--	--	--	--	9,779 1/	--	--

1/ From the Port of Progreso only. The 1972 catch was 75% of the total Mexican catch.

Source: Instituto Nacional de Pesca, Mexico City, Mexico.

Figure 1. Fishing area of Mexican commercial snapper and grouper vessels.



home port. The third type, the unregistered skiff, fishes along the shoreline at night with lights and catches a variety of small fishes and juvenile groupers, which are sold in the morning on the beach.

The breakdown of the numbers and kinds of vessels by years is listed in Table 6. Martin Contreras (pers. comm.; see footnote 2) informed me that in 1972 the offshore grouper vessels produced 57% of the grouper catch landed in Progreso; 34% was produced by inshore vessels, 8% by unregistered vessels, and less than 1% by snapper vessels.

Cuban handline vessels have fished in the same area (Campeche Bank) since 1935. In 1955 the Cuban catch was 1,600 metric tons of groupers and about 200 metric tons of snappers. In more recent years, the Cuban vessels have fished with longlines and trawls. The longline fleet harvests mostly groupers, whereas the trawl fleet catches mostly grunts, with a small incidental catch of snappers. In 1965 the Cuban fleet off Mexico caught about 5,200 metric tons of groupers and about 300 metric tons of snappers, supposedly with longlines and trawl nets (Carles Martin and Liubimova, 1967). There is also an active Cuban fishery off the west coast of Florida beyond the 19-km (12-mile limit). Using handlines and bottom longlines, the Cubans obtained catches of 1,800, 1,700, and 2,200 metric tons in 1971, 1972, and 1973 (Fuss, pers. comm.). 3/

The Snapper-Grouper Fisheries off the South Atlantic Coast of the United States

The fishing grounds lie along the southeastern U.S. coast from North Carolina to Florida and extend to the 219-m depth contour. This is a small fishery, and in 1970 the commercial catch was estimated at 800 metric tons, valued at $800,000 (US). Huntsman (MS.) 4/ gives information on the recreational fishery off North Carolina. In 1972 the catch of that fishery was 600 metric tons, increasing to 700 metric tons in 1973. There was an additional catch of about 100 metric tons of sea basses in 1973 (the black sea bass catch in 1972 was not estimated). The other fish species caught by the recreational fishermen, ranked by order of importance, are: red porgy, vermilion snapper, white grunt, and groupers. Red porgy form the largest proportion of the catch by weight.

3/ Charles Fuss, Jr., Division Chief, Law Enforcement and Marine Mammal Protection Division, NMFS, NOAA, Southeast Region, St. Petersburg, FL 33702, pers. comm.

4/ Huntsman, G. Offshore head boat fishing in North and South Carolina. Unpublished manuscript. Atlantic Estuarine Fisheries Center, NMFS, NOAA, Beaufort, NC 28516.

Table 6. Number of Vessels, by Type, Fishing for Groupers and Snappers Out of Progreso, Mexico, 1962-72. 1/ 2/

Year	Offshore Grouper Vessels	Inshore Grouper Vessels	Snapper Vessels
1962	86	7	11
1963	96	9	13
1964	103	11	15
1965	105	15	16
1966	106	23	23
1967	108	27	24
1968	116	32	29
1969	124	35	32
1970	130	37	32
1971	137	42	34
1972	137	42	37

1/ September 1975, there were 251vessels and 10 non-active vessels.

2/ The number of unregistered vessels is unknown for these years.

Source: Instituto Nacional de Pesca, Mexico City, Mexico.

STATUS OF STOCKS

GULF OF MEXICO AND THE SOUTH ATLANTIC COAST OF THE UNITED STATES

Little information is available on the life history and population dynamics of the exploited fish species. Only crude estimates of standing stocks are available, and no estimates of sustainable catch have been made; however, Bullis, Carpenter, and Roithmayr (1971), using data from exploratory surveys, have given some estimates. The snapper standing stock in the area is put at 160,000 metric tons, and the grouper standing stock for the western central Atlantic is over 110,000 metric tons. The total biomass of snappers and groupers would be about 270,000 metric tons. Using the potential yield equation given by Gulland (1971), and assuming the natural mortality M = 0.5, the potential yield would be about 68,000 metric tons.

The present production of snappers and groupers comes mainly from hand-line fishing in depths of 55-73 m off reefs, wrecks, and oil rigs. However, as revealed by exploratory fishing in the western Gulf of Mexico, there is also a sizable resource along the edge of the Continental Shelf in the 137- to 366- m depth zone which could be harvested with bottom setlines and traps.

The establishment of oil rigs in the Gulf of Mexico has created new fishing grounds for snappers but has brought commercial handlining in direct competition with recreational fishing. Although this competition has not reached a serious stage, the situation is expected to worsen as the two fisheries expand.

CAMPECHE BANK

Groupers

A detailed evaluation of the Mexican red grouper fishery was compiled by Melo (Thesis). He constructed yield isopleths (Figs. 2 and 3) based on the following information:

total mortality $Z = 0.48$
natural mortality $M = 0.24$ and 0.15
$W_\infty = 13.86$ kg (equivalent to 928 mm TL)
$K = 0.1126$

The values for Z and K are approximately the same as reported by Moe (1969) ($Z = 0.32$ and $K = 0.18$) but different for $L_\infty = 672$ mm SL; whereas for Melo (Thesis), $L_\infty = 928$ mm TL (i.e., 672 mm SL $\simeq$ 800 mm TL).

Melo's estimates provide the information necessary to compute the yield per recruit for red grouper as a function of age at first capture and fishing mortality rate. The yield isopleths are shown for $M = 0.15$ and $M = 0.24$ (Figs. 2 and 3, respectively). The point P in each figure indicates the present terms of exploitation. Both plots show that the yield per recruit

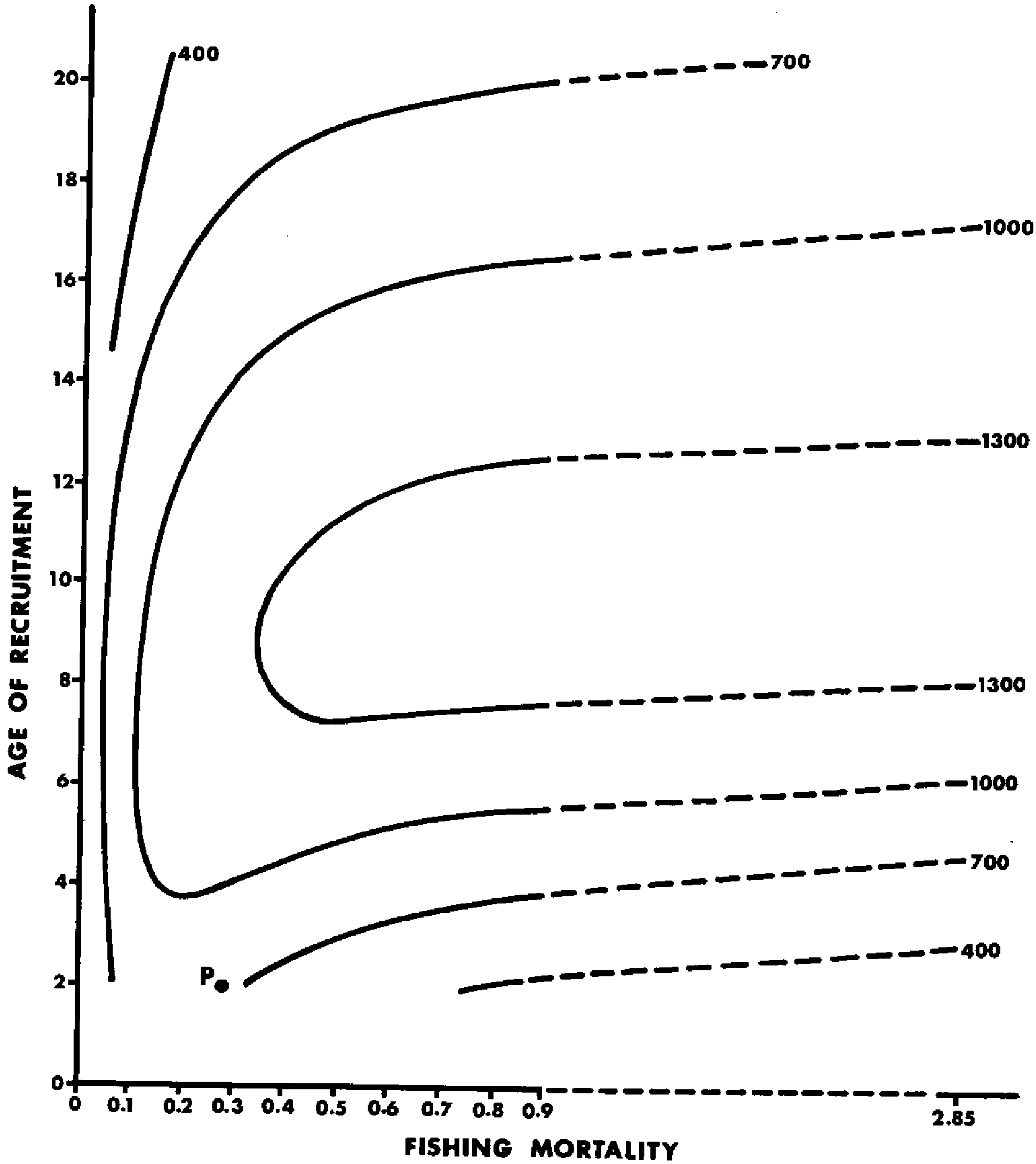


Figure 2. Yield per recruit of red grouper (Epinephelus morio) with M = 0.15, K = 0.1126. The point P marks the present fishing mortality and age at first capture. (Yields are in grams per 2-year-old recruit.)

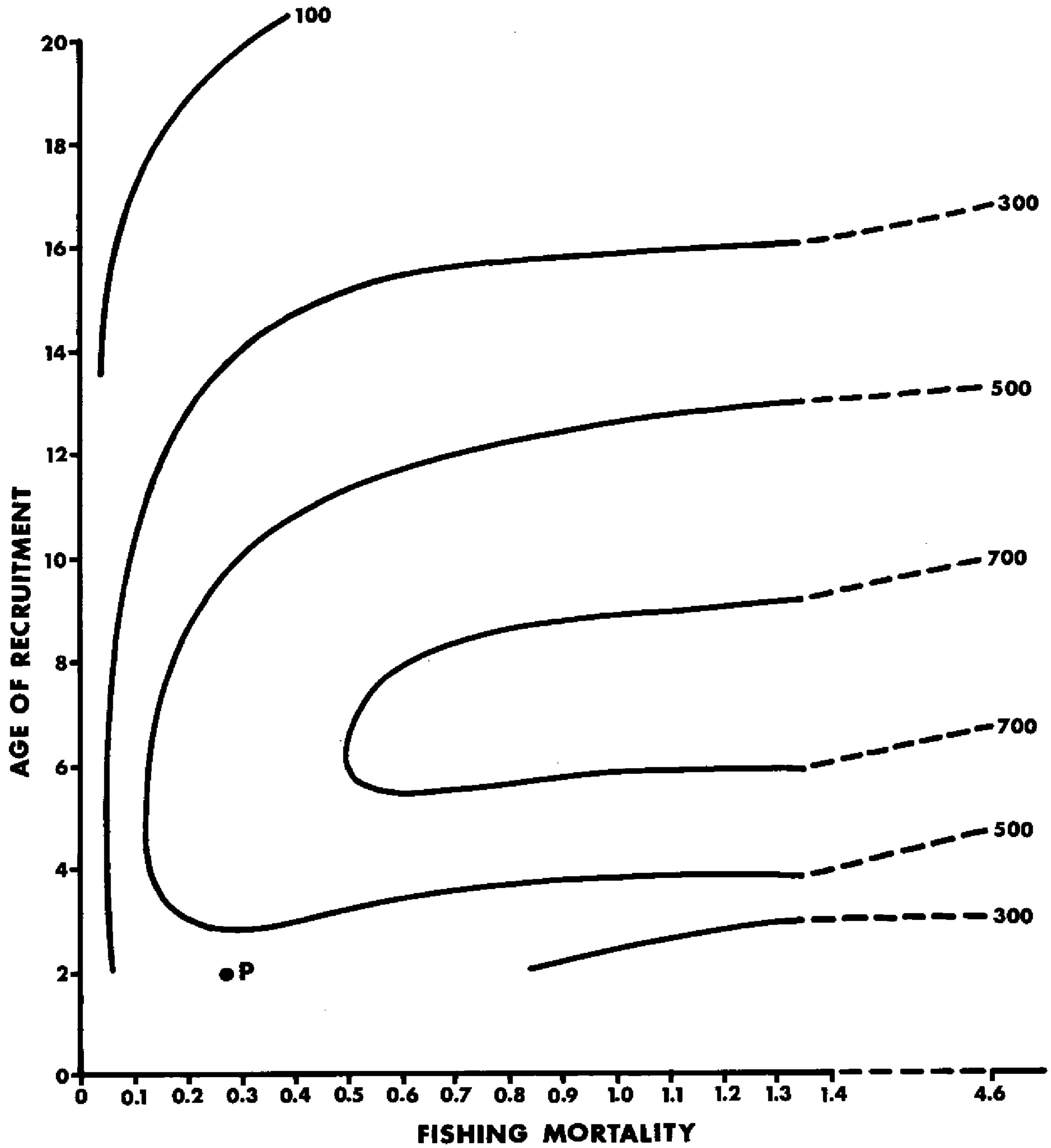


Figure 3. Yield per recruit of red grouper (Epinephelus morio) with M = 0.24, The point P marks the present fishing mortality and age at first capture. (Yields are in grams per 2-year-old recruit.)

could be nearly doubled by increasing the age at first capture from 2 years to 6 years. Hence, the total catch, under proper management, could be increased from the present 19,000 tons to perhaps 35,000 tons. On the other hand, the number of grouper vessels has increased in recent years (Table 6). Figures 2 and 3 show that the yield per recruit will decrease if fishing mortality increases and the age at first capture does not.

Length-frequency samples from the Progreso fleet have been collected since 1972, from which Melo (Thesis) estimated total mortality. Comparison of the length-frequency distribution by year shows a decrease in the dominant modal group from 45 cm in 1972 (age 4) to 32 cm (age 2) in 1974. (Fig. 4). The absence of other information prevents specific interpretation of these data, except that the average size of fishes from newly exploited stocks always decreases until some level of stability is achieved. The grouper fishery has been expanding in recent years, both in the number of vessels and perhaps also to other fishing areas. Further evaluation will require examination of catch and effort records now being collected by Mexico and Cuba.

Red Snapper

Historical

Camber (1955) and Carpenter (1965) reviewed the red snapper fisheries of the Gulf of Mexico. The Campeche Bank became an important fishing area during the early 1890's. Historically, Mexican, Cuban, and U.S. vessels fished this area for snappers. The prime species of importance has been and is *L. campechanus*; however, the term is generic and several species are marketed as "red snapper." The following analysis considers red snapper as a species group unless otherwise stated.

Camber (1955) stated that between 1935 and 1951, *L. campechanus* comprised over 93% of the U.S. catch. Probably the species composition of the Cuban and Mexican catch was similar during this period. Unfortunately, catch information is not available for the Cuban and Mexican fishery from 1937-51. Detailed U.S. catch and effort data for this period, presented by Camber (1955), indicated that about 50% of the total red snapper catch was produced by U.S. vessels.

Using Camber's 1955 sample catch and effort data of 28 vessels out of a total U.S. fleet of 39 vessels, I estimated the total catch and effort for the U.S. fleet fishing the Campeche Bank (Table 7). I constructed a simple Schaefer model using these data (Figs. 5 and 6). The maximum point of the curve indicates a MSY of 2,400 metric tons, but I have not included the catch of either the Cuban or Mexican fleets, as they are not known precisely. Camber (1955) indicated that the U.S. fleet caught approximately 50% of the total catch of red snappers from the Campeche Bank. Hence, I assumed that the total catch must have been twice the U.S. catch and also that the efficiency between fleets was similar and did not change during the time period. During that period, U.S. efficiency remained static and

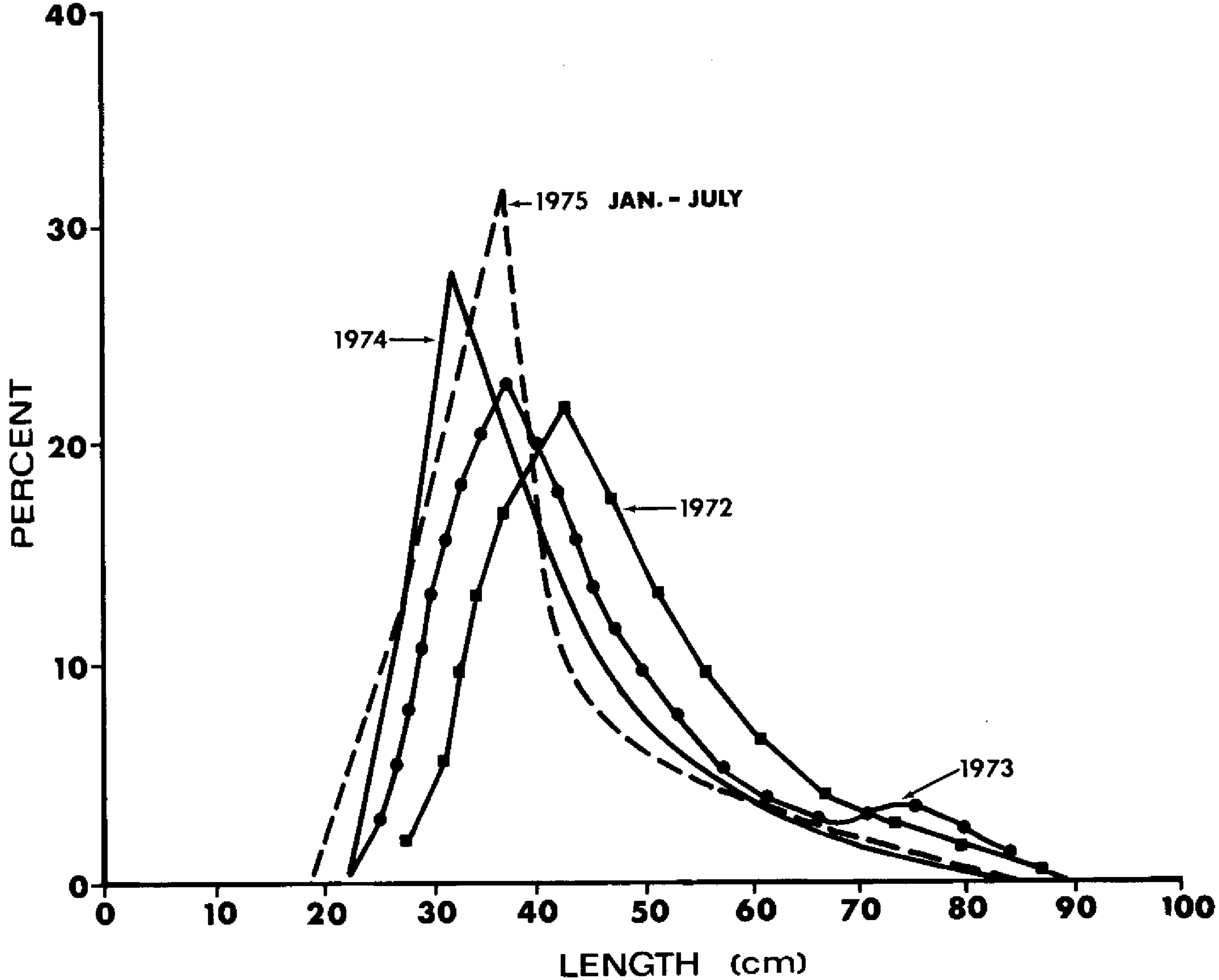


Figure 4. Red grouper length frequency sampled from the Mexican fleet, 1972 - 75.

Table 7. Estimated U.S. Catch of Red Snapper (in Metric Tons) from the Campeche Bank, 1934-51.

Year	Florida 1/ Landings	Alabama 1/ Landings	Total Landings	Selected Sample	Effort 2/ (Man-Days at Sea)	CPUE 3/ (4/5 = 6)	Estimated Total Effort (Man-Days at Sea)
1934	1,995.8	4/	4/	- -	- -	- -	- -
1937	2.032.6	423.8	2,456.4	1,463.7	67,717	0.0216	113,722
1938	2,075.2	432.9	2,508.1	- -	- -	- -	- -
1939	1,754.2	370.1	2,124.3	1,225.9	63,616	0.0193	110,067
1940	1,623.1	444.5	2,067.6	1,112.4	61,199	0.0182	113,604
1941	1,842.2	554.9	2,397.1	1,512.4	63,290	0.0239	100,297
1942	1,275.8	456.9	1,732.7	1,125.0	45,692	0.0246	70,434
1943	1,412.3	372.4	1,784.7	1,072.5	37,548	0.0286	62,402
1944	1,473.5	411.3	1,884.8	1,147.0	37,525	0.0306	61,594
1945	1,465.9	524.6	1,990.5	1,216.5	44,451	0.0274	72,646
1946	1,614.8	571.6	2,186.4	1,475.1	50,139	0.0294	74,367
1947	1,597.8	521.9	2,119.7	1,375.7	53,117	0.0259	81,842
1948	1,909.9	621.6	2,531.5	1,630.0	58,539	0.0278	91,061
1949	1,939.3	456.9	2,396.2	1,581.0	59,076	0.0268	89,410
1950	1,830.5	360.7	2,191.2	1,471.5	55,723	0.0264	83,000
1951	1,380.7	384.7	1,765.4	1,147.8	50,653	0.0227	77,771

1/ About 39 U.S. vessels fished Campeche Bank from 1937-51; the Florida and Alabama landings are believed to include the catch of at least 36 vessels.
2/ The catch effort from 28 vessels is listed under selected sample from Camber (1955).
3/ Effort for selected sample from Camber (1955).
4/ Unknown.

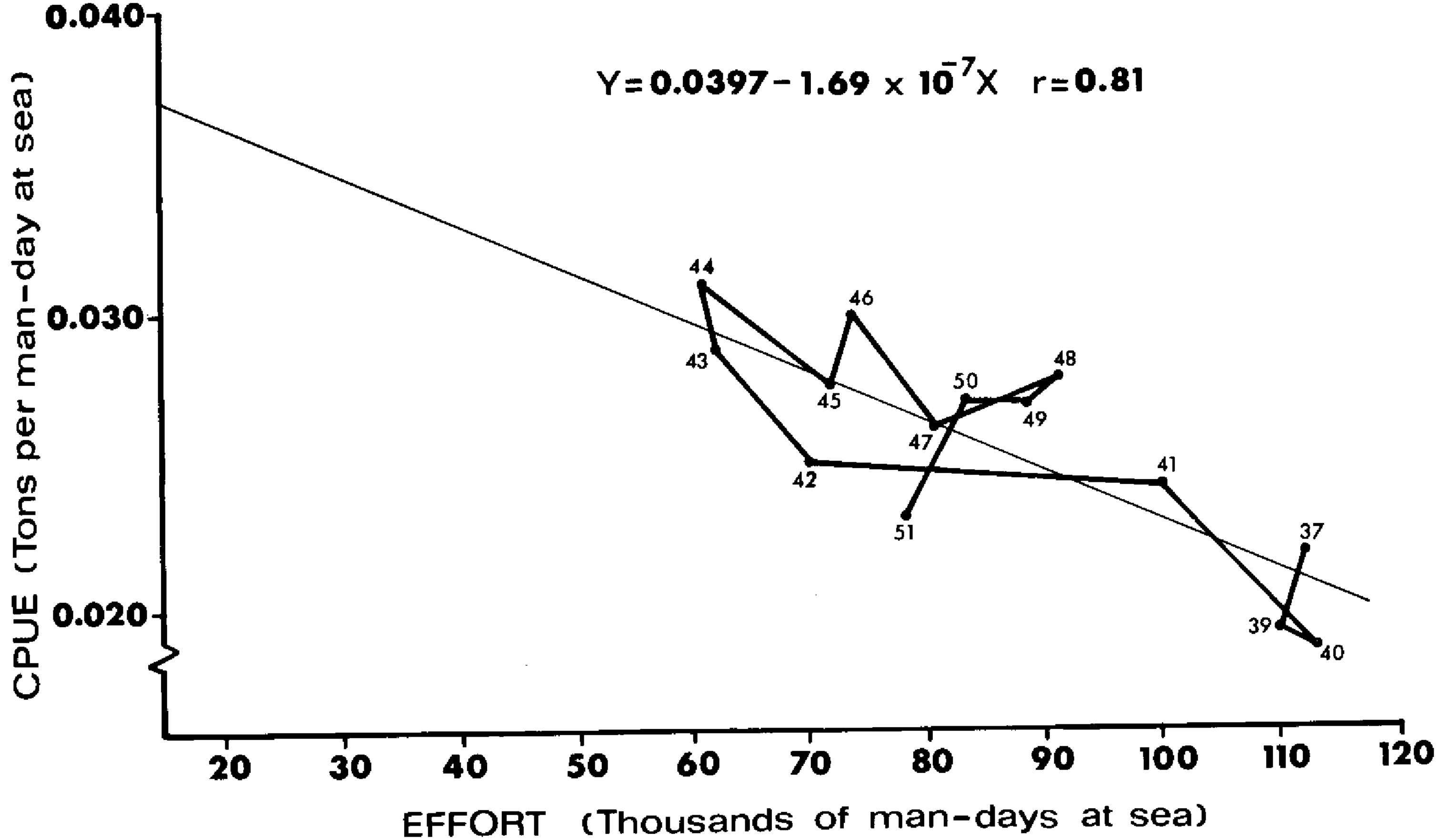


Figure 5. U.S. red snapper (_L. campechanus_) catch per unit effort on Campeche Bank, 1937-51.

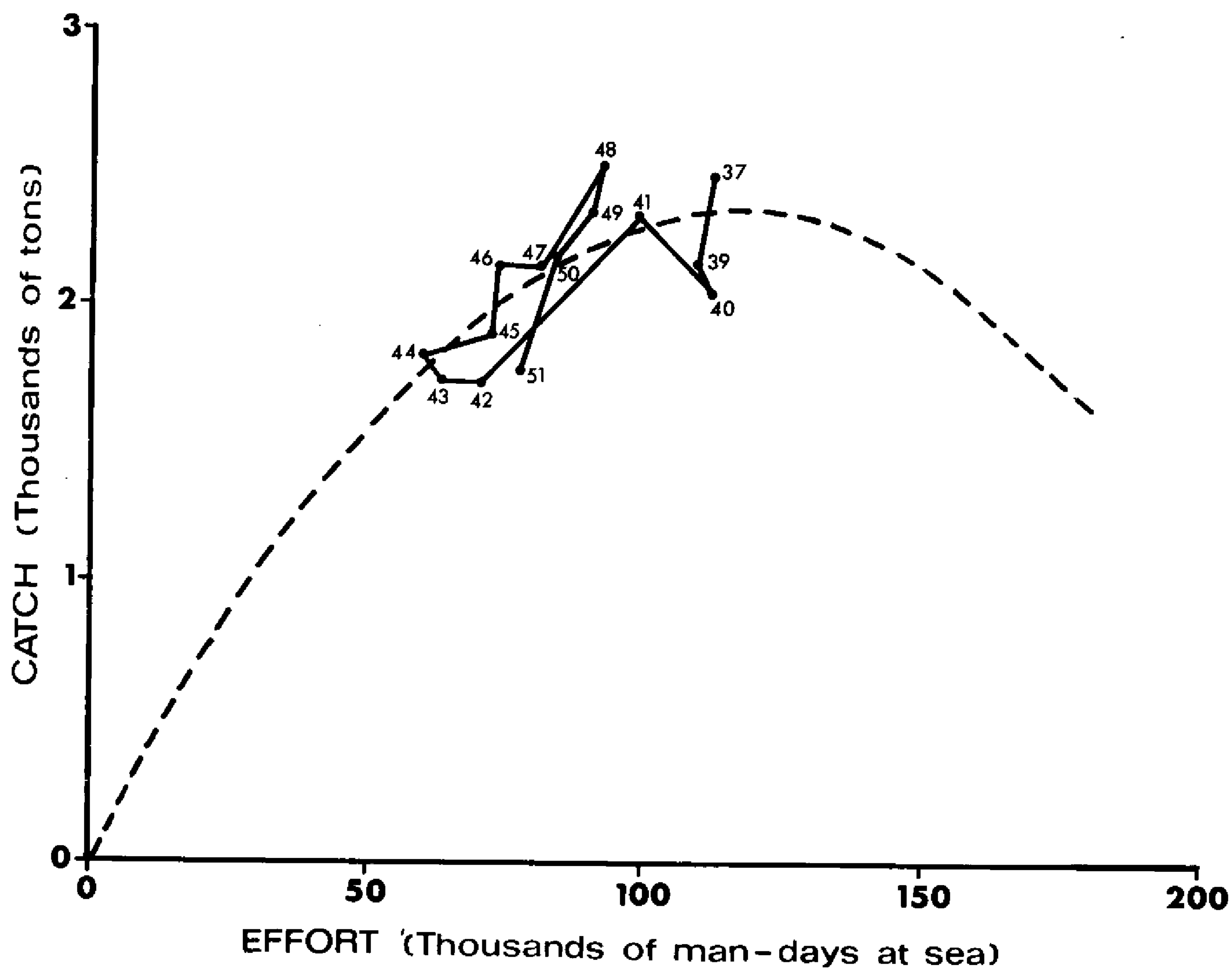


Figure 6. Schaefer model -- U.S. red snapper catch per unit effort on Campeche Bank, 1937-51.

it was not until after World War II that major changes occurred. By 1945 the entire U.S. fleet was powered by diesel engines with forward and reverse gears. The engines with gears facilitated positioning the vessel on small but productive reefs. Depth recorders were first introduced in 1946, and by 1951 handlines were replaced with hand reels. Incorporating the catch from the Cuban and Mexican fleets only changes the vertical axis of figure, thus yielding an MSY of about 4,800 tons with an effort of 240,000 man-days at sea. The peak red snapper catch was 4,169 tons in 1963, which probably consisted of 3,877 tons of L. campechanus (Table 4).

Present Status

Starting in 1962, Soviet and Cuban trawlers started to fish the Campeche Bank for porgies and grunts, and by 1966 were taking over 30,000 tons annually. The species composition of the Cuban catch consists of mainly porgies (Table 8). It appears that the U.S.S.R. catch was made up of mostly grunts, especially in 1972 (Table 1). Bradley and Bryan (1975) showed that shrimp trawling and the incidental catch of juvenile snappers in the northern Gulf of Mexico may be one reason for the decline in the commercial snapper hook-and-line fishery. More information is needed to evaluate the cause and effect of large-scale trawling on the Campeche Bank and the effect on the present snapper fishery. The present data does not indicate a decline in the snapper stocks.

Mexico presently lands about 3,000 tons of snapper annually (Table 9). The major port is Progreso, from which about 40 vessels fish specifically for red snapper with each vessel using from 7 to 10 dories employing longlines. Ninety percent of the catch consists of snappers and 10% groupers, with L. campechanus comprising about 60% of the snapper catch and mutton snapper (Lutjanus analis), 20-30% (M. Contreras, pers. comm.; see footnote 2). About 1966, the vessel size changed drastically. With a conversion to ice-preservation-type vessels, the average size of vessels increased from 30 tons to about 45 gross tons. Catch and effort data are now being collected at Progreso, but the data are not in a usable form. Detailed evaluation of the snapper stocks will require these data to be standardized and computer-compatible.

Olaechea (pers. comm.) 5/ believes that there is a considerable potential for expansion of the snapper fishery on the Campeche Banks. Trawling and longline fishing are not particularly effective in capturing snappers, as the highest density of snappers occurs on reefs where these types of gear are not usable. Hence, Olaechea believes that the majority of the present fishing effort harvests only those fishes on the less rugged areas of the Bank.

5/ A. Olaechea, Centro de Investigaciones Pesqueras, Havana, Cuba.

Table 8. Species Composition of the Cuban Trawl Fishery Catch on the Campeche Bank, 1973-74.

Species Groups	Composition (%) 1973	1974
Sparidae - porgies	56	58
Pomadasyidae - grunts	13	7
Lutjanidae - snappers	24	24
lane snapper	5	2
yellowtail snapper	12	10
vermilion snapper	1	7
other snappers	7	5
Serranidae - groupers	6	11

Source: Centro de Investigaciones Pesqueras, Havana, Cuba.

Table 9. Mexican Catch of Snappers (in Metric Tons) by District, 1963-74.

Year	Tamaulipas	Veracruz	Campeche	Yucatan	Quintana Roo	Total
1963	789	371	- -	333	--	1,493
1964	1,040	412	87	315	14	1,868
1965	980	452	146	499	25	2,102
1966	649	371	146	935	15	2,136
1967	476	343	220	1,597	33	2,669
1968	364	300	162	1,366	19	2,211
1969	306	393	197	1,326	13	2,218
1970	326	421	181	1,401	27	2,356
1971	356	35	232	1,101	33	1,757
1972	443	397	302	1,797	75	3,014
1973	- -	- -	- -	1,278 1/	--	- -
1974	- -	- -	- -	1,236 1/	--	- -

1/ From the Port of Progreso only. The 1972 catch comprised more than 86% of the total catch for the district of Yucatan.

Source: Instituto Nacional de Pesca, Mexico City, Mexico.

Finfishes

Fish trawl surveys were conducted by the U.S. Fish and Wildlife Service in 1958 and 1959 and by Cuba during 1964-72, 1974, and 1975 (Sauskan and Olaechea, 1974). The species composition between the U.S. and Cuban surveys was different, apparently because of the difference in the specific areas surveyed. The aim of the U.S. surveys was to concentrate on evaluating snapper potential, whereas the Cuban surveys were apparently more homogenous and not selective for a species group (Table 10). The U.S. and Cuban fish trawls were both outfitted with roller gear, which permitted them to operate on the rough Campeche Bank.

The U.S. Fish and Wildlife Service fish trawl data were used to estimate the standing stock of snappers, groupers, and other finfishes on the Campeche Bank, whereas the Cuban fish trawl data were used to estimate the abundance of finfishes. The U.S. data were standardized to a 21.3-m headrope, following the procedures outlined by Klima (1975), and the catch rates were adjusted to a catchability coefficient q = 0.68 to estimate standing stock. Olaechea and Hernandez (1975) compared catch rates of their standard SRT-M (23-m fish trawl) with the Bacaladero commercial trawl (32-m fish trawl) and found significant differences between their catch rates. They corrected the discrepancies by using the following equation:

$$\ln \bar{d}_2 = 4.1425 + 0.4433\ (\ln \bar{d}_1),\ \text{where}$$

$\bar{d}_2$ = density of Bacaladero net, and

$\bar{d}_1$ = density of SRT-M net.

All of the 1974-75 Cuban survey data have been standardized by this correction factor, and, where stated, the U.S. trawl survey data was also standardized by the above formula. The 23-m SRT-M trawl and the U.S. 21.3-m fish trawls are approximately comparable; therefore, I felt the correction factor described by Olaechea and Hernandez (1975) would be appropriate for the U.S. data and vice-versa. In fact, I compared the catch rates from U.S. and Cuban data using both the q = 0.68 and the Cuban correction factor (Tables 11 and 12).

Potential

Standing stock estimates from the U.S. survey indicate a finfish population ranging from 250,000 tons to 2 million tons, depending on the technique of adjusting q (Table 11). The lower value was obtained by adjusting to a q = 0.68 and the higher value by adjusting the catch rates to a Bacaladero net after Olaechea and Hernandez (1975). It appears that the 250,000 tons for standing stock value are perhaps too low, whereas a value of 2 million tons is too high. The Cuban survey data in 1974-75 indicate a finfish standing stock of approximately 1.5 million metric tons, which would

Table 10. Species Composition of the Catch from Trawl Surveys by Cuba and the United States.

Species Groups	U.S. Survey (%)	Cuban Survey (%)
Lutjanidae - snappers	0.48	0.22
L. campechanus	0.27	0.03
L. analis	0.11	0.02
L. griseus	0.01	0.02
L. synagris	0.05	0.04
Rhomboplites aurorubens	0.01	0.06
Ocyurus chrysurus	0.02	0.03
Others	0.01	0.02
Serranidae - groupers	0.06	0.10
E. morio	0.02	0.03
Others	0.04	0.08
Sparidae - porgies	1/	0.30
Pomadasyidae - grunts	1/	0.29
Others	46.00	0.09

1/ Unknown.

Sources: Miami Laboratory, Southeast Fisheries Center, NMFS, NOAA, Miami, FL 33149; and Centro de Investigaciones Pesqueras, Havana, Cuba.

Table 11. Density, Standing Stock, and Yield from U.S. Surveys, 1958-59. 1/

Species	Density (kg/hr) 2/	Standing Stock (tons)	Adjusted Density (kg/hr) 3/	Standing Stock (tons)
Snappers	13.65	121,905	- -	1,001,092
Groupers	1.58	14,110	- -	125,136
Others	13.06	116,636	- -	959,380
Total	28.29	252,652	233.53	2,085,610
Yield = 0.5(MB)	25,265 - 50,530		208,561 - 417,122	
Z ≅ 0.2 or 0.4				

1/ Survey area = 89.3×10^5 ha.

2/ q = 0.68.

3/ q adjusted to Bacaladero (Olaechea and Hernandez, 1975).

Table 12. Density of Standing Stock Adjusted from Cuban Surveys, 1974-75. 1/

Time of Survey	Uncorrected Density (tons/10 n mi^2)	Adjusted Density 2/ (tons/10 n mi^2)	Standing Stock (mt)	Adjusted Density 3/ (tons/10 n mi^2)	Standing Stock (mt)
Summer 1974	93.8	471.3	1,225,709	137.9	358,636
Fall 1974	150.7	581.5	1,512,338	221.5	576,055
Winter 1974	233.5	706.1	1,836,458	343.4	893,090
Spring 1975	165.6	606.4	1,577,169	243.5	633,270
Summer 1975	151.4	582.8	1,515,766	222.7	579,175
Average			1,533,592		608,015
Yield = 0.5 (ZB)		153,359 - 306,718		60,804 - 121,609	
$Z \cong 0.2$ or 0.4					

1/ The area of the Campeche Bank from 18 to 90 m is 28,898 n mi^2 . However, the area north of lat. 23° N. is untrawlable; therefore, the area of the trawl survey was limited to 26,007 n mi^2.

2/ q adjusted to Bacaladero (Olaechea and Hernandez, 1975).

3/ q = 0.68 (Klima, 1975).

provide a yield of between 150,000 and 300,000 tons[6/]. However, using a q = 0.68, the standing stock of 608,000 tons, provides a yield of between 60,000 and 120,000 tons. The Cuban surveys in 1964-72 indicated a standing stock of 807,000 tons, with a yield of from 106,000 to 127,000 tons (Sauskan and Olaechea, 1974)..

The most probable estimates of standing stock and yield are listed in Table 13. The potential yield for all finfishes appears to be from about 80,000 to 176,000 tons, with average standing stocks of 191,000 tons of snappers and 76,000 tons of groupers. However, I believe the grouper stocks are greatly underestimated,as trawl gear is not effective in sampling these species, and the correction factors are probably still underestimated; I did not estimate grouper potential from these data. This may also be true for the snapper populations, as these species tend to inhabit the most rugged parts of the reefs where they are unavailable to trawls. The best estimates of snapper standing stock are probably from 122,000 to 175,000 tons, with a potential yield of from 12,200 to 35,000 tons. The U.S. surveys indicate a potential of from 12,200 to 24,400 tons for all snappers, with a potential for L. campechanus of from 6,800 to 13,600 tons. The estimates for the grunts and porgies are probably fairly reliable, with a range of potential yield of from 68,000 to 136,000 tons (i.e., 344,500 + 335,000 = 679,500-ton average of all Cuban surveys) and from 90,500 to 179,000 tons (1974-75 surveys).

CARIBBEAN AND BAHAMAS

To estimate the standing stock of snappers, groupers, and related species for the Caribbean, information was used from Kawaguchi (1974), Munro and Thompson (1973), and Gonzalez-Alberdi (1975). Munro and Thompson derived a yield curve from data on the catch per canoe per year and the number of canoes per nm^2 of shelf for different areas along the Jamaican coast. From this, they obtained standing stock and density estimates which could be related to the catch rate per handline-hour. This ratio and information on catch rates in other areas were used to obtain standing stock estimates for other areas of the Caribbean. For example, Kawaguchi reported that handline fishing for reef fishes off the southeast coast of Jamaica produced 2,067 kg of fishes in 601 line-hours of fishing, or 3.34kg/line-hour. The density of reef fishes for the above area of Jamaica was

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6/ Armando Olaechea (pers. comm.; see footnote 5) indicated that the groundfish stocks of the Campeche Banks probably have a natural mortality of approximately M = 0.2. The yield calculation for the finfish stocks from the surveys were based on total mortality of Z = 0.2 and 0.4. Yield was calculated from an equation by Gulland (1971), modified slightly to:

$$Y_{max} = 0.5 \times (Z\overline{B}), \text{ where}$$

Z = total mortality, and

$\overline{B}$ = standing stock of exploited stock.

Table 13. Most Probable Estimates of Standing Stock Yield Determined from U.S. (1958-59) and Cuban (1964-72 and 1974-75) Surveys.

Species	U.S. Survey 1/ 1958-59	Cuban 2/ Survey 1962-72	Cuban 1/ Survey 1974-75	Cuban 3/ Survey 1974-75	Average All Surveys	Average Cuban Surveys 3/
Snappers	122,000	175,000	133,000	337,000	191,000	- -
Groupers	14,000	77,000	61,000	153,000	76,000	- -
Grunts	- -	244,000	176,000	445,000	- -	344,500
Porgies	117,000	209,000	182,000	461,000	- -	335,000
Others	- -	102,000	36,000	138,000	- -	120,000
Total	253,000	807,000	608,000	534,000	801,000	1,170,500
		Potential Yield Estimates				
Lower	25,000	106,000	60,000	153,000	80,000	
Upper	51,000	127,000 3/	122,000	307,000	176,000	

1/ q = 0.68.

2/ Estimate by Sausken and Olaechea (1974).

3/ q = Bacaladero.

4,754 kg/nm^2 (Table 14). Hence, to estimate the standing stock of reef fishes -- snappers, groupers, jacks, and others, I calculated an index of density of reef fishes/catch per line-hour (i.e., 4,754 kg/nm^2/3.34 kg/line-hour) as a basis for adjusting all of Kawaguchi's data to a density value. Then using the adjusted density value, I determined standing stock by multiplying the density value by the area of reef.

$$T = \frac{\text{Density (Jamaican) kg/sq. mile}}{\text{catch rate (Jamaican) kg/line-hour}} = 1423.35, \text{ and}$$

Density_i = T x CPUE_i, where

T = index of density,

CPUE_i = catch per unit effort in ith area in kg/line-hour from Kawaguchi (1974), and

Density_i = density of fishes in the ith area in kg/line-hour

Table 14. Estimates of Standing Stock of Snappers and Related Species off Jamaica.

Location	Area (km^2)	Density (kg/km^2)	Standing Stock (mt)
South coast	2,926	1,386	4,055
North coast	497	3,696	1,838
TOTAL	3,423	1,722	5,893

Source: Munro and Thompson (1973).

Venema (1973) reported that few deep water groupers and snappers are landed in the Bahamas, as most of the production comes from the shallow water banks, and that the catch per effort (an average of the catch rate of traps, handlines, and spears) was 35.7 kg/man/day. The catch of fishes and shellfishes landed in Nassau in 1971 was over 2,000 metric tons, of which at least 1,000 metric tons were lobsters and conchs.

The catch per man per fishing day could be converted to catch per handline per hour. Assuming that each man fishes 10 hours per day using one line, 35.7 kg/man/fishing day is equivalent to 3.57 kg/line/hr. This catch rate leads to an estimate of standing stock of 270,000 metric tons for the Bahamas and 17,000 metric tons for the Turks and Caicos Islands. Using a catch rate of 9.4 kg/ha given by Gonzalez-Alberdi (1975), the standing stock for the deep water reefs (55-329 m) is estimated to be 11,000 metric tons.

This estimate is within the range of from 2,200 to 22,000 metric tons given by Gonzalez-Alberdi. Similar procedures were used for catch rates given by Kawaguchi (1974) and others for areas of the Caribbean (Table 15).

The standing stock of snappers and related species is estimated at 1,292,000 and 295,000 metric tons for the Caribbean and Bahamas, respectively. Assuming the natural mortality M = 0.5, I estimated the potential yield using the equation given by Gulland (1971), viz:

(a) potential yield for the Caribbean = 323,000 metric tons,
(b) potential yeild for the Bahamas = 73,000 metric tons.

Gulland (1971) estimated the potential demersal fish production for the Caribbean and Bahamas to be 2-8 kg/ha and 2-4 kg/ha, respectively. The greatest production was reported in the narrow, northern Shelf of Jamaica (i.e., 37 kg/ha/yr) (Vidaeus, 1970).

Munro (1973) indicated that demersal fish production from coral reef areas might be much greater than that estimated by Gulland (1971). Munro reported that catches exceeded 8 kg/ha in most areas intensively fished, that catches of 11.7 kg/ha were attained in many areas, and that the rate of production of shelf-dwelling fishes may approach 17.5 kg/ha. He concluded that production in the entire Caribbean and Bahamas area, totalling 661,971 km^2, can be increased to 750,000 metric tons and that, in an intensified fishery, the catch could exceed 1 million metric tons. These quantities would be equivalent to 11.3 kg/ha and 15.1 kg/ha, respectively. Compared with the 1972 yield of 126,000 metric tons, catches of 750,000 and 1 million metric tons would represent an increase in production of from six to eight times. Bullis and Carpenter (1968) estimated the standing stock of snappers and groupers for the Caribbean and Bahamas to be 675,000 metric tons, which would give a yield of 170,000 metric tons annually.

In the light of all the available data and past estimates, the present estimate of 396,000 metric tons potential annual production for the Bahamas and Caribbean appears to be reasonable. The figures, however, may have been biased due to insufficient precise estimates of the total reef area.

CONCLUSIONS

CAMPECHE BANK

Red Snapper

The United States, Mexico, and Cuba fish the Campeche Bank for snappers, with a current total annual production of around 3,000 tons. Snappers have been the U.S.'s main interest in the Campeche Bank since the turn of the century. Peak U.S. production of 676 tons in 1963 was followed by a decline in production from 1964 to the present, with current production around 300 tons. The U.S. fleet began switching fishing areas to the Caribbean Sea in 1964; and by 1968, production from the Caribbean Sea exceeded that from off Mexico (Allen and Tashiro, 1976).

Table 15. Estimate of Standing Stock of Snappers and Related Species in the Caribbean, Including the Reef and Shelf Areas Effort, Total Catch, and Hook-and-Line Catch Rate.

Localities	Area (km^2)	Effort (hr)	Total Catch (kg)	Catch Rate (kg/hr)	Density (kg/km^2)	Standing Stock (mt)
Jamaica South						
Mackerel Bank	39.3	62.5	298.2	4.76	1,980	78
Pedro Bank	8,016.4	470.11	1,793.4	3.81	1,585	12,709
Unnamed	124.8	24.9	55.4	2.22	923	115
Alice Shoal	263.3	75.0	299.8	3.99	1,659	437
Serranilla Bank	995.2			4.90 1/	2,038	2,029
Serrane Bank	359.1			4.90 1/	2,038	732
Rosalind Bank	4,928.2	46.6	229.8	4.90	2,038	10,050
Thunder Knoll	167.6			4.90 1/	2,038	341
Between Rosalind and Unnamed Knoll	1,186.7	33.7	134.5	3.99	1,659	1,971
Central America						
Shelf area east of Honduras	6,566.4	201.8	871.3	4.31	1,792	11,777
Point Blanca to Cape Camaron (about 85°W)	99,180.0	613.9	7,226.8	11.75	4,886	484,996
Hispaniola to Virgin Islands						
Monte Cristi Bank	1,056.8	91.7	623.9	6.81	2,832	2,995
Silver Bank	2,969.6	58.5	350.3	5.99	2,491	7,399
Navidad Bank	670.3	108.0	1,200.2	11.12	4,624	3,102
Unnamed	95.1	15.0	18.4	1.22	507	48
Mona Passage	-	53.3	50.8	0.95	395	-
Puerto Rico to Virgin Islands	11,799	85.9	463.6	5.40	2,246	26,517
Leeward Islands						
Anguilla Bank	4,480.2	266.4	1,823.8	6.85	2,849	12,772
Unnamed	108.1	8.5	70.9	8.35	3,478	376
Sombrero Bank	54.7					
	256.5	36.1	180.1	4.99	2,075	532
Sombrero Bank SW	201.8					
Saba Bank	2,202.5	6.3	5.7	0.91	378	834
Barbuda to Antiqua	3,344.8	119.3	682.2	5.72	2,379	7,963
St. Kitts to Dominca	3,601.3	60.0	117.5	1.95	811	2,923
Windward Islands						
Martinique to Barbados	5,783.2	266.3	193.3	0.73	304	1,757
Shelves South America						
Continental Shelf South America, Trinidad to French Guiana	196,308.0	566.9	4,860.0	8.56	3,560	699,304
Average				5.85	2,433	
Total	354,394.1					1,291,757

1/ Estimate based on same catch rate for Rosalind Bank.

Table 15. (Continued)

Localities	Area (km^2)	Effort (hr)	Total Catch (kg)	Catch Rate (kg/hr)	Density (kg/km^2)	Standing Stock (mt)
<u>Bahamas</u>						
Bahama deep water (31-180 fathoms)	2,736.0	-	-	9.40	3,909	10,703
Bahama Island banks	179,892.0	-	-	3.57	1,485	267,260
Others - Turks, etc.	11,320.2	-	-	3.57	1,485	16,818
Total Bahamas	193,948.2	-	-	-	-	294,808
Grand Total	548,342.3	-	-	-	-	1,586,565

Sources: Kawaguchi (1974) and Gonzalez-Alberdi (1975).

Potential yield of red snapper was determined by two methods: (1) using the Schaefer model and (2) estimating standing stock from survey data. The Schaefer model indicates that a MSY of 4,800 tons of red snapper (93% L. campechanus) could be realized. The best estimate of standing stock of L. campechanus is from the U.S. survey (1958-59), in which S.S. = 122,000 tons (56% were L. campechanus). Thus, S.S. of L. campechanus = 65,000 tons, with a potential yield of from 6,800 to 13,600 tons, based on Z = 0.2-0.4. The total potential for all snappers from the U.S. survey would be from 12,200 to 24,000 tons.

The estimate of standing stock of L. campechanus from the Cuban surveys is 29,500 tons, much less than from U.S. surveys because of the difference in species composition between surveys. The estimated potential is from 2,900 to 5,900 tons. The total potential of all snappers is between 22,000 and 43,000 tons. It appears that the U.S. estimate of potential snapper yield may be more realistic. The best estimate indicates a potential yield between 4,800 and 6,800 tons for L. campechanus and a total potential yield for all snappers between 12,200 and 24,000 tons.

Present red snapper production is around 3,000 tons, of which perhaps over 90 % is L. campechanus. It appears that production could increase for L. campechanus and could be increased significantly for other snappers.

Groupers

Mexico and Cuba are the major producers of groupers on the Campeche Bank, with production in 1972 reaching almost 19,000 tons. The major species is the red grouper. Potential yield may be as great as 35,000 tons. The maximum increase in yield will require increasing fishing effort and the size and age of recruits entering the fishery from less than 3 years of age to slightly older than 5 years (Melo, Thesis). An increase in fishing effort will decrease the yield per recruit if age at first capture does not increase.

CARIBBEAN AND BAHAMAS

The potential yield for snappers and related species may be 323,000 and 73,000 tons for the Caribbean and Bahamas, respectively.

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LITERATURE CITED

Allen, D. M. and J. E. Tashiro.
1976. Status of the U.S. commercial snapper-grouper fishery. In H. R. Bullis, Jr., and A. C. Jones (editors), Proceedings: Colloquium on Snapper-Grouper Fishery Resources of the Western Central Atlantic Ocean, Florida Sea Grant Report No. 17, p. 41-76.

Bradley, E. and C. E. Bryan, III.
1975. Life history and fishery of the red snapper (Lutjanus campechanus) in the northwestern Gulf of Mexico: 1970-1974. Proc. 27th Annu. Sess., Gulf Caribb. Fish. Inst., p. 77-106

Bullis, H. R., Jr. and J.S. Carpenter.
1968. Latent fishery resources of the central western Atlantic region. Univ. Wash. Publ. Fish. N.S. 4:61-64.

Bullis, H. R., Jr., J. S. Carpenter, and C. M. Roithmayr.
1971. Untapped west-central Atlantic fisheries. In S. Shapiro (editor), Our changing fisheries, p. 374-391. U.S. Govt. Print. Off., Wash. D.C.

Camber, C. I.
1955. A survey of the red snapper fishery of the Gulf of Mexico, with special reference to the Campeche Banks. Fla. Board Conserv., Tech. Ser. No. 12, 64 p.

Carles Martin, C. A. and T. Liubimova.
1967. Datos sobre distribucion de las principales especies comerciales del Banco Campeche. In Trabajos al III Congreso Nacional de Oceanografia, Marzo 15-18, Campeche, Mexico, Centro de Investigaciones Pesqueras, Cuba, p. 60-80.

Carpenter, J. S.
1965. A review of the Gulf of Mexico red snapper fishery. U.S. Dep. Inter., Fish Wildlif. Serv., Circ. 208, 35 p.

FAO.
1964. FAO yearbook of fishery statistics. Catches and landings, 1973. FAO (Rome) 36, 590 p.

Gonzalez-Alberdi, P.
1975. Bahamas. An analysis of the data from the Bahamas Reel Fishery Survey with a preliminary estimate of the potential of the deepwater resources. FAO (Rome), FI:DP BHA/71/572/3, 38 p.

Gulland, J. A.
1971. The fish resources of the ocean. Fishing News (Books) Ltd., West Byfleet, Surrey, 255 p.

Kawaguchi, K.
1974. Handline and longline fishing explorations for snapper and related species in the Caribbean and adjacent waters. Mar. Fish. Rev. 36(9): 8-31.

Klima, E. F.
1975. A review of the fishery resources in the western central Atlantic. 1st Sess., Western Central Atlantic Fisheries Commission, Port-of-Spain, Trinidad and Tobago, WECAFC/75/Inf. 5.

Melo, A. M.
No date. Aspectos biologicos pesqueras de Epinephelus morio (Val.). Thesis, Universidad Nacional Autonoma de Mexico, 69 leaves.

Moe, M. A., Jr.
1969. Biology of the red grouper Epinephelus morio (Valenciennes) from the eastern Gulf of Mexico. Fla. Dep. Nat. Resour., Mar. Res. Lab., Prof. Pap. Ser. No. 10, 95 p.

Munro, J. L.
1973. The biology, ecology, exploitation and management of Caribbean reef fishes. Part I. Coral reef fish and fisheries of the Caribbean Sea. Res. Rep. Zool. Dep. Univ. West Indies 3, 43 p.

Munro, J. L. and R. Thompson.
1973. The biology, ecology, exploitation and management of Caribbean reef fishes. Part II. The Jamaican fishing industry, the area investigated and the objectives and methodology of the ODA/UWI fisheries ecology research project. Res. Rep. Zool. Dep. Univ. West Indies 3, 44 p.

Olaechea, A. and C. Hernandez.
1975. Resultados obtenidos en los arrastres conjuntos de dos tipos de embarcaciones en el Banco de Campeche. Resumenes de Investigacion, Havana, Cuba 2: 153-157.

Sauskan, V. I. and A. Olaechea.
1974. Ictiofauna bentonica del Banco de Campeche. Resumenes de Investigacion, Havana, Cuba 1: 102-106.

Venema, S. C.
1973. Report on the planning of exploratory fishing surveys and collecting of data on commercial landings in the UNDP/FAO Fishery Development Study, Bahamas. FAO (Rome), FAO Internal Report, UNDP/FAO Fishery Project, 23 p.

Vidaeus, L.
1970. An inventory of the Jamaican fishing industry. FAO (Rome), FAO Internal Report, UNDP/FAO Caribbean Fishery Development Project, SF/CAR/REG 180 M9, 47 p.

STATUS OF THE U.S. COMMERCIAL SNAPPER-GROUPER FISHERY[1/] [2/]

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ABSTRACT

Snappers and groupers have been fished commercially off the South Atlantic States and Gulf States for over a century, and portions of the fleet operate near foreign shores. At least 32 species of snappers and groupers are included in this diversified fishery. The 1974 commercial catch totaled 18.3 million pounds, valued at 9.5 million dollars. In 1970,82.7 million pounds were reported caught by recreational fishermen.

The commercial landings of snappers and groupers are greatest in Florida, which accounted for 59% of the snappers and 89% of the groupers, by weight, landed in 1973. In recent years most of the catch has been produced in the Gulf of Mexico off the United States, seaward of 12 miles.

From 1965 to 1973, total U.S. commercial production declined by 8.2 million pounds. The decrease was primarily in snapper production from off Mexico and grouper production from off the west coast of Florida.

Analysis of the fishery is complicated by the lack of basic catch information. The fishery takes place in state, Federal, and international waters. Therefore, research necessary for rational management may be coordinated most effectively under the State-Federal Fisheries Management Program and an international regional fisheries organization, such as the Western Central Atlantic Fisheries Commission.

1/ Contribution No. 441, Southeast Fisheries Center, Miami Laboratory, National Marine Fisheries Service, NOAA, Miami, FL 33149 and MARMAP Contribution No. 110.

2/ The fisheries in Puerto Rico, the Virgin Islands, California, and Hawaii are not discussed.

INTRODUCTION

The snapper-grouper fishery is one of the more valuable fisheries of the Southern Coastal United States. The 1974 commercial catch of 18.3 million pounds was valued at 9.5 million dollars, to which can be added a much greater value for the recreational fishery. Saltwater anglers in the South Atlantic States and Gulf States caught an estimated 82.7 million pounds of snappers and groupers in 1970, the year of the most recent survey (Deuel, 1973). An unknown quantity of marketed fish is not reported in the commercial landings.

A preliminary review of the fishery indicates impending resource problems related to increased fishing pressure by commercial, recreational, and foreign flag fishermen. Furthermore, grounds historically fished by U.S. fishermen are diminishing as the Bahamas, Mexico, and the Caribbean nations extend or enforce fisheries jurisdictions.

THE FISHERY

GENERAL

Snappers and groupers have been fished commercially from ports located in the Southern United States for more than a century. Since the beginning of the U.S. snapper-grouper fishery in the 1830's and 1840's off Key West and Pensacola, Fla., respectively, its history has been similar to that of many other fisheries. As fishing pressure increased and the grounds initially fished became less productive, fishery activity expanded into new areas. Early in the 20th century, most of the grounds in the Gulf of Mexico, including those off Mexico, had been fished by U.S. vessels (Camber, 1955; Carpenter, 1965). Beginning about 1949, expansion into new areas and deeper waters was facilitated by the use of fathometers and mechanical reels with wire lines (Siebenaler and Brady, 1952). In 1964 the U.S. snapper-grouper fleet began fishing new grounds in the Caribbean Sea off Honduras (Fishery Statistics of the United States, 1966) and by about 1970, these activities had extended southward through the western Caribbean to the Continental Shelf edge off Colombia (Carpenter and Nelson, 1971; Fishery Statistics of the United States, 1973). The fishing grounds now include waters off the South Atlantic Coast of the United States, in the Bahamas area, in the Gulf of Mexico, and in the western Caribbean Sea (Fig. 1).

Snappers and groupers are fished from depths of a few fathoms (Schroeder, 1924) to about 140 fathoms (Camber, 1955). The 15- to 60-fathom depth range is the most heavily fished and the most productive (Camber, 1955; Moe, 1963; Carpenter, 1965). Typically, snappers and groupers inhabit reef areas and hard irregular bottoms, but good catches of snappers have been made over mud bottoms (Ginsburg, 1931; Moe, 1963; Carpenter, 1965). Groupers maintain close contact with the bottom and utilize holes or crevices for cover (Smith, 1971). Both snappers and groupers are common around artificial structures (Moe, 1963; Stroud, 1966; Irby, 1974); and in the north central Gulf, offshore oil and gas platforms are a source of the commercial and recreational catch (Shinn, 1974).

Most (96% in 1971) of the snappers and groupers in the commercial catch are taken by the so-called "handline" fleet. These fish are caught by baited hooks

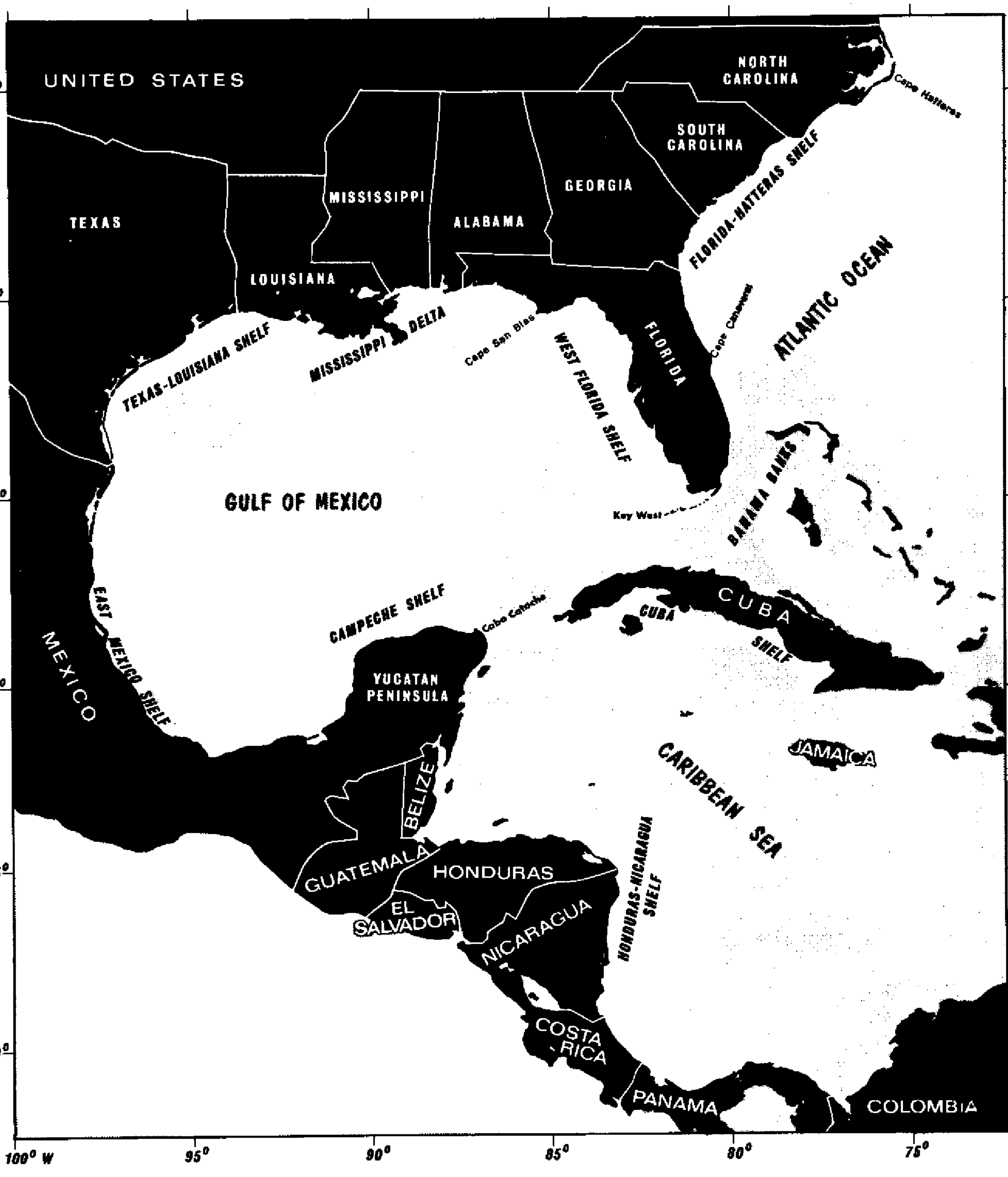

Figure 1. The general location of snapper-grouper grounds fished by U.S. vessels are shown in white. U.S. vessels do not fish all grounds shown. Off foreign shores, U.S. operations are usually restricted to international waters.

with simple handlines or mechanical reels, exclusive of trolling and longline gear. The remainder of the catch is by shrimp trawls, spiny lobster traps, fish pots, haul seines, trammel and gill nets, and longlines.[3/] The commercial handline fleet consists of vessels and boats. As defined for statistical purposes, a vessel has a capacity of 5 net tons or over, and a boat, less than 5 tons (Fishery Statistics of the United States, 1974). The vessels, of wood, steel, or fiberglass construction, are usually diesel powered and range from 26 to 79 feet in length. Many still retain the lines of the traditional snapper schooners, are masted, and use a small riding sail for the steadying effect while fishing (Tarbox, 1970). The boats are generally less than 26 feet long. Most of the fishing craft use ice to preserve the catch, but a few are equipped with freezers (Thompson and Thompson, 1972). Some of the craft are of multipurpose design to facilitate use in other fisheries, such as shrimping (Carpenter, 1965) and lobstering (Noetzel and Wojnowski, 1975). For example, about 25% of the handline vessels operating from the South Atlantic States and Gulf States in 1969 were equipped with other types of gear in addition to those classified as handlines, which are primarily mechanical reels (Noetzel and Gaynor, 1974). Included in the numbers of commercial handline craft reported in Fishery Statistics of the United States (1952-74) are an unknown number of sport, charter, and party craft from which fish were sold and reported to National Marine Fisheries Service (NMFS) statistical agents. Therefore, all the craft reported as handliners are not consistently employed in the snapper-grouper fishery. The usual purpose of such diversification is to operate profitably throughout the year. For that reason, many of the snapper-grouper fishermen are part-time and are active in other fisheries or occupations (Moe, 1963; Norville, 1975).

The fishing gear used by the handline fleet varies with the location fished and the species and sizes to be caught. The catch is retrieved by simple handlines and hand-powered, electric, or hydraulic line reels (Siebenaler and Brady, 1952; Carpenter, 1965; Tarbox, 1970). All these gears are classified as handlines by NMFS statistical agents. In recent years, monofilament lines have been used on the handlines and stainless steel lines on the mechanical reels (Kawaguchi, 1974). Except in the yellowtail snapper fishery, where weights and leaders generally are not used, the terminal gear consists of a weight, wire spreaders, rubber shocks, monofilament snoods, and hooks (Moe, 1963; Kawaguchi, 1974). From 2 to 40 baited hooks may be used with each reel line, but individual handlines sometimes have only 1 hook (Moe, 1963; Carpenter, 1965). The hooks used are both conventional style and self-hooking tuna-circle style (Carpenter, 1965; Kawaguchi, 1974). Shrimp, squid, and several species of fishes are used for bait (Carpenter, 1965).

At least 17 species of snappers (Lutjanidae) and 15 species of groupers (Serranidae) are caught in this multispecies fishery, although not all species are caught on all parts of the grounds (Table 1). The predominant species in the catch are the Gulf red snapper and the red grouper. The common names of snappers and groupers, as used by the fishing industry and in the state and Federal statistical reports, do not always identify the species landed. At

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3/ Statistics and Market News Division, National Marine Fisheries Service (NMFS), NOAA, Washington, DC 20235--General Canvass Data for 1971.

Table 1. U. S. Snapper-Grouper Fishery, Species of Snappers and Groupers Commonly Landed1/.

Common Name	Scientific Name
Snappers - Lutjanidae	
Black snapper	*Apsilus dentatus*
Queen snapper	*Etelis oculatus*
Mutton snapper	*Lutjanus analis*
Schoolmaster	*Lutjanus apodus*
Blackfin snapper	*Lutjanus buccanella*
Gulf red snapper2/	*Lutjanus campechanus*2/
Cubera snapper	*Lutjanus cyanopterus*
Gray snapper	*Lutjanus griseus*
Dog snapper	*Lutjanus jocu*
Mahogany snapper	*Lutjanus mahogoni*
Caribbean red snapper2/	*Lutjanus purpureus*2/
Lane snapper	*Lutjanus synagris*
Silk snapper	*Lutjanus vivanus*
Yellowtail snapper	*Ocyurus chrysurus*
Wenchman	*Pristipomoides aquilonaris*
Voraz3/	*Pristipomoides macrophthalmus*3/
Vermilion snapper	*Rhomboplites aurorubens*
Groupers - Serranidae	
Rock hind	*Epinephelus adscensionis*
Speckled hind	*Epinephelus drummondhayi*
Yellowedge grouper	*Epinephelus flavolimbatus*
Red hind	*Epinephelus guttatus*
Jewfish	*Epinephelus itajara*
Redgrouper	*Epinephelus morio*
Misty grouper	*Epinephelus mystacinus*
Warsaw grouper	*Epinephelus nigritus*
Snowy grouper	*Epinephelus niveatus*
Nassau grouper	*Epinephelus striatus*
Black grouper	*Mycteroperca bonaci*
Yellowmouth grouper	*Mycteroperca interstitialis*
Gag	*Mycteroperca microlepis*
Scamp	*Mycteroperca phenax*
Yellowfin grouper	*Mycteroperca venenosa*

1/ Except when noted otherwise, common and scientific names follow Bailey (1970).

2/ From Rivas (1966), who recognized two species of red snapper. These are *L. campechanus* from the Gulf of Mexico and South Atlantic Coast of the United States and *L. purpureus* from the Caribbean Sea southeastward along the coast of the Guianas and probably to Brazil. For these species, he used the common names Gulf red snapper and Caribbean red snapper, respectively.

3/ From Anderson (1967). The voraz, *Pristipomoides macrophthalmus*, is not listed in Bailey (1970).

least 11 species of snappers caught in the Gulf of Mexico are marketed as "red" snapper (Carpenter, 1965), with additional species from the Caribbean Sea. While snappers and groupers are the target of the handline fleet, many other species are also included in the by-catch. Squirrelfish (Holocentrus ascensionis) and bigeye (Priacanthus arenatus) have been marketed as "red snapper" (Ingle, 1970).

FLEET SIZE, LANDINGS, AND PORTS

In 1971 the commercial handline fleet operating at least part-time from the South Atlantic States and Gulf States was comprised of about 406 vessels and 1,602 boats, of which 350 vessels and 1,204 boats were based in the Gulf of Mexico. About 81% of the vessels and 74% of the boats were based in Florida, with most of the fleet, 70% of the vessels and 52% of the boats, located along the west coast of Florida (Table 2).

The total number of commercial vessels generally increased from 138 in 1953 to 406 in 1971, with a maximum of 546 in 1959. The number of commercial boats declined from 3,290 in 1956 to 1,602 in 1971 (Fig. 2). The near-shore commercial fleet is primarily comprised of boats which probably were replaced by recreational craft not reported in the Fishery Statistics of the United States. Recreational fishermen and their craft have increased in numbers in the last two decades (Deuel, 1973; Irby, 1974). In 1973, 986,000 private and commercially operated recreational craft more than 16 feet in length fished in the salt waters of the South Atlantic and Gulf States. In the Gulf, snappers and groupers were among the primary species sought by the operators of these craft (Ridgely, 1975).

Annual commercial landings of snappers and groupers combined reached a peak of 25.8 million pounds[4/] in 1965, followed by a gradual decrease to 17.6 million pounds in 1973. From 1965 to 1973, snapper landings declined from 15.9 to 11.0 million pounds, and grouper landings declined from 9.9 to 6.6 million pounds (Table 3; Fig. 3).

As with many fisheries in recent years, the total value (amount paid to the fishermen) of the landings has increased despite decreased total landings. The ex-vessel price per pound of snapper has increased markedly since 1965, and grouper has increased since 1971 (Table 3; Fig. 3).

The landings of snappers generally show a positive relationship to the number of vessels (Figs. 2 and 3). The anomaly in 1959 may indicate that an increased number of shrimp vessels fished for snappers part-time, reflecting the low prices paid for shrimp in that year (Fishery Statistics of the United States, 1961).

4/ While the pounds landed are generally reported by the NMFS as round (live) weight, in actuality most of the landings are in gutted weight.

Table 2. U. S. Snapper-Grouper Fishery, Handline Vessels and Boats [1/] by State, 1971.

State	Vessels (5 tons or over) Number	%	Boats (Less than 5 tons) Number	%
North Carolina	1	0.2	11	0.7
South Carolina	4	1.0	9	0.6
Georgia	4	1.0	12	0.7
Florida				
East Coast	47	11.6	366	22.8
West Coast	282	69.5	826	51.6
Alabama	11	2.7	48	3.0
Mississippi	20	4.9	--	---
Louisiana	7	1.7	186	11.6
Texas	30	7.4	144	9.0
TOTAL	406	100.0	1,602	100.0

1/ The totals include craft fishing part time and a small but unknown number of duplicates (craft reported by more than one state).

Source: Compiled from Fishery Statistics of the United States (1974).

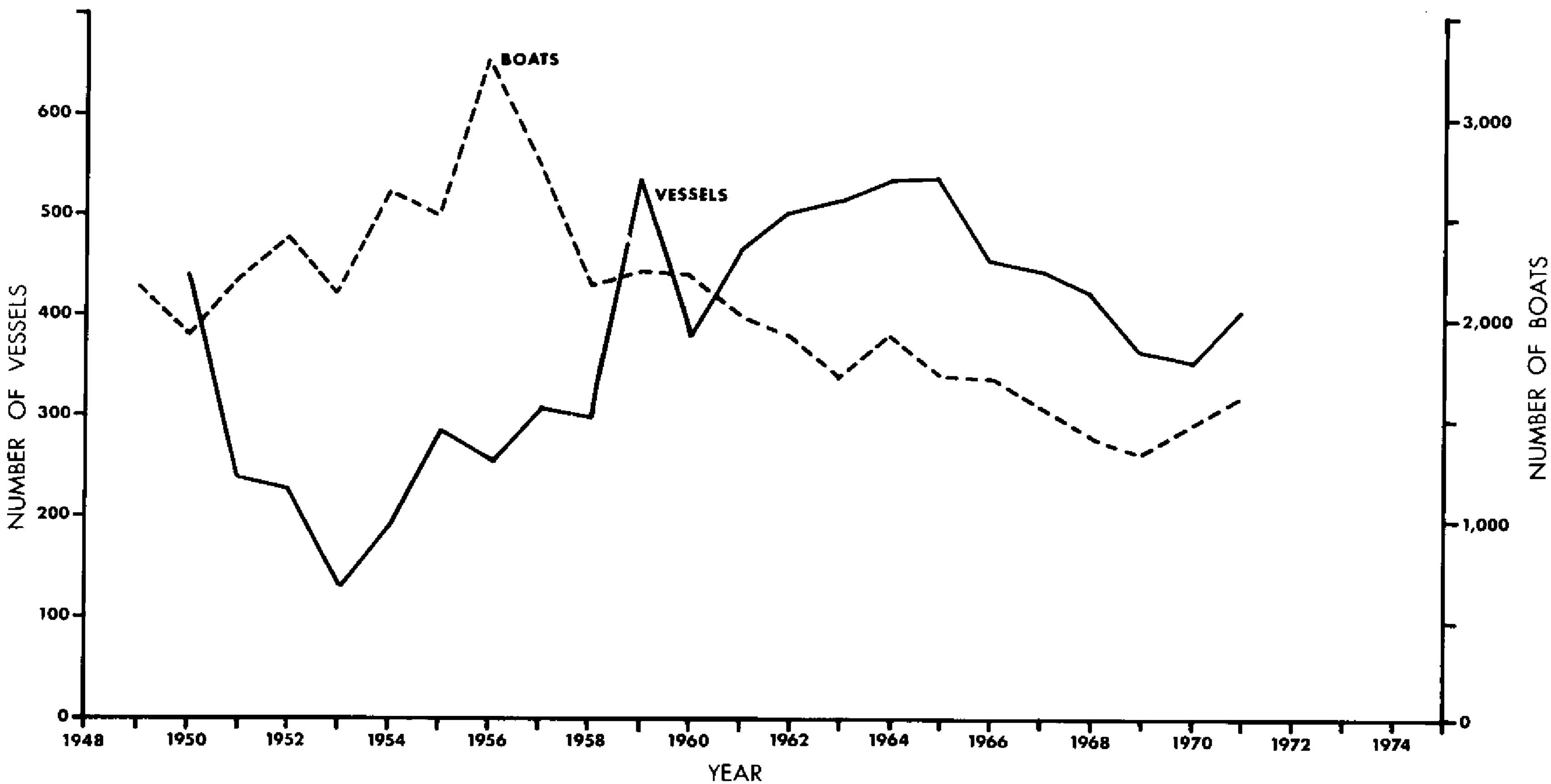

Figure 2. U.S. snapper-grouper fishery total handline vessels and boats by year, 1949-71. A vessel has a capacity of 5 net tons or over, and a boat, less than 5 tons. Source: Compiled from Fishery Statistics of the United States (1952-74).

Table 3. U.S. Snapper-Grouper Fishery, Total Landings and Value, 1949-74.[1/]

Year	Snappers Thousand Pounds	Snappers Thousand Dollars	Groupers Thousand Pounds	Groupers Thousand Dollars	Total Thousand Pounds	Total Thousand Dollars
1949	9,106	2,090	10,217	1,012	19,323	3,102
1950	7,948	1,851	6,839	629	14,787	2,480
1951	8,253	2,047	7,570	767	15,823	2,814
1952	9,865	2,312	5,967	714	15,832	3,026
1953	8,954	2,430	5,627	569	14,581	2,999
1954	9,804	2,495	6,076	668	15,880	3,163
1955	10,251	2,574	5,569	568	15,820	3,142
1956	9,917	2,449	6,755	669	16,672	3,118
1957	10,443	2,678	7,653	769	18,096	3,447
1958	11,494	2,919	4,963	544	16,457	3,463
1959	11,823	3,012	6,657	758	18,480	3,770
1960	11,996	3,039	6,859	774	18,855	3,813
1961	13,940	3,518	7,394	745	21,334	4,263
1962	14,231	3,509	8,254	840	22,485	4,349
1963	14,679	3,835	7,890	784	22,569	4,619
1964	15,628	4,456	9,106	979	24,734	5,435
1965	15,862	4,550	9,950	1,072	25,812	5,622
1966	14,691	4,627	8,493	1,055	23,184	5,682
1967	14,570	4,693	7,825	1,093	22,395	5,786
1968	13,857	4,746	8,151	1,318	22,008	6,064
1969	12,140	5,067	8,595	1,596	20,735	6,663
1970	11,422	5,071	8,637	1,573	20,059	6,644
1971	11,302	5,334	8,081	1,555	19,383	6,889
1972	11,355	6,097	8,071	2,037	19,426	8,134
1973	11,022	6,561	6,620	1,896	17,642	8,457
1974[2/]	10,823	6,905	7,500	2,600	18,323	9,505

1/ Primarily gutted weight.

2/ 1974 data are preliminary.

Sources: Compiled from Fishery Statistics of the United States (1952-74), U.S. Department of Commerce (1973-75), and Fisheries of the United States (1975).

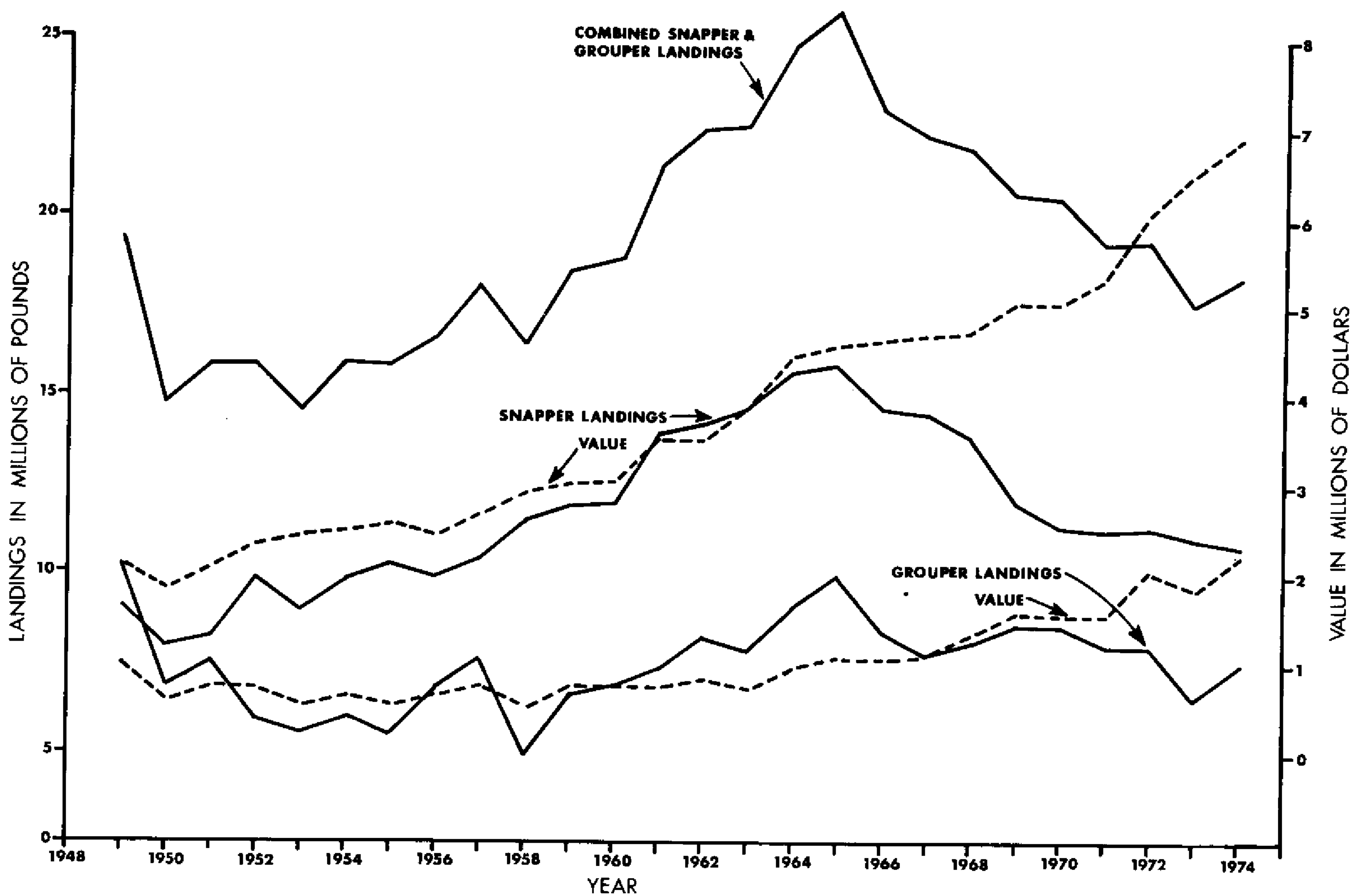

Figure 3: U.S. snapper-grouper fishery, total landings (primarily gutted weight) and value, 1949-74. 1974 data are preliminary. Sources: Compiled from Fishery Statistics of the United States (1952-74), U.S. Department of Commerce (1973-75), and Fisheries of the United States (1975).

Snappers and groupers are landed in all the coastal states from North Carolina to Texas. Since 1949 at least, yearly landings of both snappers and groupers have been greatest in Florida. In 1973, 59% of the total snapper production and 89% of the grouper production were landed in that state (Figs. 4 and 5). Most of the Florida landings of snappers and groupers were on the west coast, which accounted for about 85% of the snappers and 91% of the groupers landed in Florida from 1969 to 1973 (Table 4).

In 1973 snapper landings in Florida were 6.5 million pounds, followed by Mississippi (2.3 million pounds), Alabama (1.0 million pounds), and Texas (0.8 million pounds). The combined snapper landings of Louisiana, South Carolina, Georgia, and North Carolina were about 0.4 million pounds. Snapper landings have declined in Texas and Florida since 1964, in Alabama since 1966, and in Mississippi since 1968 (Fig. 4).

In 1973 grouper landings in Florida were 5.9 million pounds, followed by Alabama with 0.3 million pounds. The combined grouper landings of Mississippi, Texas, South Carolina, Georgia, North Carolina, and Louisiana were about 0.5 million pounds. Grouper landings have declined in Florida since 1965 (Fig. 5).

The port areas are ranked by the quantity of snappers and groupers landed in 1973 (Table 5). Landings are available by port areas only (county, parish, or district); for simplicity, cities are used to designate these areas. The major port areas for snappers and groupers combined are Pascagoula, Miss., and Panama City and Madeira Beach, Fla. Important ports of landing for snapper extend from northeast Florida to south Texas; the three major snapper port areas are Pascagoula, Miss. and Panama City and Key West, Fla. Ports of landing for grouper extend primarily from Key West, Fla. to Pascagoula, Miss. The three major grouper port areas, all located on the west coast of Florida, are Madeira Beach, Fort Myers Beach, and Bradenton.

FISHING ACTIVITIES AND CATCH BY REGION

The grounds generally fished by craft from each port area are shown in Figure 6. Snappers and groupers landed at certain U.S. ports are often captured on grounds remote from the port of landing. Therefore, landings by state are not always indicative of the production of each state's waters or particular fishing grounds.

Preliminary data are available that show the amount of the U.S. snapper-grouper catch by distance off U.S. shores and from international waters off foreign shores. In 1974 off U.S. shores, 1.4 million pounds were caught 0-3 miles offshore; 2.5 million pounds, 3-12 miles offshore; and 13.0 million pounds, 12-200 miles offshore. About 1.4 million pounds were caught off Mexico and in the Caribbean Sea combined. Both production and value are greatest from the high seas beyond the present U.S fisheries jurisdiction of 12 nautical miles (Table 6).

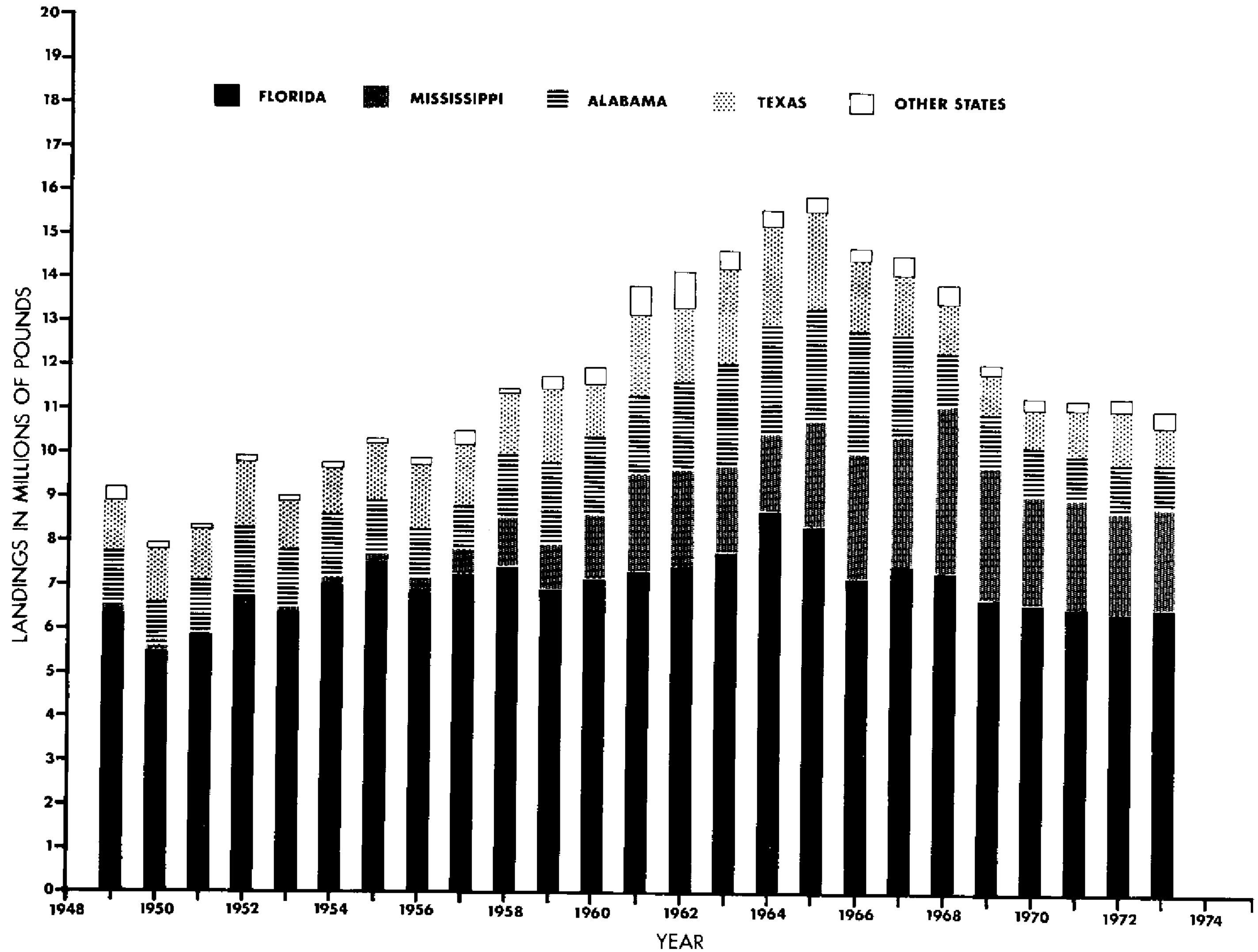

Figure 4. U.S. snapper landings (primarily gutted weight) by state, 1949-73. "Other States" includes North Carolina, South Carolina, Georgia, and Louisiana. Sources: Compiled from Fishery Statistics of the United States (1952-74) and U.S. Department of Commerce (1973-75).

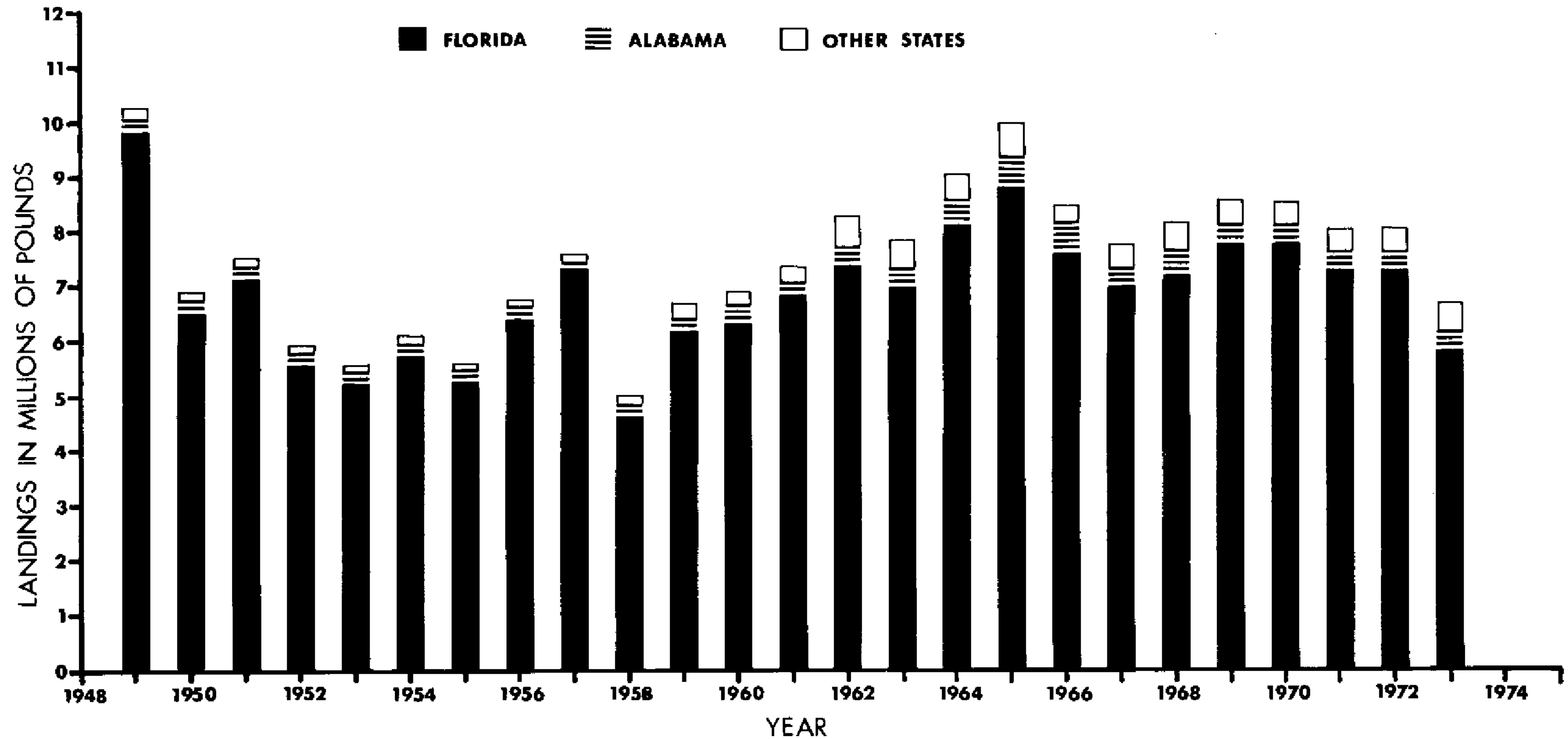

Figure 5. U.S. grouper landings (primarily gutted weight) by state, 1949-73. "Other States" includes North Carolina, South Carolina, Georgia, Mississippi, Louisiana, and Texas. Sources: Compiled from Fishery Statistics of the United States (1952-74) and U.S. Department of Commerce (1973-75).

Table 4. U.S. Snapper-Grouper Fishery, Landings on the East and West Coasts of Florida, 1969-73 1/.

Year	East Coast			West Coast		
	Snappers	Groupers	Total	Snappers	Groupers	Total
	-----Thousand Pounds--------			-------Thousand Pounds---------		
1969	1,018	599	1,617	5,822	7,329	13,151
1970	1,062	691	1,753	5,659	7,219	12,878
1971	929	751	1,680	5,712	6,671	12,383
1972	1,004	564	1,568	5,455	6,787	12,242
1973	934	525	1,459	5,617	5,367	10,984

1/ Primarily gutted weight.

Sources: Compiled from Fishery Statistics of the United States (1972-74) and U. S. Department of Commerce (1973-75).

Table 5. U. S. Snapper-Grouper Fishery, Port Areas Ranked by Quantity Landed, 1973.1/ 2/

Rank	Snappers 3/ 4/ Thousand Pounds	Snappers 3/ 4/ Principal Port by Port Area	Groupers 3/ 5/ Thousand Pounds	Groupers 3/ 5/ Principal Port by Port Area	Snappers & Groupers (Combined) 6/ Thousand Pounds	Snappers & Groupers (Combined) 6/ Principal Port by Port Area
1	2,327	Pascagoula, Miss.	1,951	Madeira Beach, Fla.	2,546	Pascagoula, Miss.
2	2,048	Panama City, Fla.	825	Ft. Myers Beach, Fla.	2,333	Panama City, Fla.
3	1,220	Key West, Fla.	691	Bradenton, Fla.	2,207	Madeira Beach, Fla.
4	738	Mobile, Ala.	535	Key West, Fla.	1,755	Key West, Fla.
5	688	Pensacola, Fla.	384	Carabelle, Fla.	1,443	Ft. Myers Beach, Fla.
6	618	Ft. Myers Beach, Fla.	285	Panama City, Fla.	961	Mobile, Ala.
7	382	Port Isabel, Tex.	223	Mobile, Ala.	937	Bradenton, Fla.
8	363	Niceville, Fla.	219	Pascagoula, Miss.	808	Pensacola, Fla.
9	298	Golden Meadow, La.	120	Pensacola, Fla.	384	Carabelle, Fla.
10	264	Miami, Fla.	119	Tampa, Fla.	382	Port Isabel, Tex.
11	256	Madeira Beach, Fla	101	Nokomis, Fla.	363	Niceville, Fla.
12	246	Bradenton, Fla.				
13	222	Bon Secour, Ala.				
14	197	Mayport, Fla.				
15	196	Aransas Pass, Tex.				
16	177	Riviera Beach, Fla.				
17	104	Galveston, Tex.				

1/ Landings are available by port area (county, parish, or district); for simplicity, the principal ports are used to designate these areas.
2/ Listed in descending order by pounds landed (primarily gutted weight).
3/ Includes only those port areas with snapper or grouper landings that exceeded 100 thousand pounds.
4/ Gulf red snapper is the predominant snapper landed at most of the ports listed. The exceptions are yellowtail snapper at Key West and Miami, Fla. and mutton snapper at Riviera Beach, Fla.
5/ Red grouper is the predominant grouper landed at the ports listed.
6/ Includes only those port areas with snapper and grouper landings (combined) that exceeded 360 thousand pounds.

Source: Landings compiled from U.S. Department of Commerce (1973-75).

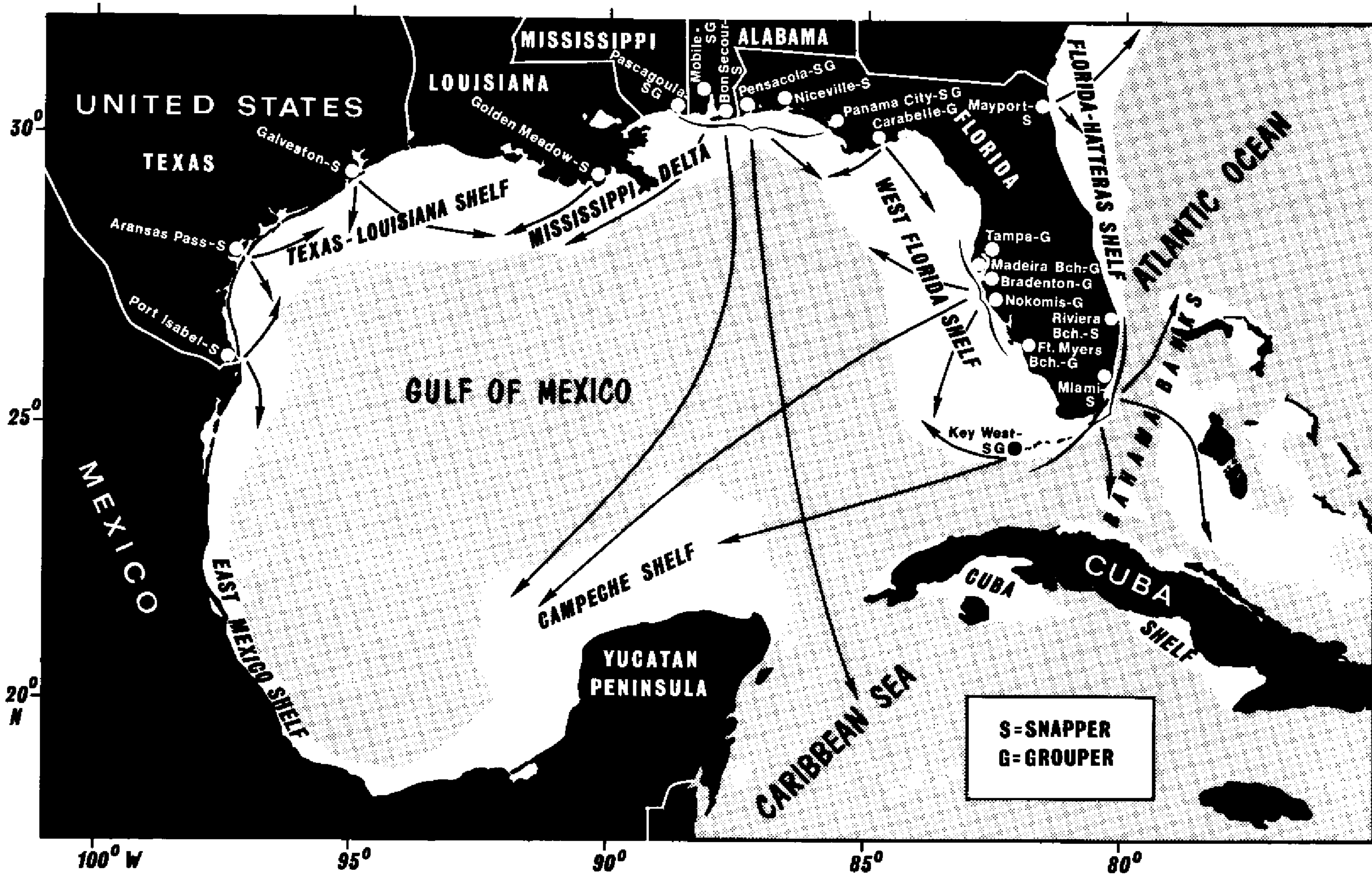

Figure 6. U.S. snapper-grouper fishery, port areas and grounds fished. Landings (primarily gutted weight) are available by port areas only (county, parish, or district); for simplicity, the principal ports are used to designate these areas. Included are only those port areas with snapper or grouper landings that exceeded 100,000 pounds. Sources: Snapper and grouper port areas were identified from Table 5. Information concerning grounds fished based on information from Moe (1963) and Carpenter (1965), updated by NOAA, NMFS Fishery Reporting Specialists located in the South Atlantic and Gulf States. Trips to the Campeche Shelf and Caribbean Sea have decreased in recent years.

Table 6. U.S. Snapper-Grouper Fishery, Catch off U.S. Shores and from International Waters off Foreign Shores, 1971-74. 1/ 2/

Year	Distance off U.S. Shores: 0-3 Miles, Thousand Pounds	0-3 Miles, Thousand Dollars	3-12 Miles, Thousand Pounds	3-12 Miles, Thousand Dollars	12-200 Miles, Thousand Pounds	12-200 Miles, Thousand Dollars	Total off U.S. Shores 0-200 Miles, Thousand Pounds	Total off U.S. Shores 0-200 Miles, Thousand Dollars	International Waters off Foreign Shores, Thousand Pounds	International Waters off Foreign Shores, Thousand Dollars	Combined Total off U.S. and Foreign Shores, Thousand Pounds	Combined Total off U.S. and Foreign Shores, Thousand Dollars
1971	765	236	2,917	984	13,095	4,785	16,777	6,005	1,878	734	18,655	6,739
1972	560	281	3,492	1,402	12,730	5,512	16,782	7,195	2,253	980	19,035	8,175
1973	1,378	638	2,429	1,092	13,265	6,438	17,072	8,172	1,471	691	18,543	8,863
1974	1,403	699	2,490	1,261	13,029	6,866	16,922	8,826	1,401	679	18,323	9,505

1/ Primarily gutted weight.

2/ These data are preliminary and, due to certain inclusions or exclusions, the combined totals do not agree exactly with those shown in Table 3 for 1971-73.

Source: Compiled from Fisheries of the United States (1972-75).

To further facilitate analysis of the fishery, we have arbitrarily divided the fishing grounds into four regions for which we are able to show annual catch data. The divisions have been governed by geographical and national boundaries, and also by the form of the available data. The regions delineated are: (1) the South Atlantic Coast of the United States, (2) the Gulf of Mexico off the United States, (3) the Gulf of Mexico and Caribbean Sea off Mexico, and (4) the Western Caribbean Sea, except off Mexico. In discussing the U.S. fishery by region, we have included information on fishing activities by other nations which may affect the U.S. fishery.

South Atlantic Coast of the United States

The snapper-grouper grounds off the South Atlantic Coast extend from Cape Hatteras, N.C. to just east of Key West, Fla. on the Florida-Hatteras Shelf and Shelf edge, in depths from 7 to 65 fathoms (Moe, 1963; Struhsaker, 1969; Schwartz, 1972). Included in the discussion of the South Atlantic Coast grounds is the Bahamas area, since the U.S. catch from the Bahamas is not reported separately. The Bahamas area generally fished by U.S. craft is in international waters of the Bahama Banks, either on the banks or along the edges of the banks in depths of 80-130 fathoms[5/] (Fig. 1). In 1969 the Bahamas established an exclusive fishing zone of 12 nautical miles, which encompasses part of the fishing area.

Snapper-grouper craft that fish the grounds immediately off the East Coast of the United States generally depart from ports that are relatively near the fishing grounds. A few vessels that fish off the East Coast land on the Gulf Coast. U.S. craft that fish the Bahamas area originate primarily from ports in southeast Florida and from Key West (Fig. 6).

A relatively small portion of the U.S. snapper-grouper fleet participates in the fishery off the South Atlantic Coast. In 1971 there were about 56 vessels and 398 boats operating in the handline fleet along the South Atlantic Coast, with most of these craft based along the Florida east coast (Table 2). There is some seasonal exchange of handline vessels between the South Atlantic Coast and the Gulf of Mexico (Moe, 1963; Sekavec and Huntsman, 1972).

The snapper-grouper landings statistics for the South Atlantic Coast are available, but not specific location of capture. The landings, however, are generally from waters adjacent to the state of landing; so state landings indicate the catch location. Exceptions are occasional catches from off North Carolina, South Carolina, and Georgia that are landed in Florida. In addition, Bahamas catches are landed in Florida.

The annual catch of snappers for the South Atlantic Coast from 1954-73 has remained fairly steady at about 2.0 million pounds (Fig. 7). From 1958 to 1966, the grouper catch averaged about 0.5 million pounds annually.

5/ Information provided by snapper-grouper fishermen.

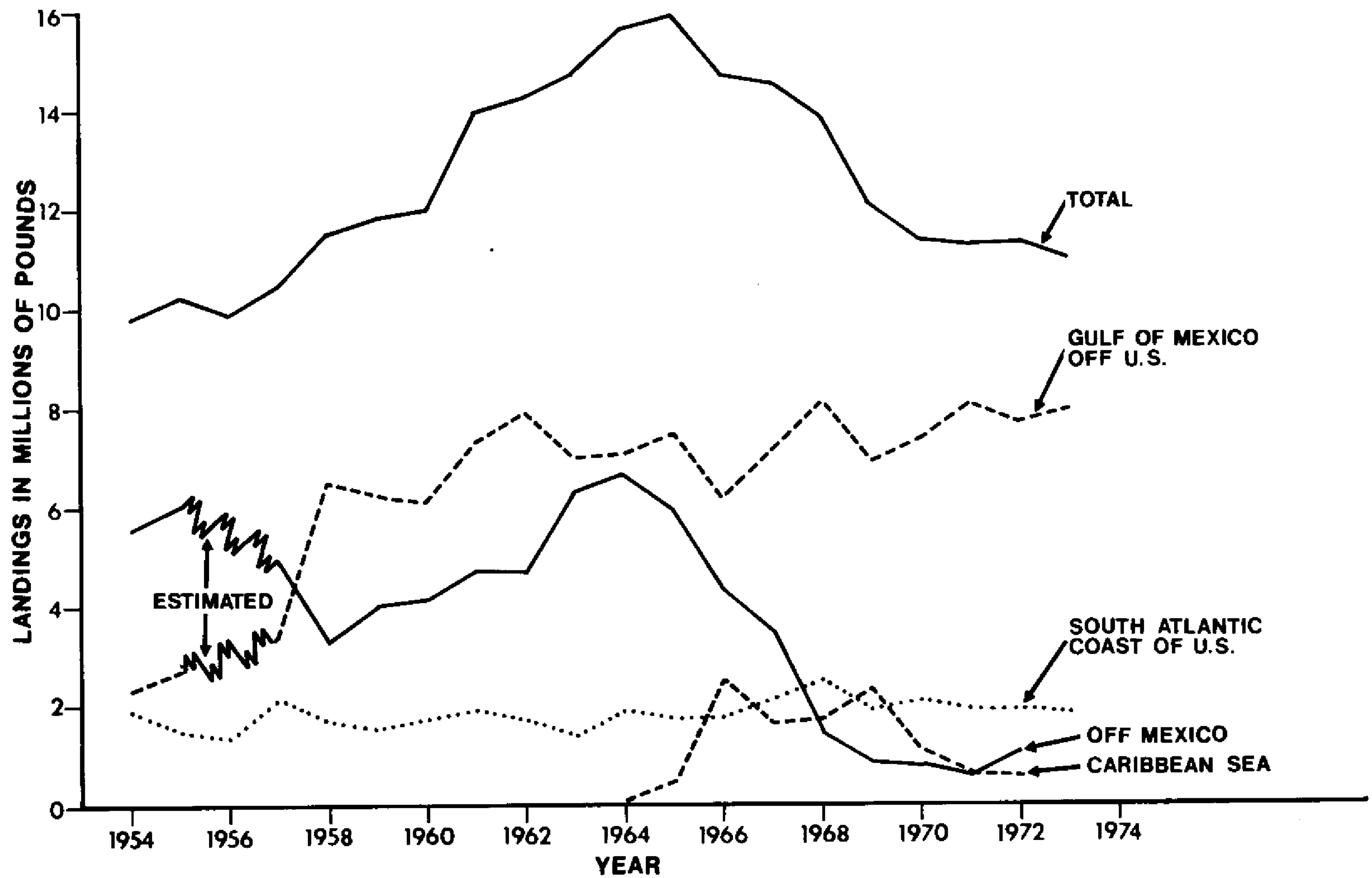

Figure 7. U.S. snapper catch (primarily gutted weight) by region, 1954-73. 1973 regional catches are preliminary and only the combined catch (1.2 million pounds) from off Mexico and in the Caribbean Sea is available. Sources: Compiled from Fishery Statistics of the United States (1956-64); Carpenter (1965); Statistics and Market News Division, NMFS, NOAA, Washington, D.C. 20235--General Canvass Data for 1963-72; Fisheries of the United States (1974); and U.S. Department of Commerce (1974-75).

From 1967 to 1973, the annual catch has been about 1.0 million pounds (Fig. 8). Most of the South Atlantic Coast catch of snappers and groupers is from the Florida-Bahamas area, where 96% was caught in 1972. A sharp drop in North Carolina snapper landings in 1958 was attributed to a mortality of snappers possibly caused by a cold-water intrusion (Sekavec and Huntsman, 1972).

The principal species caught are not known with certainty, since certain common names used commercially may include several species. Among the species caught in the northern sector (Cape Hatteras, N.C. to Cape Canaveral, Fla.) are Gulf red, silk, and vermilion snappers; and red grouper, gag, and scamp. In the southern sector (Cape Canaveral to Key West, Fla. and the Bahamas) the numbers of species increase and include Gulf red, silk, gray, mutton, and yellowtail snappers; and red grouper, gag, scamp, and black grouper (Moe, 1963; Struhsaker, 1969; Sekavec and Huntsman, 1972).

The Bahamian flag snapper-grouper fishery is concentrated on the shallow water banks relatively close to the Bahama Islands. The fish are caught by fish pots and handlines. The total landings of snappers and groupers, combined, by Bahamians are not available but, from information provided by Bahamas Information Services (1974), landings are estimated at about 2 million pounds annually from 1971 to 1973. Groupers comprise about 71% of the snapper-grouper catch.

Cuban flag vessels handline for snappers and groupers on the southwestern Bahama Banks (Ritzhaupt, 1965), but there is no information concerning the amount of catch.

Gulf of Mexico, off the United States

The snapper-grouper grounds off the Gulf Coast of the United States extend from Key West, Fla. to the U.S.-Mexico border. The grounds are located on the West Florida Shelf, the Mississippi Delta, and the Texas-Louisiana Shelf (Fig. 1) in depths from 10 to over 100 fathoms (Camber, 1955; Moe, 1963).

The smaller snapper-grouper craft that fish these grounds are based at nearby ports along the Gulf Coast and make 1- to 12-day trips. The larger, traditional snapper vessels, based mainly in the vicinities of Panama City, Fla., Mobile, Ala., and Pascagoula, Miss., remain at sea for up to 3 weeks. These vessels are capable of operating anywhere in the Gulf (Moe, 1963; Norville, 1975). In 1971 there were 350 snapper-grouper vessels and 1,204 boats based along the Gulf Coast, with most along the west coast of Florida (Table 2).

The snapper catch from the Gulf of Mexico off the United States increased from 2.3 to 7.9 million pounds from 1954 to 1962. From 1962 to 1973, the annual catch averaged 7.4 million pounds (Fig. 7). The grouper catch increased from 4.8 to 8.0 million pounds from 1954 to 1965, but it decreased to 5.4 million pounds by 1973 (Fig. 8).

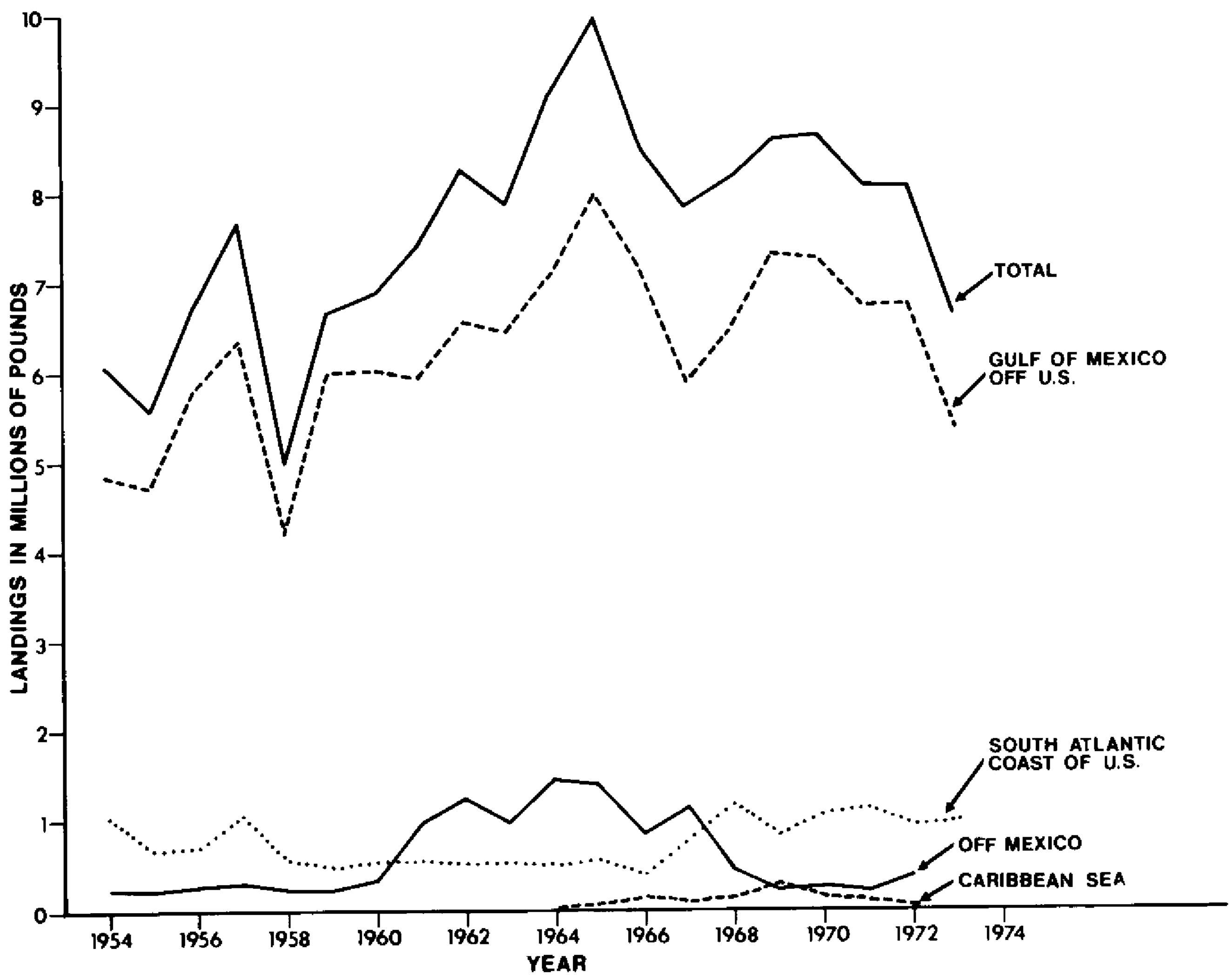

Figure 8. U.S. grouper catch (primarily gutted weight) by region, 1963-71. 1973 regional catches are preliminary and only the combined catch (0.3 million pounds) from off Mexico and in the Caribbean Sea is available. Sources: Compiled from Fishery Statistics of the United States (1956-64); Carpenter (1965); Statistics and Market News Division, NMFS, NOAA, Washington, D.C. 20235--General Canvass Data for 1963-72; Fisheries of the United States (1974); and U.S. Department of Commerce (1974-75).

In this region, most snappers are caught off the north central Gulf Coast and most groupers off the central west coast of Florida. The principal species caught from Key West to Cape San Blas, Fla. are Gulf red, gray, and yellowtail snappers; and red grouper and gag. From Cape San Blas to the U.S.-Mexico border, the Gulf red snapper predominates (Camber, 1955; Moe, 1963).

Cuban flag vessels also fish for snappers and groupers on the West Florida Shelf. The fishery, which began in 1850, originally used sailing vessels and handlines (Mar y Pesca, 1966). The motor vessels now in use are up to 75 feet in length, carry up to eight motor dories each, and use bottom longlines and handlines. The vessels remain on the grounds about 25 days per trip (Fuss, 1972).

From 1971 to 1974, between 44 and 56 Cuban fishing vessels operated off the Florida west coast annually. For these years, the annual catches were estimated to be 4.0, 3.8, 5.0, and 3.5 million pounds, respectively. The principal species caught by the Cuban fleet is red grouper, but other groupers and snappers are taken (Fuss, pers. comm.)6/.

Gulf of Mexico and Caribbean Sea, off Mexico

The snapper-grouper grounds in the Gulf of Mexico and Caribbean Sea, off Mexico, extend from the U.S.-Mexico border to the Mexico-Belize border. The principal grounds are on the Campeche Shelf. The East Mexico Shelf and the Shelf waters from Cabo Catoche to Belize in the Caribbean are fished to a lesser degree (Fig. 1). The grounds fished by the U.S. fleet range in depth from 20 to 140 fathoms (Camber, 1955; Bureau of Commercial Fisheries7/).

Portions of the snapper-grouper grounds off Mexico are regulated by Mexican law. Prior to 1968, fishing was unrestricted in waters beyond 9 nautical miles off the Mexican coast and islands. From 1968 through 1972, Mexico claimed a contiguous fishery zone 9-12 miles offshore; but under a bilateral agreement between the United States and Mexico, U.S. vessels were permitted to continue fishing in the 9- to 12-mile zone. The agreement was not renewed, and in 1973, U.S. vessels were excluded from fishing inside of 12 miles.

6/ C. M. Fuss, Jr., Division Chief, Law Enforcement and Marine Mammal Protection Division, NMFS, NOAA, Southeast Region, St. Petersburg, FL 33702, pers. comm., 1973 and 1975.

7/ Bureau of Commercial Fisheries. No date (1964?). United States fishery for snapper and grouper in and adjacent to Mexican waters--Gulf of Mexico. Unpublished report, 47 p. Bureau of Commercial Fisheries, Exploratory Fishing and Gear Research Base (now Southeast Fisheries Center, Pascagoula Laboratory, NMFS, NOAA), Pascagoula, MS 39567.

The U.S. fleet is composed mostly of vessels based along the northern Gulf Coast from Panama City, Fla. to Pascagoula, Miss., but a few vessels depart from Madeira Beach and Key West, Fla. and Port Isabel, Tex. About 1964, from 100 to 150 U.S. vessels fished the grounds off Mexico (Carpenter, 1965), but the number of vessels and trips has decreased in recent years (Norville, 1975). An estimated 30-35 vessels fished off Mexico in 1971.8/ These vessels made at least one 2- to 3-week trip to these grounds annually.

The U.S. snapper catch for this region declined from 1955 to 1958 (from 6.0 to 3.3 million pounds), but increased to 6.7 million pounds in 1964. From 1964 to 1972, the catch again declined to 1.1 million pounds (Fig. 7). The grouper catch averaged 0.2 million pounds annually from 1954 to 1960 and increased to 1.4 million pounds in 1964. From 1964 to 1972, the catch declined to 0.4 million pounds (Fig. 8).

The effects of the present Mexican law on U.S. snapper-grouper production are not known with certainty, since U.S. vessels have been excluded from the 9- to 12-mile contiguous fishery zone only since January 1, 1973. Available information for 1968-71 indicates, however, that about 15% of the total catch off the Mexican coast was taken in the 9- to 12-mile zone now closed to non-Mexican vessels.9/

The principal species caught by the U.S. fleet are the Gulf red and silk snappers and the red grouper (Camber, 1955; Moe, 1963; Bureau of Commercial Fisheries, see footnote 7).

Mexican, Cuban, and Soviet Union flag vessels also participate in the snapper-grouper fishery off Mexico. Mexican vessels were reported active in the 1930's (Jarvis, 1935). The grounds fished by the Mexican fleet are primarily on the Campeche Shelf (Solis Ramirez, 1970) where about 90% of the total Mexican catch was produced in 1970. The grounds on the East Mexico Shelf and in the Caribbean Sea off Mexico, contribute minimally to the total catch (Secretaria de Industria y Comercio, 1972).

The total number of craft in the Mexican snapper-grouper fleet is unavailable. However, about 130 offshore vessels and 470 inshore boats and canoes fished on the Campeche Shelf in 1969 (Solis Ramirez, 1970). About 80 snapper craft, ranging from 40-footers down to open canoes, fished on the East Mexico Shelf in the early 1960's (Commercial Fisheries Review, 1965). Mexico is presently updating her fleet with the addition of 100 new snapper vessels (Fish Boat, 1974). Most of the Mexican catch is by handlines, handpowered reels, and longlines (Commercial Fisheries Review, 1965 and 1968; Solis Ramirez, 1970; Klima, 1976).

8/ Statistics and Market News Division, NMFS, NOAA, Washington, DC 20235. Unpublished data.

9/ Statistics and Market News Division, Southeast Region, NMFS, NOAA, New Orleans, LA 70130. Unpublished data.

Groupers constituted 77% of the Mexican snapper-grouper catch from 1964 to 1974. The grouper catch decreased to 10.5 million pounds in 1967 but increased to 31.1 million pounds in 1972. The snapper catch increased from 4.2 million pounds in 1964 to 7.7 million pounds in 1972 (Table 7). Red grouper is the dominant species in the catch,with most production on the Campeche Shelf. Of the snappers, Gulf red snapper predominates and is also produced primarily on the Campeche Shelf (Secretaria de Industria y Comercio, 1972).

The Cuban snapper-grouper fishery off Mexico began as a handline fishery from sailing vessels in 1850 (Mar y Pesca, 1966). The Cuban fleet fishes on the Campeche Shelf, primarily in depths of 8-44 fathoms (Carles Martin and Liubimova, 1967). The hook-and-line fleet, of up to 54 vessels (Mar y Pesca, 1974), is part of the same bottom longline and handline fleet that fishes off the West Florida Shelf, and the methods used are the same. The Cubans began using the bottom longline in 1960 (Bedian R. and Romay L., 1974).

The Cuban hook-and-line snapper-grouper catch on the Campeche Shelf in 1965 was 12.3 million pounds (Carles Martin and Liubimova, 1967). Data for the Campeche Shelf catch in more recent years (to 1973) is not directly available. From catch statistics (Young, 1971; Fuss, 1972; Saez, 1973), we estimated the annual catch to be about 12 million pounds. The composition of the hook-and-line catch is about 90% red grouper, with Gulf red snapper the most abundant snapper (Carles Martin and Liubimova, 1967).

Since 1962, Cuban and Soviet Union fish trawlers have worked the Campeche Shelf, primarily in depths of 14-35 fathoms (Buesa, 1964; Sal'nikov, 1965). In the mid-1960's, the Cuban fleet consisted of 5 trawlers and the Soviet fleet, up to 10 trawlers (Buesa, 1964; Sokolova, 1965).

The catches of the Cuban and Soviet trawlers are primarily demersal fish, including snappers (juveniles and adults) and groupers (Sokolova, 1965; Vasil'ev and Torin, 1965). In 1965 the Cuban trawl catch produced about 0.7 million pounds of snappers and groupers (Carles Martin and Liubimova, 1967). Indications are that since 1966, Soviet trawling activity has decreased, while the Cuban trawl catch has shown a marked increase (Kravanja, 1972). The total trawl catch of snappers and groupers in recent years is unreported. Of the snapper and grouper catch by trawl, about 54% by weight are snappers and 46%, groupers (Carles Martin and Liubimova, 1967).

Western Caribbean Sea, Except off Mexico

The snapper-grouper grounds in the Western Caribbean Sea, except off Mexico, extend from the Mexico-Belize border to Colombia in depths up to 125 fathoms (Fig. 1). Most U.S. fishing activity has been on the Honduras-Nicaragua Shelf, near islands and on oceanic banks; lesser activity is reported from the Shelves off Belize, Panama, and western Colombia (Carpenter and Nelson, 1971; see footnote 3).

Table 7. Mexican Snapper-Grouper Fishery, Catch from the Gulf of Mexico and Caribbean Sea off Mexico, 1964-74.1/ 2/

Year	Snappers	Groupers	Total
	-------- Thousand Pounds	--------------------	--------------------
1964	4,202	16,176	20,378
1965	4,700	16,337	21,037
1966	4,795	17,199	21,994
1967	5,887	10,527	16,414
1968	4,945	12,881	17,826
1969	4,963	17,175	22,138
1970	6,393	19,842	26,235
1971	6,393	23,590	29,983
1972	7,716	31,306	39,022
1973	7,716	27,117	34,833
1974	6,834	29,322	36,156

1/ Mexican flag vessels.

2/ Live weight.

Sources: 1964-69 compiled from Secretaria de Industrio y Comercio (1968, 1972); 1970-74 compiled from FAO, Catch Statistics for the WECAF area for 1970-74 (Unpublished).

U.S. vessels generally operate far from shore. Most of the Shelf and bank area is claimed as territorial sea or fishery zone by adjacent western Caribbean nations, and fishing licenses or permits are usually required. A U.S.-Colombia treaty (1972) guarantees continued U.S. fishing adjacent to certain Colombian cays east of Nicaragua (Marine Fisheries Review, 1972).

The U.S. fleet is essentially the same fleet that fishes off Mexico. From 1965 to 1971, as many as 33 U.S. snapper vessels were fishing the Honduras-Nicaragua Shelf and associated banks. Three vessels fished the edge of the Shelf off western Colombia (Carpenter and Nelson, 1971).

From the beginning of this fishery in late 1964 (Fishery Statistics of the United States, 1966), the snapper catches increased to 2.4 million pounds in 1966, but they declined to 0.6 million pounds by 1972 (Fig. 7). The relatively small grouper catches (less than 0.2 million pounds annually) followed a similar trend (Fig. 8). The principal species caught by the U.S. fleet are the silk, Caribbean red, and blackfin snappers (Carpenter and Nelson, 1971).

Fishermen from countries bordering the western Caribbean Sea are also actively fishing that region, but there is little information concerning craft and catches. U.S. import records show, however, that these countries export snapper and grouper to the United States. The fish are often processed by U.S.-owned companies.10/

An unknown number of Mexican snapper-grouper vessels make trips to the Honduras-Nicaragua Shelf from the Yucatan Peninsula (Richard).11/

Belize has an estimated 1,000 full- and part-time fishermen; snappers and groupers are included in their catch by handline and weir. Fishing during seasonal snapper and grouper concentrations exists at several cays, where more than 300 handline boats may participate (Craig, 1966).

For Honduras, the total number of fishermen is not known, although a trap fishery with 90 men, 50 dories, and 4 carrier vessels existed in 1967. The catch, partly snappers and groupers, is transported to Jamaica. A small handline and trap fishery supplies the local markets of coastal Honduras (Miller).12/

10/ Partial or proxy ownership by a national of the particular country involved is the usual practice.

11/ Joseph D. Richard, Associate Professor, Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, FL 33149, pers. comm., 1975.

12/ Miller, G. C. 1967. Trip report--foreign travel, western Caribbean, March-May 1967. Unpublished report, 8 p. Bureau of Commercial Fisheries, Tropical Atlantic Biological Laboratory (now Southeast Fisheries Center, Miami Laboratory, NMFS, NOAA), Miami, FL 33149.

Little information is available on the catch of snappers and groupers by fishermen from Nicaragua, Costa Rica, and Panama. The artisanal and shrimp fishermen apparently account for the total catch (Gonzales Lopez, 1967).

Off western Colombia, snappers and groupers are caught by fishermen from Curacao and Venezuela and landed in Colombia (Voss, 1967).

From Jamaica, 150 - 200 motorized canoes, based on oceanic cays and supplied by carrier vessels, fish as far west as the Honduras-Nicaragua Shelf (Munro and Thompson, 1973).

No information is available on Cuban snapper-grouper fishing in the western Caribbean, except for the domestic fishery on the Cuba Shelf, which is beyond the scope of this publication.

DISCUSSION

Despite the apparent extensive fishing grounds available, the total U.S. landings of snappers and groupers declined from 25.8 million pounds in 1965 to 17.6 million pounds in 1973. The 8.2 million-pound decrease represented 4.8 million pounds of snappers and 3.3 million pounds of groupers (Fig. 3).

The U.S. snapper decline was in the catch off Mexico and, to a lesser extent, in the Caribbean Sea. For these two regions combined, the catch declined from 6.8 million pounds in 1966 to 1.2 million pounds in 1973. The declines in the snapper catch began after 1964 off Mexico and after 1969 in the Caribbean. In the Gulf of Mexico off the United States, the catch remained steady, averaging 7.4 million pounds annually from 1962 to 1973. For the South Atlantic Coast of the United States, the annual catch was constant at about 2.0 million pounds (Fig. 7).

For groupers, most of the U.S. decline was in the catch in the Gulf of Mexico off the United States, where the catch decreased from 8.0 million pounds in 1965 to 5.4 million pounds in 1973. Off Mexico and in the Caribbean Sea, the combined catch declined from 1.4 million pounds in 1965 to 0.3 million pounds in 1973. The declines in the grouper catch began after 1965 off Mexico and after 1969 in the Caribbean. For the South Atlantic Coast, the catch has increased since 1966 and now averages about 1.0 million pounds annually (Fig. 8).

The decline in U.S. snapper-grouper production off Mexico since 1964 is probably related to increased U.S. and foreign fishing on those grounds in the early 1960's. In 1962 vessels of the Soviet Union and Cuba began fish trawling on Campeche Shelf. Snappers and, to a lesser extent, groupers are included in these trawl catches (Buesa, 1964; Sokolova, 1965; Vasil'ev and Torin, 1965). Furthermore, the Mexican handline and longline catch has increased since at least 1964 (Table 7). In 1963 catches by individual U.S. handline vessels off Mexico declined and were composed of smaller fish; these problems were attributed to the increased numbers of U.S. and foreign vessels fishing these grounds (Fishery Statistics of the United States, 1965). The high total U.S. snapper production off Mexico in 1964 was apparently achieved by increased numbers of U.S. handline vessels (Fig. 2).

In late 1964 U.S. vessels began fishing in the Caribbean Sea off Honduras, where better snapper catches could be made (Fishery Statistics of the United States, 1966). During the next few years, with the continuing decline of U.S. catches off Mexico, there was a shift of U.S. fishing effort to the Caribbean Sea (Fishery Statistics of the United States, 1971), which reduced production off Mexico. By 1968 U.S. snapper production from the Caribbean Sea exceeded that from off Mexico, but the combined production was less than in 1967 (Fig. 7). Caribbean production has declined since 1969. This decline has been attributed to reduced fishing effort resulting from poor market acceptance of snapper from waters off Honduras, smaller catches per vessel, increased operating costs of long trips, and the hazard of seizure for violation of territorial claims of western Caribbean countries (Barry, 1968; Fishery Statistics of the United States, 1972-73).

The annual production by region can vary with shifts in fishing location by portions of the U.S. vessel fleet. Since at least 1957, the annual U.S. production from off Mexico and the Caribbean Sea combined, generally fluctuated inversely with the production in the Gulf of Mexico off the United States. The relationship continued after the decline of the combined distant water production began in 1966, reflecting fewer trips off Mexico and to the Caribbean Sea. After 1966, however, production off the United States did not show an increase proportional to the decrease in distant water production, perhaps because the total number of U.S. vessels declined after 1965 (Fig. 7; Fig. 2).

Although the total snapper catch for the Gulf of Mexico off the United States has remained steady since 1961, catches per vessel have decreased (Fishery Statistics of the United States, 1973; Bradley and Bryan, 1975; Norville, 1975). In addition, Norville reports that the average size of the fish caught has declined. Bradley and Bryan observed that juvenile red snappers occupy the brown shrimp (*Penaeus aztecus*) grounds off Texas and that the snapper fishery may be affected by the capture of small snappers in shrimp trawls. This source of mortality, which probably began with the development of the brown shrimp fishery in the late 1940's, may extend to other snapper nursery grounds that support shrimp fisheries. In addition, an increasing number of snappers are caught in the Gulf by recreational fishermen (Deuel, 1973), who fish closer to shore than commercial fishermen. Since juvenile snappers occur in shallower water than adults (Rivas, 1970), the recreational fishery tends to catch smaller fish.

The cause of the decline in grouper production in the Gulf of Mexico off the United States (primarily on the West Florida Shelf) is not known (Fig. 8). According to Moe (1969), annual production at the beginning of the decline (1965-68) decreased despite apparent increased effort by the U.S. commercial fleet. It is probable that effort has continued to increase as production declined. There is additional fishing pressure from the

Cuban bottom longline fleet, which caught an estimated 5.0 million pounds off Florida in 1973 (Fuss, 1972; Fuss, see footnote 6). Pressure is also applied by recreational fishermen who primarily take immature fish (Moe, 1969).

The annual production of grouper off Mexico and in the Caribbean Sea was always low since the grouper catch was incidental to the more valuable snapper catch in those waters (Carpenter, 1965). The decline in these grouper catches is probably associated with the previously described reduction in U.S. fishing effort for snapper in those waters.

CONCLUSIONS

The reported declines in catch per fishing craft may indicate: (1) that the abundance of snapper-grouper is reduced; (2) that U.S. commercial fishermen are obtaining smaller portions of the available stocks; or (3) both. With reduced catches per craft and the squeeze between costs and returns, the U.S. snapper-grouper fishery is finding it difficult to operate successfully, particularly on distant fishing grounds.

Most of the U.S. commercial catch now originates in the Gulf of Mexico off the United States, seaward of 12 miles, in international waters. It is anticipated that western central Atlantic nations (including the United States) will extend fisheries jurisdiction to 200 miles, resulting in exclusive control of most snapper-grouper grounds by the adjacent coastal or island nation. The U.S. snapper-grouper fishery, therefore, will become essentially a domestic fishery.

Analysis of the multispecies snapper-grouper fishery is complicated by the use of several methods of capture and by the lack of basic information from the various user-groups, which include U.S. commercial and recreational fishermen and foreign fishermen. Catch and associated effort data are not generally available, and the species and size compositions of the catch (which includes up to 32 species of snappers and groupers) are not known with any precision.

The fishery takes place in state, Federal, and international waters, through which there is movement of fish stocks. Therefore, research necessary for rational management may be coordinated most effectively under the State-Federal Fisheries Management Program and an international regional fisheries organization, such as the Western Central Atlantic Fisheries Commission.

LITERATURE CITED

Anderson, W. D., Jr.

1967. Field guide to the snappers (Lutjanidae) of the western Atlantic. U.S. Dep. Inter., Fish Wildl. Serv., Circ. 252, 14 p.

Bahamas Information Services.

1974. Agriculture and fisheries -- the need to produce more food. Bahamas Information Services, Public Affairs Dep., 62 p.

Bailey, R. M. (chairman).

1970. A list of common and scientific names of fishes from the United States and Canada. Am. Fish. Soc., Spec. Publ. 6, 150 p.

Barry, E. J.

1968. Gulf fisheries (selected areas) - 1967. U.S. Dep. Inter., Fish Wildl. Serv., Market News Service, New Orleans, La., 28 p.

Bedian R., F. and S. Romay L.

1974. El palangre huachinanguero. Instituto Nacional de Pesca, Mexico, Serie Divulgacion 9, 16 p.

Bradley, E. and C. E. Bryan, III.

1975. Life history and fishery of the red snapper (Lutjanus campechanus) in the northwestern Gulf of Mexico: 1970-1974. Proc. 27th Annu. Sess., Gulf Caribb. Fish. Inst., p. 77-106.

Buesa, R. J.

1964. La pesquerias cubanas. Centro de Investigaciones Pesqueras, Cuba, Contrib. 20, 93 p.

Camber, C. I.

1955. A survey of the red snapper fishery of the Gulf of Mexico, with special reference to the Campeche Banks. Fla. Board Conserv., Tech. Ser. No. 12, 64 p.

Carles Martin, C. A. and T. Liubimova.

1967. Datos sobre distribucion de las principales especies comerciales del Banco de Campeche. In Trabajos al III Congreso Nacional de Oceanografia, Marzo 15-18, Campeche, Mexico, Centro de Investigaciones Pesqueras, Cuba, p. 60-80.

Carpenter, J. S.

1965. A review of the Gulf of Mexico red snapper fishery. U.S. Dep. Inter., Fish Wildl. Serv., Circ. 208, 35 p.

Carpenter, J. S. and W. R. Nelson.

1971. Fishery potential for snapper and grouper in the Caribbean area and the Guianas. In Symposium on Investigations and Resources of the Caribbean Sea and Adjacent Regions, p. 21-26. FAO, Fish. Rep. 71.2.

Commercial Fisheries Review.

1965. Mexico - fishing center at Tampico. Commer. Fish. Rev. 27(7): 83-84.

Commercial Fisheries Review.

1968. The fisheries of Campeche. Commer. Fish. Rev. 30(12):82.

Craig, A. K.

1966. Geography of fishing in British Honduras and adjacent coastal areas. La. State Univ. Coastal Stud. Inst., Tech. Rep. 28, 143 p.

Deuel, D. G.

1973. 1970 salt-water angling survey. U.S. Dep. Commer., NOAA, NMFS, Curr. Fish. Stat., No. 6200, 54 p.

FAO.

1974. Atlantic, western central (Fishing area 31), nominal catches by species and by countries, 1965-72. FAO Fish. Circ. 615, 38 p.

Fish Boat.

1974. Mexico - an ambitious plan for upgrading fisheries calls for 120 new shrimp trawlers. Fish Boat 19(8): 61.

Fisheries of the United States.

1972-75. Current fishery statistics, Nos. 5900, 6100, 6400, and 6700. U.S. Dep. Commer., NOAA, NMFS, Wash., D. C.

Fishery Statistics of the United States.

1952-74. Statistical digests Nos. 25, 27, 30, 34, 36, 39, 41, 43, 44, 49, 51, 53, 54, 56-65. U.S. Dep. Commer., NOAA, NMFS (before 1968 by U.S. Dep. Inter., Fish Wildl. Serv.), Wash., D.C.

Fuss, C. M., Jr.

1972. Foreign fishing off the southeastern United States under the currently accepted contiguous sea limitation. Proc. 24th Annu. Sess., Gulf Caribb. Fish. Inst., p. 19-32.

Ginsburg, I.

1931. Commercial snappers (Lutianidae) of the Gulf of Mexico. U.S. Dep. Commer., Bull. U.S. Bur. Fish. 46: 265-276.

Gonzales Lopez, J. L.

1967. Informe sobre la encuesta pesquera preliminar en el istmo centroamericano. Proyecto Regional de Desarrollo Pesquero en Centroamerica. Boletin Tecnico (FAO) 1(2): 99.

Ingle, R. M.

1970. Summary of Florida commercial marine landings, 1970. Fla. Dep. Nat. Resour., Div. Mar. Resour., Bur. Mar. Sci. Tech., 59 p.

Irby, E. W., Jr.

1974. A fishing survey of Choctawatchee Bay and adjacent Gulf of Mexico waters. Fla. Mar. Res. Publ. No. 2, 26 p.

Jarvis, N. D.

1935. Fishery for red snappers and groupers in the Gulf of Mexico. U.S. Dep. Commer., Bur. Fish., Invest. Rep. 26, 29 p.

Kawaguchi, K.

1974. Handline and longline fishing explorations for snapper and related species in the Caribbean and adjacent waters. Mar. Fish. Rev. 36(9): 8-31.

Klima, E. F.

1976. Snapper and grouper resources of the western central Atlantic Ocean. In H. R. Bullis, Jr. and A. C. Jones (editors), Proceedings: Colloquium on Snapper-Grouper Fishery Resources of the Western Central Atlantic Ocean, Florida Sea Grant Report No. 17, p. 5-40.

Kravanja, M.

1972. Soviet and Cuban fisheries in the Caribbean. In J. D. Theberge (editor), Soviet seapower in the Caribbean: political and strategic implications, p. 135-172. Praeger Publishers, N.Y.

Mar y Pesca.

1966. Cherna americana. Mar y Pesca (Cuba) 6, (included among unnumbered pages following p. 60).

Mar y Pesca.

1974. /No title; article concerns Cuban fisheries/. Mar y Pesca (Cuba) 102, (unnumbered pages between p. 34 and 35).

Marine Fisheries Review.

1972. U.S. and Colombia sign Caribbean fishing treaty. Mar. Fish. Rev. 34(9-10): 63.

Moe, M. A., Jr.

1963. A survey of offshore fishing in Florida. Fla. Board Conserv. Mar. Lab., Prof. Pap. Ser. No. 4, 117 p.

Moe, M. A., Jr.

1969. Biology of the red grouper *Epinephelus morio* (Valenciennes) from the eastern Gulf of Mexico. Fla. Dep. Nat. Resour., Mar. Res. Lab., Prof. Pap. Ser. No. 10, 95 p.

Munro, J. L. and R. Thompson.

1973. The biology, ecology, exploitation and management of Caribbean reef fishes. Part II. The Jamaican fishing industry, the area investigated and the objectives and methodology of the ODA/UWI fisheries ecology research project. Res. Rep. Zool. Dep. Univ. West Indies 3, 44 p.

Noetzel, B. G. and W. M. Gaynor.

1974. U.S. commercial fishery vessels by gear type, 1969. U.S. Dep. Commer., NOAA, NMFS, Curr. Fish. Stat., No. 6543, 24 p.

Noetzel, B. G. and M. J. Wojnowski.

1975. Costs and earnings in the spiny lobster fishery, Florida Keys. Mar. Fish. Rev. 37(4): 25-31.

Norville, W.

1975. Gulf red snapper fishing hurting; smaller boats may be an answer. Natl. Fisherman 55(9): 19-A and 27-A.

Ridgely, J.

1975. Selected information on recreational boats in the United States. Mar. Fish. Rev. 37(2): 16-18.

Ritzhaupt, H.

1965. Las pesquerias de Cuba y algunas recomendaciones para su intensificacion. Centro de Investigaciones Pesqueras, Cuba, Contrib. 21, 110 p.

Rivas. L. R.

1966. Review of the Lutjanus campechanus complex of red snappers. Q. J. Fla. Acad. Sci. 29(2): 117-136.

Rivas, L. R.

1970. Snappers of the western Atlantic. Commer. Fish. Rev. 32(1): 41-44.

Saez, L. M.

1973. Pescando a la gorda. Mar y Pesca (Cuba) 91: 4-11.

Sal'nikov, N. E.

1965. Fishery research in the Gulf of Mexico and the Caribbean Sea. In A.S. Bogdanov (editor), Soviet-Cuban fishery research. All-Union Res. Inst. Mar. Fish. Oceanogr., Fish. Res. Cent. Natl. Piscicultural Inst. Republ. Cuba, p. 78-171. (Translated by Israel Program Sci. Transl., 1969).

Schroeder, W. C.

1924. Fisheries of Key West and the clam industry of southern Florida. Appendix 12, 74 p. (Document No. 962). Rep. U.S. Comm. Fish. fiscal year 1923, Dep. Commer., Bur. Fish.

Schwartz, F. J.

1972. Recent occurrences of cubera snappers (Pisces, Lutjanidae) in North Carolina Atlantic Ocean water. J. Elisha Mitchell Sci. Soc. 88: 252-254.

Secretaria de Industria y Comercio.

1968, 1972. Estadisticas basicas de la actividad pesquera nacional, 1967 and 1968-1970. Secretaria de Industria y Comercio, Direccion General de Regiones Pesqueras, Mexico.

Sekavec, G. B. and G. R. Huntsman.

1972. Reef fishing on the Carolina Continental Shelf. Proc. 15th Int. Game Fish Res. Conf., p. 76-86.

Shinn, E. A.

1974. Oil structures as artificial reefs. Proc. Int. Conf. Artificial Reefs. TAMU (Texas A & M U) - SG-74-103: 91-96.

Siebenaler, J. B. and W. Brady.

1952. A high speed manual commercial fishing reel. Fla. Board Conserv., Tech. Ser. No. 4, 11 p.

Smith, C. L.

1971. A revision of the American groupers _Epinephelus_ and allied genera. Bull. Am. Mus. Nat. Hist. 146: 241.

Sokolova, L. V.

1965. Distribution and biological characteristics of the main commercial fish of Campeche Bank. _In_ A.S. Bogdanov (editor), Soviet-Cuban fishery research. All-Union Res. Inst. Mar. Fish. Oceanogr., Fish. Res. Cent. Natl. Piscicultural Inst. Republ. Cuba, p. 208-224. (Translated by Israel Program Sci. Transl., 1969).

Solis Ramirez, M.

1970. The red grouper fishery of Yucatan Peninsula, Mexico. Proc. 22nd Annu. Sess., Gulf Caribb. Fish. Inst., p. 122-129.

Stroud, R. H.

1966. Artificial reefs as tools of sport fishery management in coastal marine waters. Proc. 10th Int. Game Fish Conf., p. 1-12.

Struhsaker, P.

1969. Demersal fish resources: composition, distribution, and commercial potential of the Continental Shelf stocks off southeastern United States. Fish. Ind. Res. 4(7): 261-300.

Tarbox, L. H.

1970. The red snapper fleet of the Gulf Coast. Natl. Fisherman 50(13): 129-132.

Thompson, H. C. and M. H. Thompson.

1972. Inhibition of flesh browning and skin color fading in frozen fillets of yelloweye snapper (Lutjanus vivanus). U.S. Dep. Commer., NOAA Tech. Rep. NMFS SSRF-644, 6 p.

U.S. Department of Commerce.

1973-75. North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas landings, annual summaries 1972-73, Curr. Fish. Stat., U.S. Dep. Commer., NOAA, NMFS, Wash., D.C.

Vasil'ev, G. D. and Yu. A. Torin.

1965. Oceanographic and fishing-biological characteristics of the Gulf of Mexico and the Caribbean Sea. In A.S. Bogdanov (editor), Soviet-Cuban fishery research. All-Union Res. Inst. Mar. Fish. Oceanogr., Fish. Res. Cent. Natl. Piscicultural Inst. Republ. Cuba, p. 225-250. (Translated by Israel Program Sci. Transl., 1969.)

Voss, G. L.

1967. Bioenvironmental and radiological-safety feasibility studies, Atlantic-Pacific interoceanic Canal. Phase I - Final Report, Marine resources and ecology. Prepared for Battelle Memorial Institute, Columbus (Ohio) Laboratories under Atomic Energy Commission prime Contract No. AT(26-1)-171, 143 p.

Young, E. P.

1971. Five fleets supply fish to Cuba. Fishing News Int. 10(5): 22-29.

RECREATIONAL FISHERIES FOR SNAPPERS AND GROUPERS IN THE GULF OF MEXICO[1/]

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ABSTRACT

Recreational fishing for snappers and groupers is conducted mainly from boats. Three general types of boats are used: party boats (also called head boats), charter boats, and private boats. Sizes of these boats range from small (12- to 16-foot) private boats to large (85-foot) party boats. Snappers and groupers are the top choices of species sought by anglers while fishing from party boats and charter boats. These species are also highly desired by private boat anglers.

Available statistics for snappers and groupers caught in the Gulf of Mexico indicate that catches by recreational anglers are substantially higher than those by commercial fishermen. The aggregate catches of snappers and groupers in the Gulf of Mexico by commercial fishermen in 1965 and 1970 were 22.1 and 16.3 million pounds, respectively. Comparable data for recreational anglers were 59.5 and 32.0 million pounds.

In 1970 the number of recreational anglers fishing in the Gulf of Mexico for snappers was estimated at 437,000 and for groupers at 301,000. The average annual expenditure by salt-water anglers in the Gulf of Mexico in 1970 was estimated at \$178. Thus, the 437,000 anglers spent about \$77.8 million and the 301,000 anglers spent about \$53.6 million in pursuit of their avocation. These numbers probably are not additive, since the grouper anglers also may have fished for snappers.

In 1973 the number of private boats fishing in the Gulf of Mexico was estimated at 348,595; the number of party boats and charter boats was estimated at 437. The annual gross revenue for these 437 commercial sport boats was estimated at \$16.9 million. Comparable data for the private boats were not available.

1/ MARMAP Contribution No. 116.

INTRODUCTION

Recreational fishing for snappers and groupers in the Gulf of Mexico is conducted mainly from boats in offshore waters. Snappers and groupers are also caught by spear fishermen using SCUBA in offshore waters, by anglers from boats in bays and along the coast, and by anglers on shore; but the catch and effort from these methods are considerably less than from boats in offshore waters.

Boats used in the recreational snapper-grouper fisheries range from small (12- to 16-foot) private boats with outboard motors to large (85-foot) party boats with powerful diesel engines. Anglers fishing from these boats use various types of rods and reels, including electric reels.

Snappers and groupers are demersal, carnivorous fishes, ranging in size from less than a pound to several hundred pounds when fully grown. They occur throughout the Gulf of Mexico and are eagerly sought by both recreational and commercial fishermen.

The principal species of snappers sought by anglers belong to the genera *Lutjanus*, *Ocyurus*, and *Rhomboplites*. The most desired species are the red snapper (*L. campechanus*), yellowtail snapper (*O. chrysurus*), gray snapper (*L. griseus*), and vermilion snapper (*R. aurorubens*).

The principal species of groupers sought by anglers belong to the genera *Epinephelus* and *Mycteroperca*. The most desired species are the red grouper (*E. morio*), Warsaw grouper (*E. nigritus*), black grouper (*M. bonaci*), gag (*M. microlepis*), and scamp (*M. phenax*).

CATCH AND EFFORT STATISTICS

The only statistics on catches by recreational fishermen in the Gulf of Mexico are presented in the Salt-Water Angling Surveys of 1960, 1965, and 1970 (Clark, 1962; Deuel and Clark, 1968; Deuel, 1973), wherein several species are lumped together as snappers and as groupers. The aggregate catches for snappers and groupers for the three years are presented in Table 1. The relative importance of the recreational catches is evident when recreational catches are compared to commercial catches (Riley, 1971). In 1960, for example, recreational catches of snappers amounted to 9.6 million pounds versus 10.9 million pounds for commercial catches; in 1965 the catches were 43.6 million pounds versus 13.0 million pounds, respectively; and in 1970 the catches were 15.1 million pounds versus 9.4 million pounds. For groupers, data for 1960 on commercial catches were unavailable, but for 1965 recreational catches amounted to 15.9 million pounds, while commercial catches amounted to 9.1 million pounds; in 1970 the respective catches were 16.9 million pounds versus 7.1 million pounds.

The importance of snappers and groupers to boat anglers has been indicated in a survey conducted in 1973 for the National Marine Fisheries Service by Information Concepts, Incorporated (Bromberg, 1973). Groupers and red snapper ranked third and fourth, respectively, as the species most sought by anglers

Table 1. Estimated Catch and Effort in the Recreational Fisheries for Snappers and Groupers in the Gulf of Mexico.

	1960	1965	1970
Number caught			
Snappers	3,434,000	10,244,000	5,598,000
Groupers	9,346,000	2,153,000	3,576,000
Weight caught (pounds)			
Snappers	9,590,000	43,589,000	15,096,000
Groupers	74,770,000	15,913,000	16,856,000
Number of anglers			
Snappers	186,000	395,000	437,000
Groupers	238,000	222,000	301,000
Number caught by fishing method			
Snappers by boat fishing	3,152,000	10,070,000	4,748,000
Snappers by shore fishing	282,000	174,000	850,000
Groupers by boat fishing	8,747,000	1,918,000	3,043,000
Groupers by shore fishing	599,000	235,000	533,000
Number caught by fishing area			
Snappers in ocean	---	8,000,000	3,717,000
Snappers in sounds and bays	---	2,244,000	1,881,000
Groupers in ocean	---	1,300,000	2,682,000
Groupers in sounds and bays	---	853,000	894,000

Sources: Clark (1962), Deuel and Clark (1968), and Deuel (1973).

fishing on private boats. On commercial sportfishing boats (charter boats and party boats), anglers ranked red snapper, snappers, and groupers as the first, second, and third most sought species (Table 2).

Most snappers and groupers are caught by boat anglers in offshore waters. As indicated in the Salt-Water Angling Surveys, on the average, about 90% of these fishes (by number) were caught from boats and about 10% from shore (including piers, jettys, and bridges). About 70% of the snappers and groupers were caught in oceanic waters of the Gulf of Mexico, while about 30% were caught in sounds and bays (Table 1).

The number of anglers catching snappers and groupers has also been estimated in the Salt-Water Angling Surveys. From 1960 to 1970 the number of anglers catching snappers increased during each of the 5-year periods, from 186,000 to 395,000 to 437,000 (Table 1). The number of anglers catching groupers was 238,000 in 1960, decreased to 222,000 in 1965, and increased to 301,000 in 1970.

Boat fishing effort during 1973 was estimated by Information Concepts, Incorporated. Using the data on the number of trips made by private boats and commercial sportfishing boats (Table 3) and the percentages of trips during which snappers and groupers were sought (Table 2), the number of trips made for snapper fishing by private boats in the Gulf of Mexico in 1973 was estimated at 363,014; the number for groupers was estimated at 365,607. For the 437 commercial sportfishing boats, the estimated number of trips in 1973 for snappers was 31,778 and for groupers, 21,441. The average duration of trips for both classes of boats was a little over one day. The numbers of trips for snappers and for groupers most likely are not additive, as many anglers who fish for demersal species would not have a preference of one over the other. Therefore, the percentage of ocean trips made for snappers and groupers by commercial sportfishing boats probably lies between 53.8% and 90.1% (53.8% + 36.3%).

VALUE OF RECREATIONAL FISHERIES FOR SNAPPERS AND GROUPERS

In 1970 the number of recreational anglers who caught snappers in the Gulf of Mexico was estimated at 437,000, the number who caught groupers was 301,000 (Table 1). In the 1970 National Survey of Fishing and Hunting (U.S. Department of the Interior, 1972), the average annual expenditure of an angler in the Gulf of Mexico was estimated at \$178. Assuming that the percentage of the expenditure specifically for snappers and groupers is half or more of the annual expenditure, the 437,000 anglers spent between \$38.9 million (437,000 x \$89) and \$77.8 million (437,000 x \$178) fishing for snappers, and the 301,000 anglers spent between \$26.8 million (301,000 x \$89) and \$53.6 million (301,000 x \$178) fishing for groupers. These numbers most likely are not additive, since grouper anglers probably fished for snappers also.

The 1973 boat fishing survey conducted by Information Concepts, Incorporated estimated the number of commercial sportfishing boats in the entire United States. These were segregated by boat length, and average annual gross revenues were estimated for boats of each length category. If the same revenue estimates were applied to commercial sportfishing boats in the Gulf of Mexico,

Table 2. The Ten Fishes Most Sought by Boat Anglers as a Percentage of Total Fishing Trips in the Gulf of Mexico.

Private Recreational Boats		Commercial Sportfishing Boats	
Species	%	Species	%
1. Trout (unspecified)	30.7	1. Red Snapper	53.8
2. Snook	14.8	2. Snappers	36.4
3. Groupers	14.1	3. Groupers	36.3
4. Red snapper	14.0	4. King mackerel	33.6
5. Spanish mackerel	13.3	5. Kingfishes	27.6
6. Red drum	11.9	6. Billfishes	20.9
7. Spotted seatrout	11.5	7. Black drum	20.4
8. Anything that would bite	11.1	8. Red drum	20.4
9. King mackerel	8.1	9. Spotted seatrout	20.4
10. Kingfishes	7.7	10. Yellowtail snapper	15.1

Source: Bromberg (1973).

Table 3. Estimated Effort for Recreational Boat Fisheries for Snappers and Groupers in the Gulf of Mexico in 1973.

	Private Recreational Boats	Commercial Sportfishing Boats
Total number of boats fishing in salt water	348,595	437
Number of boats fishing in open ocean	185,327	437
Number of fishing trips in open ocean	2,592,956	59,066
Number of fishing days in open ocean	2,839,222	60,521
Percentage of trips seeking snappers	14.0	53.8
Number of trips seeking snappers	363,014	31,778
Number of days seeking snappers	397,491	32,560
Percentage of trips seeking groupers	14.1	36.3
Number of trips seeking groupers	365,607	21,441
Number of days seeking groupers	400,330	21,969

Source: Bromberg (1973).

the total annual gross revenue by the 437 sportfishing boats in the Gulf would be $16.9 million (Table 4).

RESEARCH NEEDS

The statistics cited in this report have shortcomings, as they are based on small samples (Clark, 1962; Deuel and Clark, 1968; Bromberg, 1973; Deuel, 1973). Enlarging the sample size is difficult due to the high cost of doing so. Nevertheless, the need to refine statistics on our recreational fisheries is evident, as illustrated by the estimated number of commercial sportfishing boats (charter boats and party boats) in the Gulf of Mexico in 1973. This number was 437 (Bromberg, 1973). Researchers at the Panama City Laboratory of the Gulf Coastal Fisheries Center, National Marine Fisheries Service, have estimated that on the Gulf coast of Florida alone, over 900 of these boats exist. Their estimate was obtained in 1975 in consultation with the district offices of the Florida Marine Patrol.

Other refinements needed are: 1) the identification of the various species of snappers and groupers caught by anglers, and 2) knowledge of the distribution and landings of these species with respect to location and season. Obtaining such data is difficult, as the identification of some species of snappers and groupers is difficult even for biologists.

Also, the frequency of obtaining catch and effort statistics needs to be increased. Obtaining such data at 5-year intervals does not permit assessment of fish stocks with reasonable confidence. However, increasing the frequency of gathering data entails additional costs, as does increasing sizes of samples.

In summary, the recreational fisheries for snappers and groupers in the Gulf of Mexico is principally a boat fishery in oceanic waters. Catches by recreational anglers appear to be substantially greater than those by commercial fishermen. Statistics on catch and effort exist, but their use is limited, due to small sample sizes, long intervals between surveys, and lack of specific identification of the species. The need for more refined and intensive surveys of the recreational fisheries for snappers and groupers is evident.

Table 4. Estimated Annual Gross Revenue of Commercial Salt-Water Sportfishing Boats.

Size Class	Number of Commercial Sportfishing Boats	Average Annual Gross Revenue	Total Annual Gross Revenue
Entire United States			
Less than 40 feet	549	$ 6,610	$ 3,628,890
40 feet to less than 65 feet	1,747	17,211	30,067,617
65 feet or more	200	260,891	52,178,200
Total	2,496	---	$85,874,707
Gulf of Mexico			
Less than 40 feet	85	$ 6,610	$ 561,850
40 feet to less than 65 feet	310	17,211	5,335,410
65 feet or more	42	260,891	10,957,422
Total	437	---	$16,854,682

Source: Bromberg (1973).

LITERATURE CITED

Bromberg, K. M.
1973. Determination of the number of commercial and non-commercial recreational boats in the United States, their use, and selected characteristics. Final report, NMFS Contract No. 3-35490 to Information Concepts, Incorporated, 111 p. Distributed by NTIS, U.S. Dep. Commer., Wash., D.C.

Clark, J. R.
1962. The 1960 salt-water angling survey. U.S. Dep. Inter., Fish Wildl. Serv., Circ. 153, 36 p.

Deuel, D. G.
1973. 1970 salt-water angling survey. U.S. Dep. Commer., NOAA, NMFS, Curr. Fish. Stat., No. 6200, 54 p.

Deuel, D. G. and J. R. Clark.
1968. The 1965 salt-water angling survey. U.S. Dep. Inter., Fish Wildl. Serv., Resour. Publ. 67, 51 p.

Riley, F.
1971. Fisheries of the United States, 1970. U.S. Dep. Commer., NOAA, NMFS, Curr. Fish. Stat., No. 5600, 79 p.

U.S. Department of the Interior.
1972. National survey of fishing and hunting 1970. U.S. Dep. Inter., Fish Wildl. Serv., Resour. Publ. 95, 108 p.

BIOLOGICAL RESEARCH ON SNAPPERS AND GROUPERS AS RELATED TO FISHERY MANAGEMENT REQUIREMENTS [1/]

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ABSTRACT

Fewer than two dozen pertinent studies have been published on the biology of snappers and groupers as related to fishery management requirements. Almost half of this research was based on tagging programs which described migratory patterns. There has been only one major effort on the basic life history of red grouper (Epinephelus morio) and two investigations on red snapper (Lutjanus campechanus) life history. This paucity of data exemplifies the need for similar life history studies, if sound management policies are to be adopted in assuring maximum sustained yield.

1/ Contribution No. 270, Florida Department of Natural Resources, Marine Research Laboratory, St. Petersburg, FL 33701.

Twelve years ago in a brief note describing length-weight relationships of young red snapper (Lutjanus campechanus) from the northern Gulf of Mexico, Charles Dawson began his text by chiding fishery biologists for neglecting to gather sufficient biological information to adequately manage the fishery for this extremely valuable species. Today, in Pensacola, Fla., the birthplace 125 years ago of this important Gulf fishery, we may finally examine what yet needs to be known.

Dr. Dawson's admonishments were not unheeded. Two years later, in 1965, Frank Moseley presented a master's thesis to the University of Texas faculty on the biology of red snapper in the northwestern Gulf of Mexico. That same year, Martin Moe began a contribution to the life history of red grouper (Epinephelus morio) for the (then) Florida Board of Conservation, which also eventually fulfilled partial requirements of a master's degree at the University of South Florida. Previously, most of the biological research on snappers and groupers was confined to contributions from a series of tagging studies conducted in Florida with assistance from the Schlitz Brewing Company and from scattered ecological surveys, such as John Bardach's observations on Bermuda reef fish movement and Springer and McErlean's similar studies at Key Largo in the Florida Keys. These tagging studies, as well as earlier surveys of the actual fisheries and gear development work, did not address key aspects of the biology of groupers and snappers. Thus, these studies did not supply vital information required to support management recommendations, should the fisheries need such regulation.

Even with Moe's contributions to red grouper life history, Moseley's work on red snapper life history, and Bradley and Bryan's investigation of red snapper and associated fishes and crustaceans trawled off Texas in 1970-72, we wonder whether there is sufficient biological information to correctly manage the stocks. The latter work (conducted by the Texas Parks and Wildlife Department with PL 88-309 funds from the National Marine Fisheries Service, NOAA), one other short contribution to the age of sexual succession in protogynously hermaphroditic gag (Mycteroperca microlepis) by McErlean and Smith in 1964, and current work on red snapper age, growth, and reproduction (by Florida Department of Natural Resources biologists) are just beginning to answer some of the following fishery management questions:

1) HOW LONG DO THE FISH LIVE; HOW FAST DO THEY GROW; AND WHAT AGE CLASSES ARE VULNERABLE TO THE FISHERIES?

* Red grouper can live as long as 30 years, but their effective fishable life span is 17 years. Growth rates of male and female red grouper have been theoretically established for ages 1-15. Males reach a slightly larger ultimate length than do females, but the rate of growth for each sex is believed to be similar.

* Gag have tentatively been described as attaining 18 cm standard length (SL) within the first year and subsequently growing from 8 to 10 cm SL per year, up to age 6. Eventual age has not been established and theoretical growth has not been determined.

* Red snapper may live at least 9-11 years, but neither their effective fishable life span nor theoretical growth rates have been adequately determined. Western Gulf of Mexico red snapper were estimated to achieve 20-25 cm SL within a year and to grow from 6 to 9 cm per year, up to their fourth "spawning period." Analysis of measurements at recapture of tagged red snapper revealed that such an estimated growth rate appears reasonable.

2) WHEN DO THE FISH BECOME SEXUALLY MATURE; WHAT IS THE FECUNDITY OF FISH OF THE PRINCIPAL SPAWNING AGES?

* Red grouper, protogynously hermaphroditic, undergo sexual transition from female to male between ages 5-10 years at a rate of approximately 15% per year. Males are reproductively significant in the population after 10 years. Females are mature (capable of spawning) between ages 4-6 but, in terms of fecundity, achieve their greatest reproductive potential when they reach 8-12 years of age.

* Gag, also protogynously hermaphroditic, mature as females during their 4th or 5th year and transform into males at approximately age 10 or 11.

* Red snapper have been thought to mature within only one year, but this has yet to be verified.

3) WHERE, WHEN, AND HOW OFTEN DO THEY SPAWN?

* Gonadal activity of red grouper was evident in tissue collections made in January and February, as well as in October and November samples. Correlated with the photoperiod, the January-February gonadal activity culminated in late spring spawning, while the October-November activity regressed into a "resting state" by December. No histological evidence was found to suggest individual fish spawned more than once each year. Spawning occurs principally during April and May. Off the Florida west coast, spawning is thought to occur in 13-15 fathoms.

* Gag are in spawning condition from January through March, and spawners are believed to be confined to the commercially exploitable stocks from deeper water off west Florida.

* Gonadal activity of red snapper has been observed in tissue collections from specimens captured as early as June and as late as November, from depths greater than 20 fathoms off Tarpon Springs, Fla. Spawning is thought to occur several times throughout the summer, principally during July through September. Two spawning areas have been observed during July and August by commercial fishermen. These areas are in 10-20 fathoms, due south of Panama City, Fla., over a firm sand bottom of gentle

gradient and little relief. This agrees with observations off Texas, where spawning activities over level bottom within 20 fathoms have also been reported. Red snapper apparently spawn in the western Gulf of Mexico (and off Campeche) from June (or July) through September, with a peak occurring in July and August. A second spawning during "fall" off Texas has also been postulated.

4) <u>WHERE ARE THE LARVAE AND JUVENILES DISTRIBUTED --SPECIFICALLY, DO THEY REQUIRE CRITICAL ECOLOGICAL NICHES?</u>

* Little is known of the distribution, or even of descriptive characters of red snapper, red grouper, or gag larvae.

* Red grouper are thought to leave the plankton to become benthic at about 20-25 mm SL. Juveniles are dispersed in low densities over hard bottom in depths of at least 20 fathoms, where they display cryptic behavior and are thus inaccessible to most collecting gear.

* Juvenile gag have a similar distribution but extend, especially during summer, even farther into sheltered, saline bays and coastal lagoons, where they inhabit <u>Thalassia</u> grass flats or congregate near rock piles. They are often taken with other fishes incidental to bait shrimp trawled from grass flats along Florida's central west coast.

* Juvenile red snapper have been captured off Texas over smooth bottom which is regularly trawled for shrimp. It is generally thought that as red snapper grow older, they seek deeper water, although some evidence indicates juveniles subsequently return to shallower water during spring and summer after the first winter's emigration from such areas.

5) <u>WHAT IS THE DISTRIBUTION OF JUVENILES RELATIVE TO THE FISHERY; WHAT CAUSES SUCH A DISTRIBUTION?</u>

* Red grouper from 1 to 6 years old (less than 50 cm SL) inhabit nearshore reefs and historically have been the mainstay of the central west Florida coastal party boat fishery. Larger, older fish have comprised the commercial catch from deeper water farther offshore. Moe cautioned that since long-lived, slow-growing fishes are more susceptible to population reduction through fishing pressure than short-lived, fast-growing fishes, constant and intensified removal of newly recruited year classes could hinder maintenance of sufficient numbers of large fish needed to maintain the reproductive viability of the resource.

* Gag follow the same pattern as red grouper, displaying an even greater variation in distribution during their life span.

Unfortunately, specific details are not as well known as they are for red grouper.

* Red snapper juveniles, up to about 15 cm fork length (FL), that seasonally inhabit smooth bottom during summer have been readily captured with shrimp trawls. Young red snapper of a similar size have also been collected with hook and line over smooth bottom off Florida, where they appear to forage in compact schools. The young red snapper do not remain long in one spot, but definitely return to the same vicinity in subsequent summers, as evidenced by tag returns.

  The stomach contents of juvenile red snapper captured in shallow water indicate they are opportunistic feeders. Invertebrates (shrimps, crabs, and squids) constitute a substantial portion of their diet, with even tunicates being included (probably by accident) due to sheer availability rather than desirability. Stomach eversion of larger fish from deeper waters, due principally to fishing methods, hinders accurate diet comparisons. Seasonal changes in benthic macrofauna with the onset of winter undoubtedly influence the assumed movement of red snapper into deeper water (greater than 15 fathoms) following summer forages. The predominance of squids and mud-burrowing shrimps in the stomachs of young red snapper is evidence of nocturnal feeding behavior.

6) <u>WHAT ARE THE GENERAL MOVEMENT PATTERNS OF EXPLOITABLE FISH STOCKS; WHAT IS THEIR AVAILABILITY TO THE FISHERY; AND HOW IS THIS RELATED TO THE REPRODUCTIVE OR RECRUITMENT PATTERNS OF THE SPECIES?</u>

* Red grouper move offshore from the shallower reef environments as they attain sexual maturity at about 40 cm SL (age 5). Commercial fishermen report seasonal movement of the species in deeper, offshore water (15-50 fathoms); extensive movement is also verified by tag returns, although distinct patterns are not known. Young red grouper do not move during their residence at nearshore reefs.

* Black grouper (*Mycteroperca bonaci*) tagged and released at inshore patch reefs in the Florida Keys also displayed strong home-reef specificity. Even a hurricane failed to disrupt their residence during that study. This seems to be common with serranids, judging from similar results in Bermuda tagging studies. When individual Nassau grouper (*Epinephelus striatus*) and red hind (*E. guttatus*) were transported to other reefs in the vicinity, they all returned to their original reef. Extensive tagging of young gag at nearshore reefs off the Florida west coast yielded the same evidence of tenacious reef specificity.

* Red snapper also definitely show specific reef residency. This is indicated by seasonal returns to summer forage areas, as well as distinct congregation at reefs in deeper water. The only extensive movement seen in red snapper tagged in the northern Gulf of Mexico occurred among fish released at reefs in water deeper than 15 fathoms. It is unknown whether such movement was forage-motivated or whether it occurred in response to reproductive stimuli. Again, movement was only notable when the fish began living in deeper, offshore areas after leaving the shallower reefs, where they did not move appreciably.

BIBLIOGRAPHY

Bardach, J. E.
1958. On the movements of certain Bermuda reef fishes. Ecology 39(1): 139-146.

Bardach, J. E., C. L. Smith, and D. W. Menzel.
1958. Final report. Bermuda fisheries research program. Bermuda Trade Development Board, Hamilton, Bermuda, 59 p.

Beaumariage, D. S.
1969. Returns from the 1965 Schlitz tagging program including a cumulative analysis of previous results. Fla. Dep. Nat. Resour., Mar. Res. Lab., Tech. Ser. No. 59, 38 p.

Beaumariage, D. S. and A. C. Wittich.
1966. Returns from the 1964 Schlitz tagging program. Fla. Board Conserv. Mar. Lab., Tech. Ser. No. 47, 50 p.

Bradley, E. and C. E. Bryan, III.
1973. Northwestern Gulf of Mexico marine fisheries investigation - Study No. 2, 1970-1973. Project No. 2-109-R. U. S. Dep. Commer., NOAA, NMFS, St. Petersburg, Fla., 134 p.

Camber, C. I.
1955. A survey of the red snapper fishery of the Gulf of Mexico, with special reference to the Campeche Banks. Fla. Board Conserv., Tech. Ser. No. 12, 64 p.

Carpenter, J. S.
1965. A review of the Gulf of Mexico red snapper fishery. U. S. Dep. Inter., Fish Wildl. Serv., Circ. 208, 35 p.

Collins, J. W.
1885. The red snapper grounds in the Gulf of Mexico. Bull. U. S. Fish. Comm. 5(10): 145-146.

Dawson, C. E.
1963. Length and weight relationships of young red snappers from the northern Gulf of Mexico. Trans. Amer. Fish. Soc. 92(3):310-311.

Futch, C. R. and J. M. Torpey.
1966. The red snapper - a valuable marine resource. Fla. Board Conserv. Mar. Lab., Salt Water Fish. Leafl. 4, 4 p.

Ginsburg, I.
1931. Commercial snappers (Lutianidae) of the Gulf of Mexico. U. S. Dep. Commer., Bull. U. S. Bur. Fish. 46:265-276.

Jarvis, N. D.
1935. Fishery for red snappers and groupers in the Gulf of Mexico. U. S. Dep. Commer., Bur. Fish Invest. Rep. 26, 29 p.

Mc Erlean, A. J.
1963. A study of the age and growth of the gag, Mycteroperca microlepis, Goode and Bean Pisces: Serranidae on the west coast of Florida. Fla. Board Conserv. Mar. Lab., Tech. Ser. No. 41, 29 p.

McErlean, A. J. and C. L. Smith.
1964. The age of sexual succession in the protogynous hermaphrodite, Mycteroperca microlepis. Trans. Amer. Fish. Soc. 93(3):301-302.

Moe, M. A., Jr.
1963 A survey of offshore fishing in Florida. Fla. Board Conserv. Mar. Lab., Prof. Pap. Ser. No. 4, 117 p.

__________.
1966. Tagging fishes in Florida offshore waters. Fla. Board Conserv. Mar. Lab., Tech. Ser. No. 49, 40 p.

__________.
1967. Prolonged survival and migration of three tagged reef fishes in the Gulf of Mexico. Trans. Amer. Fish Soc. 96(2): 228-229.

__________.
1969. Biology of the red grouper Epinephelus morio (Valenciennes) from the eastern Gulf of Mexico. Fla. Dep. Nat. Resour., Mar. Res. Lab., Prof. Pap. Ser. No. 10, 95 p.

Moe, M. A., Jr., D. S. Beaumariage, and R. W. Topp.
1970. Return of tagged gag, Mycteroperca microlepis, and Caribbean red snapper, Lutjanus campechanus, after six years of freedom. Trans. Amer. Fish. Soc. 99(2):428-429.

Moseley, F. N.
1965. Biology of the red snapper, Lutjanus aya Bloch, of the northwestern Gulf of Mexico. Master's Thesis, Univ. Texas, Austin, 53 p.

Reid, G. K., Jr.
1954. An ecological study of the Gulf of Mexico fishes in the vicinity of Cedar Key, Florida. Bull. Mar. Sci. Gulf Caribb. 4(1), 94 p.

Rivas, L. R.
1964. Western Atlantic serranid fishes (groupers) of the genus Epinephelus. Q. J. Fla. Acad. Sci. 27(1):17-30.

Springer, V. G. and A. J. McErlean.
1962. A study of the behavior of some tagged south Florida coral reef fishes. Am. Midl. Nat. 67(2): 386-397.

Topp, R. W.
1963. The tagging of fishes in Florida 1962 program. Fla. Board Conserv. Mar. Lab., Prof. Pap. Ser. No. 5, 76p.

———.
1964. Residence habits of the red snapper. Underwater Nat. 2(3): 15-17.

THE GULF OF MEXICO COMMERCIAL AND RECREATIONAL RED SNAPPER-GROUPER FISHERY: AN ECONOMIC ANALYSIS OF PRODUCTION, MARKETING, AND PRICES

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ABSTRACT

Owners and captains of both commercial red snapper boats and party boats along the north Florida Gulf coast were interviewed in 1975. Cost and return data were collected and analyzed for 1974. Also documented and analyzed was the economic importance to the region of the commercial and party boat industries.

Price analyses include seasonal dockside price differentials paid for red snapper and groupers, annual variation in prices, and dockside price differences between landing regions. Past research on the demand for red snapper is examined and price response equations for monthly and annual dockside prices for Texas, Alabama, Mississippi, Florida, and the U. S. red snapper and grouper industries are presented, where data are sufficient. The importance of imports to the industry is discussed.

Marketing information includes a general discussion of the marketing channels for red snapper and groupers landed along the north Florida Gulf coast and a preliminary analysis of gross marketing margins for red snapper.

Finally, the need for management programs in the red snapper-grouper industry receives comment. The variables that must be observed and considered in a management program are discussed. The opinions of boat captains and owners concerning production trends and management needs in the fishery are noted.

INTRODUCTION

During the 1950's and until about 1965, the commercial landings of red snapper in the United States increased annually at a fairly rapid rate. 1/2/ Landings were 8.9 million pounds in 1952 and increased to a high of 14.0 million pounds by 1965. Total U.S. landings decreased to about 9 million pounds annually in 1970-73 (Fig. 1). In 1973 red snapper represented about 80% of the total U. S. commercial snapper landings, compared to about 94% in the early 1950's.

Florida is the leading state in commercial red snapper landings, with annual production in 1973 of slightly over 4 million pounds. These landings represent a decrease from those of the middle 1960's, when landings reached a high of about 7 million pounds (Fig. 1). Commercial landings in Texas, Alabama, and Mississippi have also declined from their peaks, which in Alabama and Mississippi occurred several years later than in Florida. These data indicate a decline for the total fishery, rather than just a shift in landings from one region or state to another.

Commercial grouper[3/] landings in the United States also declined after 1965, when a high of 9.6 million pounds was recorded. Annual grouper landings have fluctuated more than snapper landings (Fig. 2). Again, Florida is the leading state, with almost all U.S. commercial grouper landings reported from that state.

Similar commercial landings patterns are expected for snappers and groupers since both groups of fishes are often fished with the same vessels and gear and at similar locations. In addition, the economic incentive for snapper fishing is expected to influence grouper landings. Red snapper are more valuable than groupers; and increased fishing effort for red snapper, influenced by higher prices, causes increased grouper landings, because of the complementarity in production.

The recreational catch of snappers and groupers in the United States in 1970 was estimated at 82.7 million pounds (Deuel, 1973). By species group, the catch was groupers, 41.0 million pounds; yellowtail snapper, 21.0 million; red snapper, 17.3 million; and snappers, 3.4 million pounds. These data indicate that, while red snapper constituted the largest part of the commercial catch, groupers and yellowtail snapper were also important to sport fishermen. Although these estimates contain unmeasured sampling and

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1/ A discussion and analysis of the Gulf of Mexico red snapper fishery from 1875-1951 can be found in a publication by Camber (1955).

2/ In this paper the term "red snapper" is used as a market category consisting primarily of the Gulf red snapper, *Lutjanus campechanus*. For some areas, lesser amounts of other species of snappers are included with Gulf red snapper and are not separated in the landing statistics.

3/ Primarily red grouper, *Epinephelus morio*.

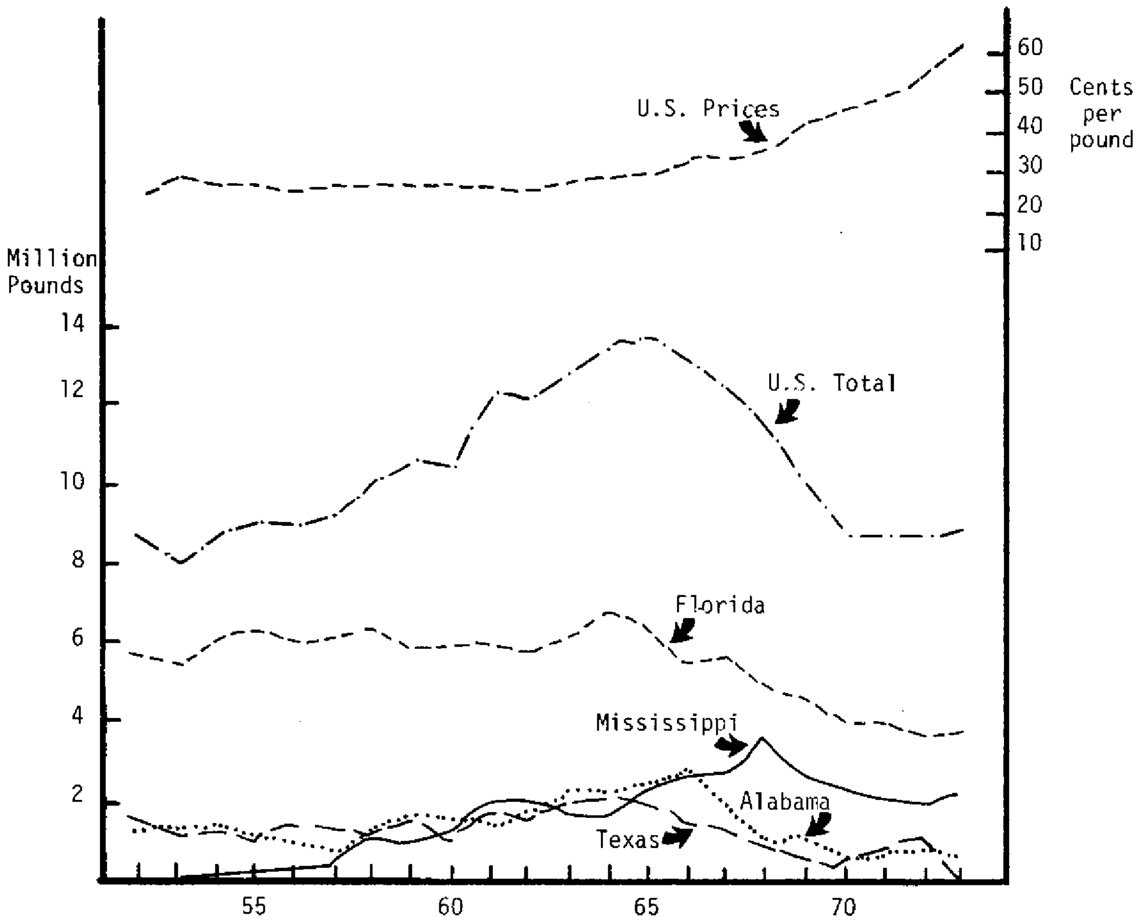

Figure 1.--Annual red snapper landings in Florida, Mississippi, Texas, Alabama, and the United States and dockside prices in the United States, 1952-73.

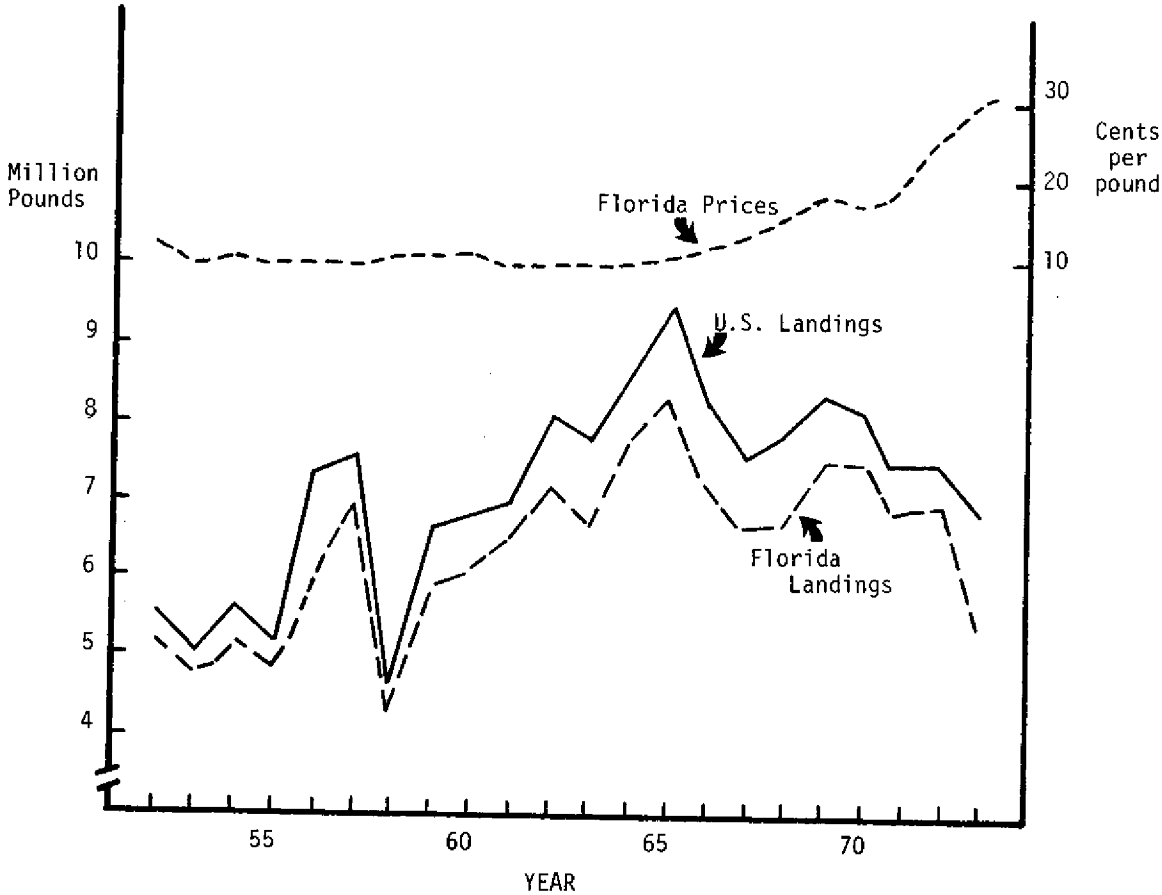

Figure 2.--Annual grouper landings in Florida and the United States and dockside prices in Florida, 1952-73.

response errors, the importance of the recreational catch cannot be ignored. This importance is further substantiated by the cost and return budgets for party boats presented later in this paper. Premium prices paid for red snapper and accessibility of yellowtail snapper and grouper fishing areas to sport fishermen are primary reasons for the catch differences between the commercial and recreational fisheries.

In this paper, marketing and price analyses are presented for the commercial red snapper-grouper fishery. Both the commercial industry and the north Florida Gulf coast recreational party boat industry were considered in the analysis of costs and returns, together with the impact of these industries on the north Florida Gulf coast economy.

LANDINGS AND PRICE TRENDS

In terms of commercial dockside prices, red snapper are about twice as valuable as grouper. The average price for red snapper landed in the United States increased from 24¢ per pound in 1952 to 56¢ in 1972 (Fig. 1). Average grouper prices increased from around 10¢ per pound in the 1950's and early 1960's to 26¢ in 1972. Florida grouper prices are similar to U.S. grouper prices, since most commercial grouper production is landed in Florida (Fig. 2).

ANNUAL PRICES

Dockside prices for red snapper along the Gulf Coast vary with the location of landing. Prices in Alabama were about 24¢ per pound in the early 1950's and rose to an average of 46¢ in 1973 (Fig. 3). Texas prices in 1973 averaged 51¢ per pound, compared to early 1950 prices of about 24¢ (Fig. 4). Mississippi prices were 46¢ in 1973, an increase from 24¢ in the early 1950's (Fig. 5).

Since 1964, dockside prices for red snapper landed in Florida generally have been higher than those reported in other states. In the early 1950's, Florida prices were about 26¢ per pound, but recently prices increased to over 76¢ (Fig. 6). Price differentials between states can be seen in Figure 7. Prices in Mississippi, Texas, and Alabama, expressed as a difference from Florida prices, were similar to Florida prices through 1963 (usually less than a 2¢ to 4¢ difference). In 1964 Florida prices began to increase more rapidly than prices in the other states (Fig. 7). Prices reported in Alabama and Mississippi remained relatively stable, and by 1973 they were 29¢ per pound lower than Florida prices. Texas prices were 24¢ per pound lower than Florida prices in 1973. These price differentials between states can be attributed both to different market outlets and to quality differences. Some buyers in Florida market fish soon after they are caught, while those in other states more often market fish caught in waters farther offshore. Fish caught farther offshore have been iced for longer periods of time and, thus, bring lower market prices.

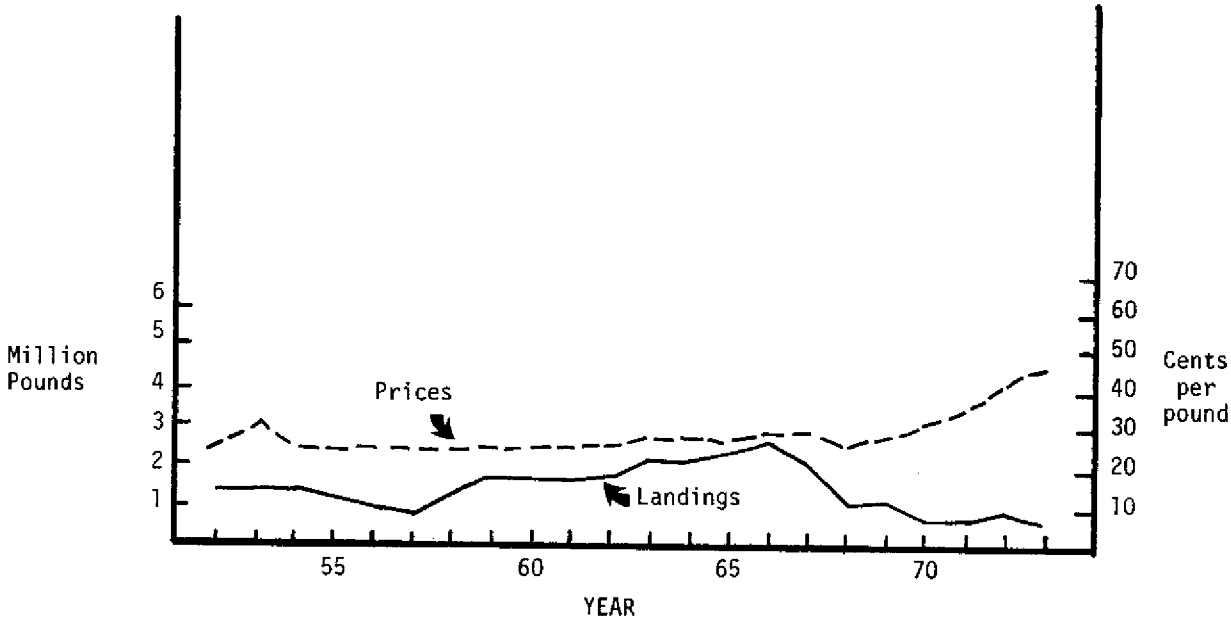

Figure 3.--Annual red snapper landings and dockside prices in Alabama, 1952-73.

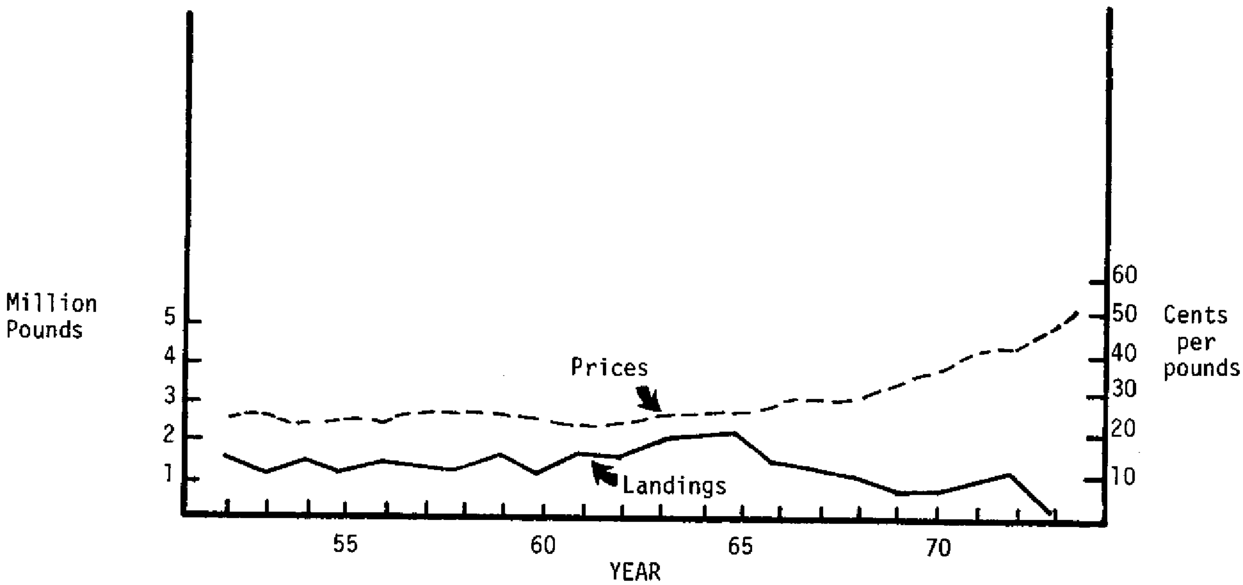

Figure 4.--Annual red snapper landings and dockside prices in Texas, 1952-73.

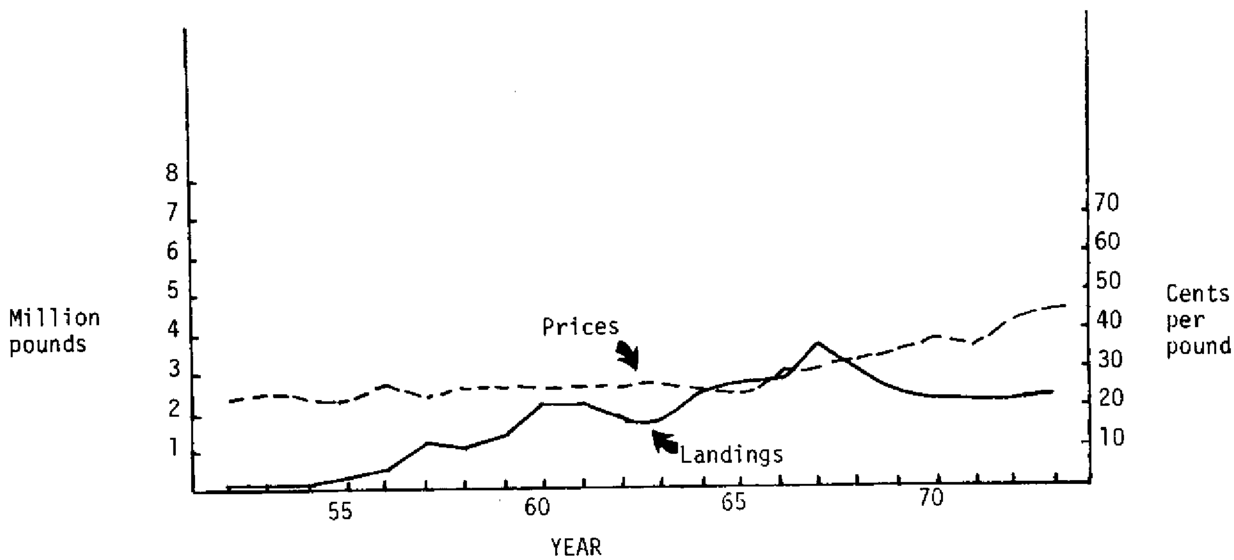

Figure 5 .--Annual red snapper landings and dockside prices in Mississippi, 1952-73.

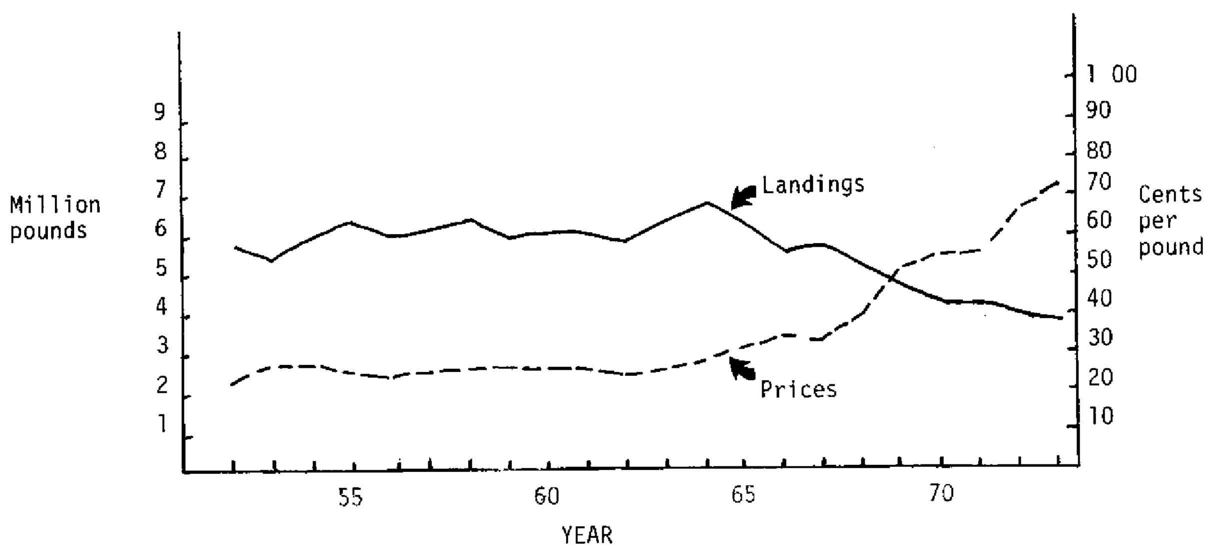

Figure 6 .--Annual red snapper landings and dockside prices in Florida, 1952-73.

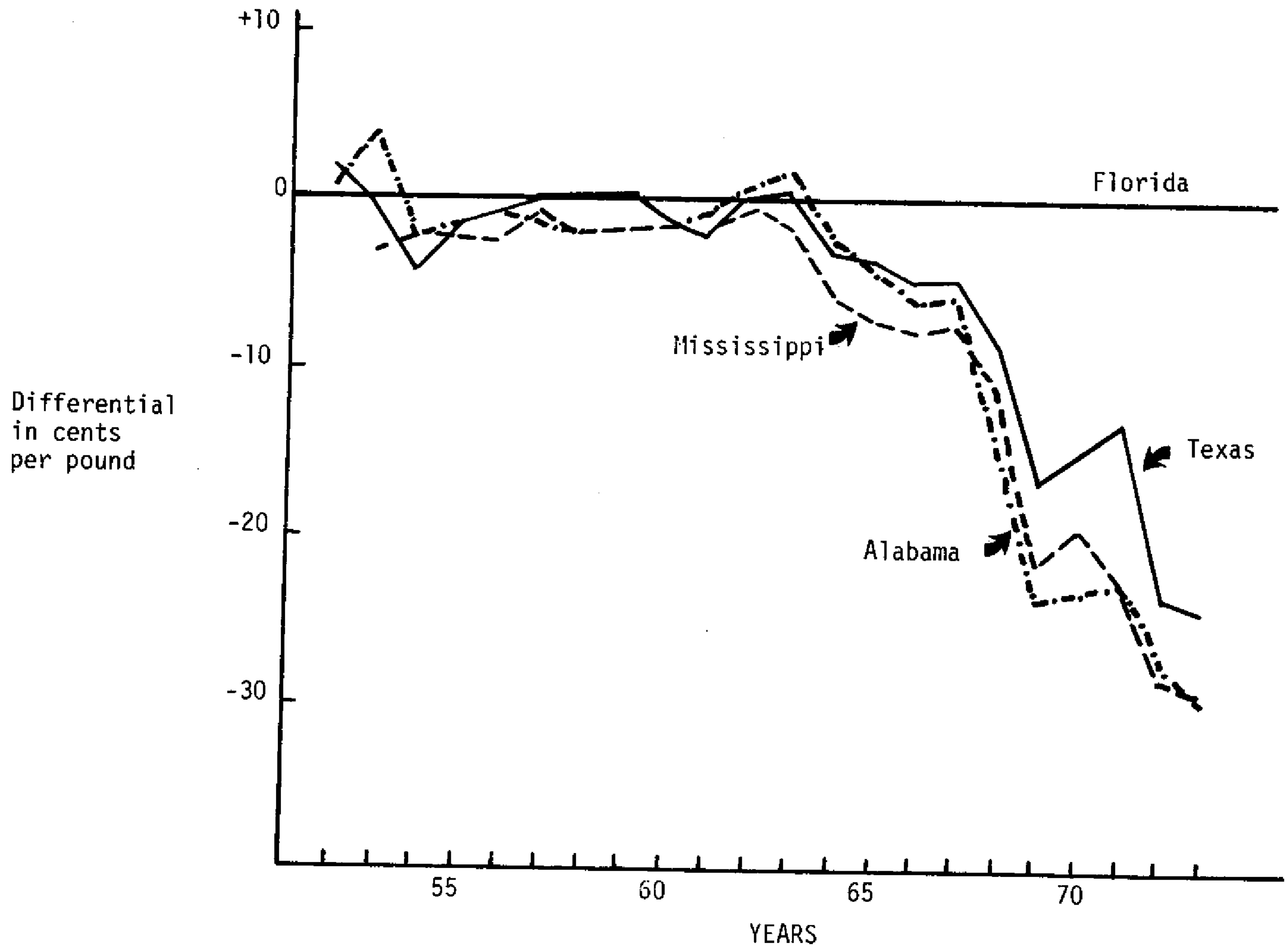

Figure 7.--Texas, Alabama, and Mississippi red snapper dockside prices expressed as differentials from Florida prices, 1952-73.

Annual grouper prices in Florida have also shown large increases in the last few years (Fig. 2). Annual prices averaged about 10¢ to 11¢ per pound during the 1950's, but reached a high of 31¢ per pound in 1973. Grouper prices in other Gulf Coast States are normally much lower than in Florida. Prices reported in 1973 for Texas, Alabama, and Mississippi were 13¢, 17¢, and 18¢ per pound, respectively. In comparison to Florida, landings in these states are relatively small.

The dockside prices actually paid to individual captains or boat owners vary substantially from those reported in annual statistics. During 1973, the reported average price for red snapper landed in Florida, based on landings and value statistics, was 76¢ per pound. Actual prices paid at the dock ranged from about 50¢ to 85¢ per pound. The actual price paid depends on the type of agreement between captains or boat owners and buyers. Buyers or fishhouse owners pay higher prices to independent boats than to company-owned boats. Prices paid to company-owned boats are "accounting" prices, resulting from internal record-keeping procedures. Generally, the price paid the company-owned boat is slightly more than one-half the "common" dockside value, because of the record-keeping procedures and slightly different crew-share arrangements. The independent boat owner must pay all his costs, including insurance, depreciation, and his other fixed costs, from the price received for his catch. However, company-owned boats account for costs differently and can recover their costs from the lower price. The average prices reported measure the weighted average of these two kinds of prices, and the accuracy of the reported price would depend on the particular mix of independent and company-owned boats in each state.

MONTHLY PRICES

Seasonal variations in red snapper landings are apparent from examination of monthly landings data. From January 1968 to July 1974, Florida red snapper landings were lowest during the winter months of December or January in 6 out of 7 years. Maximum landings occurred during the spring and early summer (Fig. 8). This pattern was influenced by weather conditions affecting the offshore fishery. Monthly average prices appear to be affected slightly by monthly landing patterns. In those months with high landings, average prices in the same month and following month normally fell from 1¢ to 6¢ per pound, with most decreases in the 1¢ to 3¢ range. Prices increased when landings decreased. Overall, prices increased over time, while the total amount of red snapper landed decreased (Fig. 8).

Monthly red snapper landings in Mississippi showed fluctuations similar to those in Florida, although definite low points in landings did not consistently appear in December-January. Monthly price variations were similar to those in Florida. Lower monthly landings brought temporary price decreases, but the overall pattern increased over time (Fig. 9).

Florida grouper landings tended to be more seasonal than those of red snapper (Fig. 10). After January 1968, monthly landings were as high as

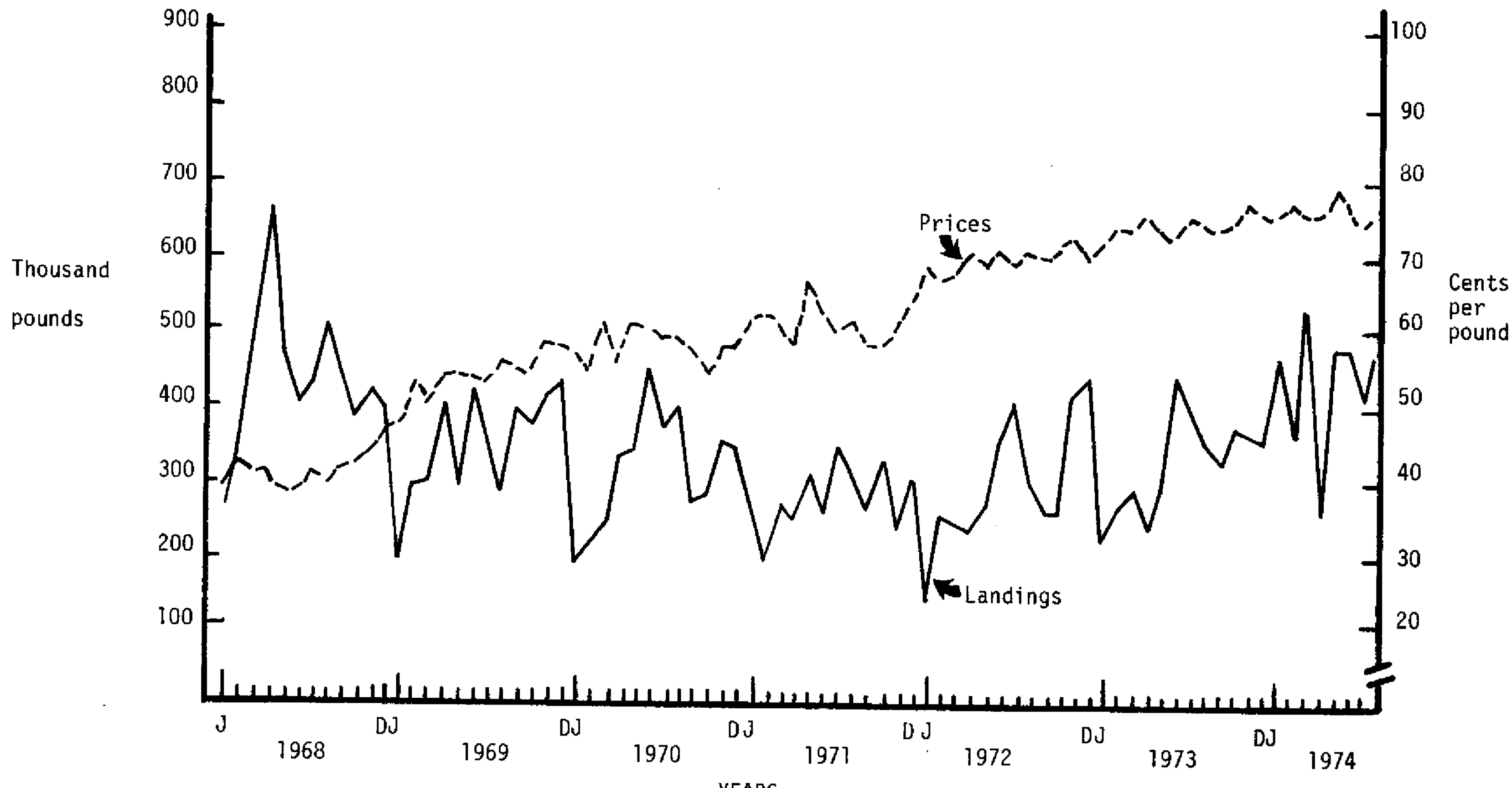

Figure 8.--Monthly red snapper landings and dockside prices in Florida, January 1968 through July 1974.

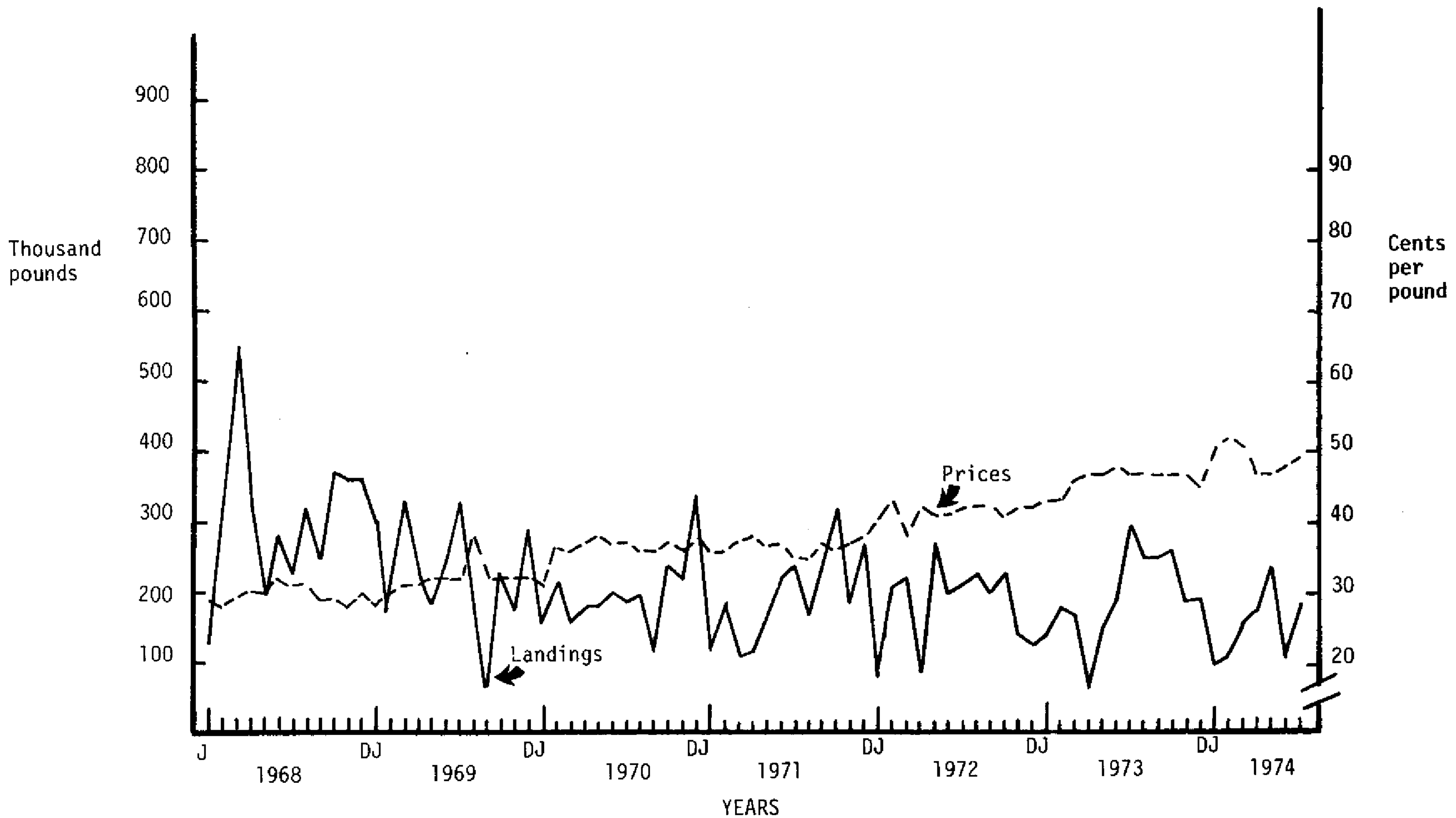

Figure 9.--Monthly red snapper landings and dockside prices in Mississippi, January 1968 through July 1974.

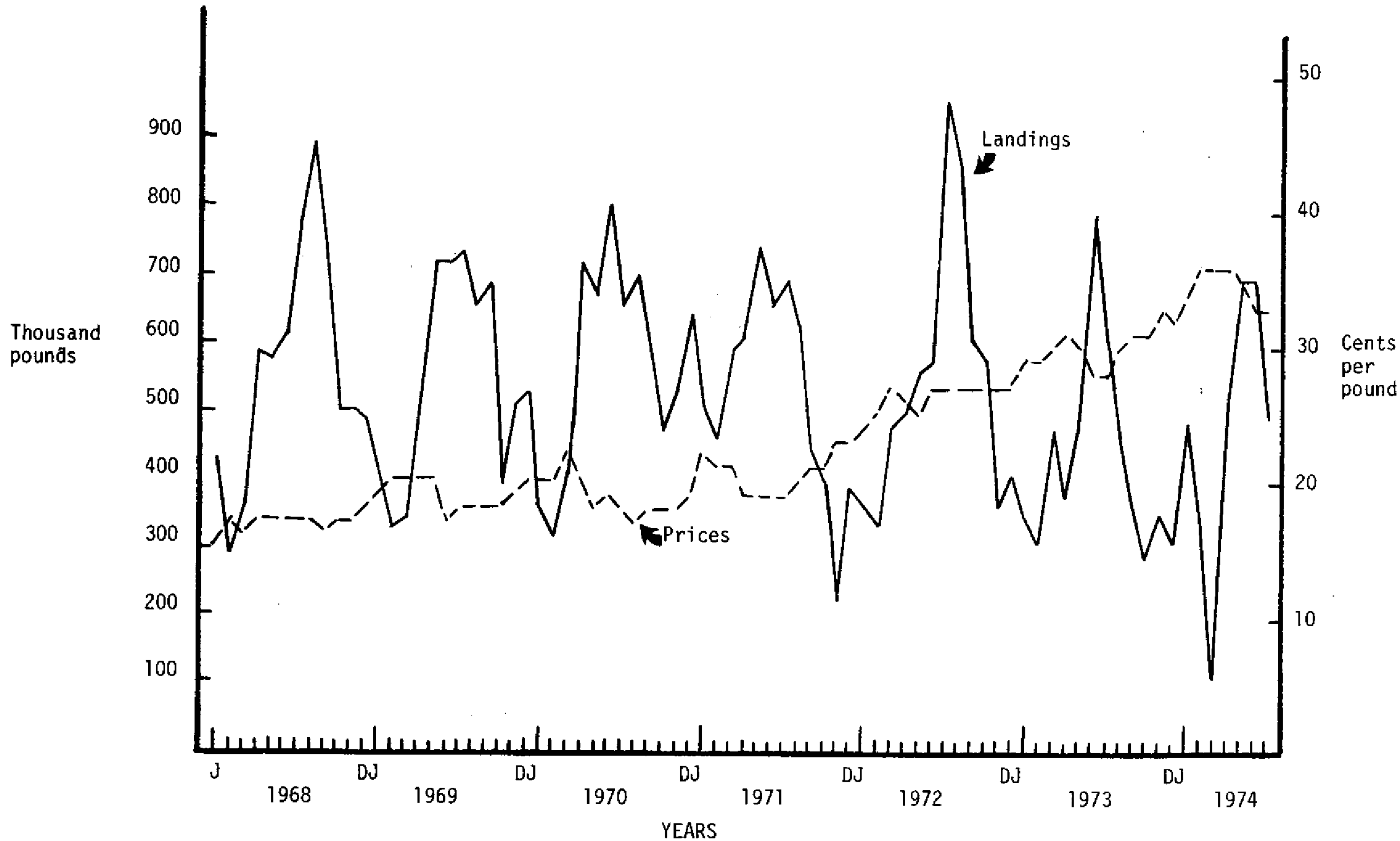

Figure 10.--Monthly grouper landings and dockside prices in Florida, January 1968 through July 1974.

1.2 million pounds (March 1974) and as low as 220,000 pounds (November 1971). As would be expected, low production occurred during the winter and high production occurred during the early summer. Monthly average prices fluctuated with volume landed, but at times remained constant for periods of several months. Temporary price declines, in most cases, were associated with large production increases.

DEMAND ANALYSIS

Food commodity prices are established at the producer level and at the several levels in the marketing system. The prices of red snapper and groupers are affected by their seasonal supply on the market, the supply of other fish and meat that can be consumed, consumer desires and income, and other variables. Price response equations estimated for this paper are concerned with dockside prices.

Waugh and Norton (1969) reported that red snapper prices at the Fulton Fish Market (New York, N.Y.) did not show significant seasonal patterns, which suggests that there were no significant shifts in seasonal demand. Since income was specifically accounted for in the estimated equation and other demand shifters could be assumed constant within the period, any shift in demand would probably have been due to seasonality. Changes in consumer income were important in influencing market prices. The quantity of red snapper offered for sale at the Fulton Market did not significantly affect prices in the New York Market.

Price response equations for red snapper prices in Florida, Texas, Alabama, and Mississippi demonstrate the importance of the Florida industry in influencing annual dockside prices. The quantity of red snapper landed in Florida was statistically significant in influencing Florida prices (Table 1: Equation 1). Total personal income in the United States was used to measure increase in demand, resulting from higher personal income and greater population. The income coefficient was significant. The estimated Florida price equation shows that a 1 million-pound increase in red snapper landings would result in a 5.5¢ decrease in average dockside price paid at Florida ports (Table 1: Equation 1). Similar equations estimated for Texas, Alabama, and Mississippi, however, did not result in significant price-quantity relationships. In addition to the nonsignificance, statistical estimation problems for these three equations also made them unacceptable. Further examination, and the fact that Florida dockside prices are much higher than dockside prices in the other three states, suggest the Florida industry is a price leader for the United States. Since Florida lands a large portion of the total commercial catch, pays a higher price, and is able to influence the total market, the less dominant states in the industry may pay prices based on Florida prices and, in turn, accept the remainder of the total market share.

To test this hypothesis, regressions were estimated relating other state prices to Florida prices. Prices paid in Florida were extremely important in influencing prices in each of the other three states (Table 1: Equations 2, 3, and 4). A 1¢ increase in Florida price resulted in price increases in Texas, Alabama, and Mississippi of 0.54¢, 0.27¢, and 0.36¢, respectively.

Table 1. Price Response Equations for Annual Dockside Red Snapper Prices in Florida, Texas, Alabama, Mississippi, and the United States, 1952-71. 1/

Equation	Region	Dependent Variable 2/	Constant	Independent Variables 3/			R^2	Durbin-Watson Statistic
				Q_t	$P_t^{Fla.}$	I_t		
1	Florida	$P_t^{Fla.}$	0.4549	-0.05546 (4.16)	--	0.00004 (8.20)	0.94	1.27
2	Texas	$P_t^{Tex.}$	0.1024	0.00724 (0.70)	0.54243 (14.44)	--	0.94	1.70
3	Alabama	$P_t^{Ala.}$	0.1605	0.01619 (2.10)	0.27158 (6.97)	--	0.74	1.86
4	Mississippi	$P_t^{Miss.}$	0.1493	0.00076 (0.25)	0.35962 (11.99)	--	0.94	2.04
5	United States	$P_t^{U.S.}$	0.2506	-0.01329 (8.95)	--	0.00004 (26.61)	0.98	1.79

1/ Number of observations is 20 for all equations except Mississippi. There were no reported landings in 1952 in Mississippi. Number shown in parentheses in the t statistic.

2/ Dependent variable is annual dockside price of red snapper in dollars per pound in each region in year t.

3/ Independent variables are:

Q_t = Annual quantity of red snapper landed in each region in year t in millions of pounds.

$P_t^{Fla.}$ = Annual dockside price of red snapper in dollars per pound in Florida in year t.

I_t = U. S. total personal income in billions of dollars in year t.

Landings of red snapper in each of these states were not statistically important in influencing prices in that state. Both total personal income and quantity landed were important in influencing dockside price for the total U. S. industry (Table 1: Equation 5).

Total personal income and quantity landed were both important in determining annual grouper prices (Table 2). A 1 million-pound increase in the quantity of groupers landed in Florida would cause a 1.3¢ decline in dockside prices (Table 2: Equation 1). In the industry as a whole, the same landings increase would cause a 1¢ decrease in U. S. prices (Table 2: Equation 2). As with red snapper, grouper prices appear to be more responsive to grouper landings in Florida than prices in remaining states are responsive to grouper landings in those states.

IMPORTS

The imports of red snapper and groupers are also important in determining price through their effect on the available market supply. Imports of acceptable quality to satisfy domestic consumers will always be important, as long as they can be purchased at a price equal to or less than domestic prices. Existing import data on both snappers and groupers are incomplete and are not useful for econometric analyses. In addition, the numerous product forms that are imported make comparable measurements of the total pounds difficult. Available data on snapper imports are given in Table 3.

Snapper imports are recorded at customs offices as snapper, snapper fillets, red snapper, red snapper fillets, red snapper steaks, throats and flanks, and dressed. Red snapper appear to be the most common form of import, with snapper fillets and red snapper fillets the next most common. For the 21-year period from 1952 to 1972, a total of 11.6 million pounds of imported red snapper were recorded (Table 3). The largest amount in any year was 1.06 million pounds in 1964. Snapper fillet and red snapper fillet imports during the same 21-year period were 2.48 and 2.04 million pounds, respectively. Imports of these three product forms were fairly consistent on an annual basis, except from 1968 until 1972, when no red snapper fillet imports were recorded.

Imports to the Gulf Coast States come through six ports: Port Isabel-Brownsville, Houston, Morgan City, New Orleans, Tampa, and Miami. A large portion of the red snapper and snapper fillets enter at Port Isabel-Brownsville. Annual red snapper imports through Port Isabel-Brownsville were as high as 1.0 million pounds (1964) and as low as 0.16 million pounds (1972). Imports of red snapper through this port are now lower than in previous years, while imports of snapper fillets have become more important. Miami appears to be assuming a leadership role in importing snapper fillets in recent years.

Grouper imports have also been substantial and, similarly to red snapper, are in diverse product forms (Table 4). Import classifications include grouper, grouper fillets, steaks, chunks, chips, throats, fingers, heads, and breasts. For the 21 years from 1952 to 1972, imports of grouper fillets totaled 13.1 million pounds; steaks, 0.92 million pounds; and grouper, 0.48 million pounds. Annual imports of grouper fillets have ranged as high as 3.0 million pounds (1972) and have been the most consistent product imported.

Table 2. Price Response Equations for Annual Dockside Grouper Prices in Florida and the United States, 1952-71.1/

Equation	Region	Dependent Variable2/	Constant	Independent Variables3/ Q_t	Independent Variables3/ I_t	R^2	Durbin-Watson Statistic
1	Florida	$P_t^{Fla.}$	0.1032	-0.01276 (3.72)	0.00002 (10.54)	0.88	1.52
2	United States	$P_t^{U.S}$	0.1035	-0.01012 (4.10)	0.00002 (11.32)	0.90	1.78

1/ Number of observations is 20. Number shown in parentheses is the t statistic.

2/ Dependent variable is annual dockside grouper price in dollars per pound in each region in year t.

3/ Independent variables are:

Q_t = Annual quantity of grouper landed in each region in year t in millions of pounds.

I_t = U.S. total personal income in billions of dollars in year t.

Table 3. Recorded Imports of Snapper into Gulf Coast States, 1952-72.1/

Year	Snapper	Snapper Fillets	Red Snapper	Red Snapper Fillets	Other2/
	Thousand Pounds				
1952	--	--	713.6	--	--
1953	--	--	759.5	--	--
1954	--	--	768.8	--	--
1955	--	--	724.7	--	--
1956	--	--	730.9	0.6	--
1957	--	--	589.6	24.4	--
1958	--	--	587.6	12.8	--
1959	--	202.0	314.9	12.9	--
1960	--	--	243.8	230.7	--
1961	--	376.4	513.4	--	--
1962	--	60.4	563.8	80.5	--
1963	--	25.9	576.1	168.5	25.2
1964	--	73.8	1,063.7	93.7	3.6
1965	--	142.5	896.8	360.8	9.9
1966	--	163.1	719.7	484.0	25.2
1967	--	94.0	566.2	272.2	19.3
1968	--	435.1	185.7	--	--
1969	2.0	392.4	339.1	--	0.7
1970	20.6	358.4	363.9	--	--
1971	5.3	142.0	183.4	--	1.2
1972	141.1	12.2	208.7	299.3	71.0
Total	169.0	2,478.2	11,613.9	2,040.4	156.1

Source: Market News Annual Summary: Gulf Fisheries. Annual Issues, 1952-72.

1/ Ports included and recording imports were: Port Isabel-Brownsville, Houston (started collecting data in 1963), Morgan City, New Orleans, Tampa (started collecting data in 1967), and Miami. Ports included but recording no imports were: Freeport, Port Arthur-Orange, and Mobile.

2/ Includes red snapper steaks, throats and flanks, and dressed.

Table 4. Recorded Imports of Grouper into Gulf Coast States, 1952-72.1/ 2/

Year	Grouper	Grouper Fillets	Steaks	Other 3/
	Product Form			
	------------Thousand Pounds------------			
1953	--	4.0	--	--
1955	--	1.7	--	--
1959	--	237.0	--	--
1960	--	62.3	--	--
1961	--	173.9	--	--
1962	33.9	644.0	32.2	0.1
1963	24.0	1,082.9	199.0	--
1964	70.6	1.812.1	292.7	--
1965	143.8	1,989.7	182.9	0.5
1966	54.8	2,535.0	207.3	1.5
1967	60.4	264.0	7.1	--
1968	--	302.9	--	27.8
1969	20.6	453.3	--	17.6
1970	54.1	305.9	--	--
1971	--	230.9	--	106.7
1972	17.7	3,026.3	--	97.2
Total	479.9	13,125.9	921.2	251.4

Source: Market News Annual Summary: Gulf Fisheries. Annual Issues, 1952-72.

1/ Ports included and recording imports were: Port Isabel-Brownsville, Morgan City, New Orleans, Tampa (started collecting data in 1967), and Miami. Ports included but recording no imports were: Houston, Freeport, Port Arthur-Orange, and Mobile.

2/ No imports recorded for 1952, 1954, 1956-58.

3/ Includes grouper chunks, chips, throats, fingers, heads, and breasts.

Since 1968, steaks have not been recorded, the amount of grouper has decreased, and the amount of fillets has remained substantial. Miami is the leading port for importing grouper; Port Isabel-Brownsville is second.

MARKETING MARGINS

Marketing margins represent the spread between the price the producer receives and the price received at the wholesale (producer-wholesale margin) or retail market level (producer-retail margin). To determine gross margins (those including both cost and profits), knowledge of prices paid at each of the two market levels is necessary. Fishery statistics are relatively complete at the fisherman level (dockside), but considerably more scarce at the wholesale level, and virtually non-existent at the retail level.

Wholesale prices paid at the Fulton Market for red snapper were used to estimate the gross margin between the prices received by Florida fishermen and the wholesale price level. Using Fulton Market prices is partially justified, considering that a large part of Florida's east coast landings are shipped to that market and about 30% of Florida's west coast catch is shipped to northern markets. The main difference between other wholesale prices and the Fulton Market price, if any, should primarily reflect the difference in transportation costs between the alternative wholesale markets. If price differences exist but are constant for periods of time, the absolute level of the margins will differ slightly, but the magnitude and direction of changes will be the same.

Monthly Florida dockside prices, Fulton Market wholesale prices, and computed gross margins are presented in Table 5 and Figure 11. Florida dockside prices increased approximately 25% between the first quarter of 1971 and the last quarter of 1973. The increase was stable with dockside prices varying normally only 2¢ to 3¢ per month. Fulton Market wholesale price, the price Florida fish dealers received at New York for the snapper bought from Florida fishermen, varied substantially from month to month. This variation was reflected directly in the gross margin received by the fish dealers. Dealers and wholesalers have borne all of the price variation and associated risks and costs of unstable prices.

During the 3-year period from 1971 to 1973, marketing margins varied from a low of 29¢ in August 1971 to a high of 79¢ in April 1973. The average margin for the period was approximately 47¢ per pound. This imputed margin between the two published prices does not represent the "true" margin. Prices received by company boats for their catch is a "company price," which is less than the price paid to independent boats (because of cost differences incurred by the management of company boats). These company prices are averaged with the prices paid independent owners in the recorded statistics. This makes the "true" price at dockside higher than the recorded prices in landing statistics. The average dockside price paid to independent fishermen was approximately 10¢ per pound higher than the published statistics, which are a weighted average of company-boat prices and independent-boat prices. This 10¢ price difference made the average gross margin approximately 37¢ per pound. The conclusion that local fish dealers absorb the monthy price variations still stands, assuming the 10¢ per pound discrepancy was consistent for the 3-year period under study.

Table 5. Monthly Florida Red Snapper Prices, Fulton Fish Market Prices, and Gross Marketing Margins.

Year	Month	Mean Fulton Market Price 1/	Florida Dockside Price 2/	Gross Margin
		----------------Cents per Pound	------------------------	----------------
1971	1	101.2	60.9	40.3
	2	100.9	62.6	38.3
	3	108.1	60.0	48.1
	4	118.1	68.5	59.6
	5	97.8	67.2	30.6
	6	98.0	63.7	34.3
	7	98.6	60.3	38.3
	8	90.4	61.6	28.8
	9	98.2	58.5	39.7
	10	101.6	58.0	43.6
	11	95.6	60.7	34.9
	12	107.1	64.3	42.8
1972	1	120.6	69.0	51.6
	2	120.2	67.6	52.6
	3	117.4	68.8	48.6
	4	133.0	71.7	61.3
	5	111.9	69.1	42.8
	6	115.8	69.7	46.1
	7	118.0	69.2	48.8
	8	111.2	71.6	39.6
	9	112.3	70.4	41.9
	10	115.8	71.8	44.0
	11	115.6	72.2	43.4
	12	117.4	70.6	46.8
1973	1	132.4	72.7	59.3
	2	123.2	74.2	49.0
	3	148.6	74.7	73.9
	4	155.2	76.0	79.2
	5	128.8	74.7	54.1
	6	114.7	76.0	38.7
	7	124.2	74.7	49.5
	8	128.8	73.2	55.6
	9	124.3	76.3	48.0
	10	119.2	75.0	44.2
	11	128.2	74.7	53.5
	12	118.8	75.4	43.4

1/ Average monthly prices paid at the Fulton Fish Market, as determined from National Marine Fisheries Service Market News Reports (green sheet) by the Statistics and Market News Division, Northeast Region, NMFS, Gloucester, Mass.
2/Average monthly prices determined from Florida Landings (Current Fisheries Statistics, U.S. Department of Commerce, NOAA, NMFS, Washington, D. C.).

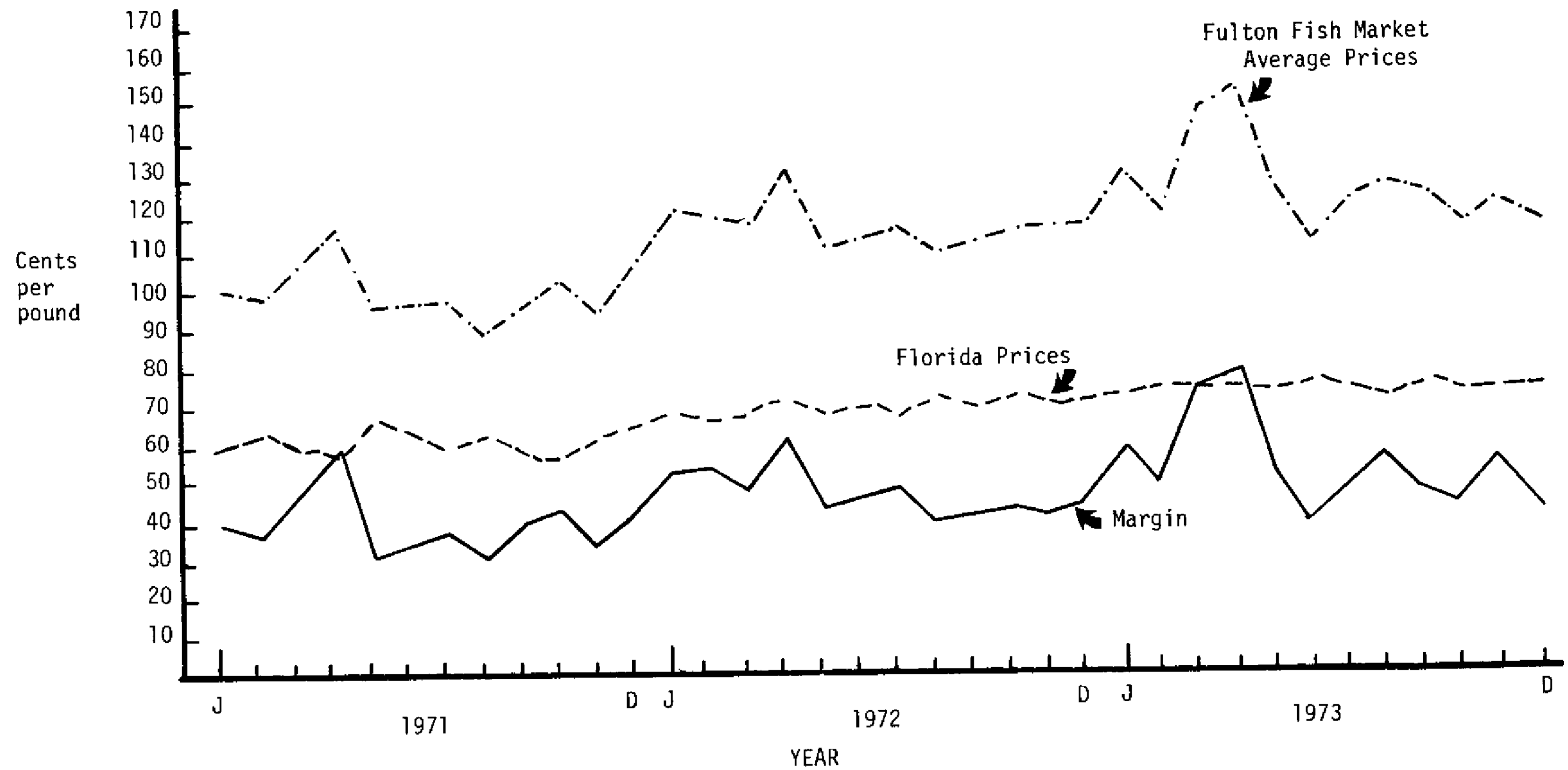

Figure 11.--Monthly Florida red snapper prices, Fulton Fish Market prices, and gross marketing margin, 1971-73.

A generalized least squares regression model was estimated to determine the relationship between the marketing margin and the Fulton Market wholesale price. The estimated linear equation is:

$$M = -74.16 + 1.01\ P_{NY}\text{, where}$$

$$M = \text{calculated margin, and}$$

$$P_{NY} = \text{New York Fulton Market price.}$$

The price coefficient of 1.01 is highly significant statistically and indicates a one-to-one relationship between the marketing margin and the Fulton Market prices. The margin varies directly (both up and down) with the price fish dealers receive for the fish they market. Alternatively, the margin relationship expressed in double log form is:

$$M = -7.99 + 2.48\ P_{NY}\text{,}$$

which indicates the margin-Fulton Market price elasticity to be 2.48; for each 1% change in Fulton Market prices, the margin moves in the same direction by 2.48%.

A survey of fish dealers acting as intermediaries between fishermen and secondary wholesalers (those buying at the Fulton Market) confirmed this margin analysis. The simple average of the total gross margin indicated in the survey was 43¢ per pound, which is between the two estimates reported above: 37¢ and 47¢ per pound. This gross margin was broken into variable and fixed costs. Variable costs for handling the product averaged 18¢ per pound, with individual estimates ranging from 15¢ to 25¢ per pound. Of this amount, transportation accounted for 7¢ per pound, with the remainder used for shipping containers, labor for loading, packing, grading and icing, ice and water, and electricity. The remaining 25¢ per pound was allocated to overhead, marketing, transaction costs, office staff, taxes, miscellaneous expenses, and a return to investment capital and management.

COSTS AND RETURNS

Costs and returns reflect several important characteristics of the industry. Costs reflect the resources employed to provide fishery products and the prices charged for the resources. Returns reflect catch rates and the prices consumers are willing to pay for the product. Together, costs and returns determine the profit levels for management, labor, and capital investments.

Fishermen or fishing firms incurring these costs and earning these returns may be divided into several categories. First, the individual sport fisherman utilizing his own resources (gear, boat, etc.) for sport fishing incurs substantial costs, and his returns are usually measured by physical consumption of the catch and satisfaction derived from the fishing experience. Second, the sport fisherman fishing from a boat or vessel on a fee basis incurs the cost of a ticket. The ticket constitutes returns to the boat or vessel owner, who incurs the cost of providing the service. Third, commercial snapper-grouper fishermen incur substantial expenses, which must be balanced against sales proceeds from their catch to provide their livelihood. This section is concerned with costs and earnings by commercial fishing and by one type of sport fishing -- party boat fishing.

COMMERCIAL FISHING

Estimated costs and returns were based on a survey of personal interviews with boat owners and captains, representing 10 commercial vessels.4/ The firms' home ports are in an area from Mexico Beach to Pensacola, Fla., although their fishing operations range as far west as Texas and the Gulf of Campeche. The budget analysis reported is the average for vessels of two length-groups: 42-47 feet (small) and 57-69 feet (large).

Red snapper was the predominant and most valuable species landed by the snapper-grouper vessels (Table 6). While grouper production nearly equaled red snapper production by the smaller vessels, groupers made up an insignificant part of production by the larger vessels.

A comparison of revenues shows the significance of red snapper in the total value of landings for both small and large vessels (Table 6). The $26,647 red snapper value represents 64% of the $41,357 total gross value of the landings for the small vessels. On the larger vessels red snapper accounted for 86% of the total value of landings.

In this report all species were valued at their "common" dockside value. This procedure differs from the record-keeping systems maintained by owners of "company boats." Generally, these firms value their catch at slightly more than one-half of the common dockside value, due to internal record-keeping procedures and slightly different crew-share arrangements. Dockside prices chosen for this study were consistent with those received by the independent vessels interviewed. Dockside value represents the value of the catch or the gross returns from the fishing effort. Dockside value is also the value for which the company could sell their catch to other fishhouses at the same market level in the marketing system.

Variable costs -- those which vary with the level of production -- made up the majority of the total cost of producing red snapper and groupers. Crew wages or shares accounted for over 40% of the variable costs (Table 6). Crewmen are generally paid on a share basis, and the crew shares reported in Table 6 reflect the net share to all crewmen on each vessel after crewmen's expenses were deducted. The small vessels averaged about 2.3 crewmen per trip, while larger vessels employed an average of 4.7 crewmen. A crewman earned an average of $4,105 per year on the small vessels and $4,439 on the large vessels. Repairs were the second largest expenditure and include hull, engine, tackle, and equipment maintenance. Fuel, oil, groceries, and bait were about equal in cost.

4/ A detailed report entitled "Costs and returns for Gulf of Mexico commercial red snapper-grouper vessels by vessel size, 1974" by Fred J. Prochaska and James C. Cato was published in 1975 as an eight-page Florida Sea Grant and Florida Cooperative Extension Service Marine Advisory Bulletin (SUSF-SG-75-006).

Table 6. Average Costs and Returns for Gulf of Mexico Commercial Red Snapper-Grouper Vessels by Length Class, 1974.

Item	Vessel Size: Small[1/] (42-47 feet) Pounds	Dollars	Percent	Large[2/] (57-69 feet) Pounds	Dollars	Percent
Returns:						
Red snapper	32,654	26,647	64.4	92,995	83,696	86.3
Groupers	28,325	12,899	31.2	4,409	1,985	2.0
Others	3,991	1,811	4.4	32,424	11,349	11.7
Total	64,970	41,357	100.00	129,828	97,030	100.0
Variable costs:						
Fuel and oil		2,207	8.5		4,053	7.7
Groceries		2,721	10.5		5,211	9.9
Bait		1,978	7.6		5,955	11.3
Ice		1,171	4.5		2,317	4.4
Repairs and maintenance		4,084	15.7		8,762	16.7
Crew shares[3/]		9,443	36.3		20,865	39.7
Other		481	1.8		1,516	2.9
Total		22,085	84.9		48,679	92.6
Fixed costs:						
Depreciation		2,770	10.6		3,842	7.3
License		52	0.0		55	0.1
Interest		793	3.0		0	0.0
Insurance		326	1.3		0	0.0
Total		3,941	15.1		3,897	7.4
Total Costs		26,026	100.0		52,576	100.0
Total net returns to captains and owners[4/]		15,331			44,454	

1/ Costs and returns represent an average of four vessels.

2/ Costs and returns represent an average of six vessels.

3/ On the small vessels, the average crew size was 2.3 men, and on the large vessels,the average was 4.7 men. Crew shares are net share, after deduction of crew expenses.

4/ Total net returns to captain and owner represent captains' salaries, return on investiments, and owners' labor and management.

Total fixed costs were similar between the two size classes of vessels. Depreciation (hull, engine, and equipment) was greater for the larger vessels, as would be expected (Table 6). The smaller depreciation for the small vessels was offset by higher costs of insurance and interest, since owners of larger vessels carried their own risk and provided their own financing.

Total costs per vessel were $26,026 for the small vessels, compared to $52,576 for the large vessels. The higher costs for larger vessels, however, were more than offset by the higher value of the catch.

Total net returns per year to captains and boat owners was $44,454 for large vessels and $15,331 for small vessels (Table 7). Seven of the 10 commercial vessels included in this analysis were owned by individuals other than the captain. The captain's net return (return after deduction of captain's share of expenses) averaged $18,226 on large vessels and $6,286 on small vessels (Table 7). However, for three of the four small vessels, the captain and the owner were the same person. Thus, the total net return, before taxes, for these owner-operators was $15,331, which is still less than the $18,226 income of captains on the six company boats.

The net return to investment reflects the amount the owners could earn on the capital they have invested in the firm by investing in other activities, such as the financial market. Capital investments for the larger vessels averaged $67,267, over 2.5 times the average investment ($25,526) for the smaller vessels. The residual, after net returns on investment are determined, is the return to labor and management. Specific activities include boat maintenance, marketing, personnel and business management, etc. Owners of larger vessels usually are multi-vessel firms which require an office staff. Salaries for the staff are paid from the net returns to the owner. The relatively large net return to ownership of the large vessels also reflects the fact that owners of these vessels carried their own insurance and provided all required capital.

PARTY BOAT FISHING

The analysis of party boat operations was based on data collected through personal interviews with the owners of seven boats.5/ Boats included in the survey range in length from 65 to 85 feet and the largest have a carrying capacity of more than 50 fishermen. The boats are based along the north Florida Gulf coast.

During 1974, an average of 6,714 sport fishermen paid to fish on each boat (Table 8). The length of trip varied from one-half day to 2 days. The charges for these trips ranged from $8.50 for a half-day trip to $45 for a 2-day trip. The majority of the trips are 1-day trips, which begin between 2 a.m. and 7 a.m., depending on distance to fishing grounds, and usually end about 5 p.m.

5/ A detailed report entitled "Northwest Florida Gulf coast red snapper-grouper party boat operations: an economic analysis, 1974" by Fred J. Prochaska and James C. Cato was published in 1975 as a nine-page Florida Sea Grant and Florida Cooperative Extension Service Marine Advisory Bulletin (SUSF-SG-75-007).

Table 7. Net Returns to Captains and Boat Owners for Gulf of Mexico Commercial Red Snapper-Grouper Vessels by Length Class, 1974[1/].

Item	Vessel Size: Small (42-47 feet)	Vessel Size: Large (57-69 feet)
	Dollars	
Total revenue	41,357	97,030
Total cost	26,026	52,576
Total net returns to captain and owner	15,331	44,454
Net to captain[2/]	6,286	18,226
Net to investment[3/]	2,122	5,381
Net to owner's labor and management [4/]	6,923	20,847

1/ Based on Table 6.

2/ The captain's share is estimated at 41% of the total net return. This rate is based on an average of seven vessels where the captain and the owner were not the same person.

3/ Net to investment is an imputed return to capital investment at an assumed interest rate of 8%.

4/ Net to owner's labor and management reflects payment for the owner's labor and management. Specific functions include rigging and supervising the maintenance of vessels, procurement of labor and supplies, and marketing and office duties, such as accounting and personnel management.

Table 8. Number of Fishermen and Catch for Northwest Florida Party Boats, 1974.

Item	Average Per Boat	Catch Per Fisherman 1/	Catch Composition (%)
Number of fishermen	6,714		
Pounds of catch:			
Red snapper	50,286	7.5	37
Groupers	49,143	7.3	37
Others	34,857	5.2	26
Total	134,286	20.1	100

1/ Totals may not add due to rounding.

The average annual catch per boat in 1974 was 134,286 pounds, which consisted of approximately 37% red snapper, 37% groupers, and 26% other species. Average total catch per fisherman was 7.5 pounds of red snapper, 7.3 pounds of groupers, and 5.2 pounds of other fishes such as croaker and sea bass. At 1974 commercial prices in Florida, the average daily catch per fisherman was worth approximately $12.6/ Retail value of the average catch would be two to three times this amount.

Ticket sales averaged $141,200 per boat in 1974 (Table 9). These accounted for 99% of the gross revenue collected by boat owners for their party boat operations.7/ Concession returns to boat owners included in the sample averaged $1,329 per boat.

Variable costs (costs directly dependent on actual fishing effort) of party boat operations represented 61% of total costs. Tackle (including hooks, lines, and sinkers, but excluding rods and reels) was the largest single component of variable cost of $16,243 annually (Table 9). Tackle and bait accounted for approximately 23% of total cost and for over one-third of variable cost. Each fisherman cost the boat owner an average of $2.42 for lost tackle. Bait used per fisherman averaged 7.6 pounds, which cost an average of $1.37 per person.

6/ Red snapper were valued at 90¢ per pound, groupers at 45¢ per pound, and other fishes at 35¢ per pound.

7/ Some party boats are used for commercial fishing during the slack sport-fishing season. Costs and returns associated with this activity were not included in this analysis.

Table 9. Costs and Returns for Northwest Florida Party Boats, 1974.

Item	Average Per Boat	Average Per Fisherman[1]	Percent
	------------------Dollars------------------		
Returns:			
Ticket sales	141,200	21.03	99
Concession	1,329	0.20	1
Total	142,529	21.23	100
Variable Costs:			
Fuel and oil	15,786	2.35	14
Bait	9,200	1.37	8
Ice	993	0.15	1
Crew	13,968	2.08	12
Tackle	16,243	2.42	15
Repairs	12,143	1.81	11
Total	68,333	10.18	61
Fixed Costs:			
Depreciation	9,929	1.48	9
Captain's salary	15,893	2.37	13
Office and dock expenses	9,559	1.42	9
Advertising	1,829	0.27	2
Insurance	3,286	0.49	3
Interest	3,143	0.47	3
Total	43,639	6.50	39
Total Costs	111,972	16.68	100
Total Net returns:	30,557	4.55	100
Opportunity cost of investment[2]	12,451	1.85	41
Net returns to management[3]	18,106	2.70	59

1/ Totals may not add due to rounding.

2/ Opportunity cost of investment represents that return the boat owner could receive, if funds were invested at 8% interest.

3/ Net returns to management represents the income received for labor and management functions by the owners.

Fuel and oil were the second largest expenditure. Fuel consumption averaged 47,000 gallons per year. Fuel and oil cost $15,786 annually per boat, or 14% of total cost and 23% of variable cost. Crew wages, excluding captains' salaries, were responsible for 12% of total party boat costs. In addition to the captain, a first mate and from one to two deck hands provide the necessary labor. The time these crewmen work depends on the amount of fishing activity; and they are paid on an hourly basis. Hull, engine, and gear repairs averaged $12,143 per boat.

Captains are usually paid a fixed salary instead of the hourly wage rate paid crew members. Captains' salaries accounted for approximately 13% of total costs and were the largest component of fixed costs (Table 9). Depreciation on hull, engine, gear and tackle, and office and administrative costs each accounted for 9% of total costs. Office and administrative costs included sales clerks' salaries, telephone, electricity, docking fees, accounting fees, and other miscellaneous costs.

Total costs of operating a party boat in 1974 averaged $111,972 (Table 9). Net returns per boat, before all taxes, averaged $30,557. These represent the owner's share for his management, risk taking, and return on investment. Average investment per boat in this study was $155,643. Assuming an 8% interest on investments, the opportunity cost of capital (or return to investment) was $12,451 per boat per year (Table 9). This left the owner a net return of $18,106 before taxes for his labor and management.

ECONOMIC IMPACT

Costs incurred by commercial vessel fishermen or party boat owners represent sales made by other (support) industries which provide economic services and goods to the fishing industry. These sales represent employment and income to members of the support industries. Estimates in this paper of the importance of red snapper fishing to the Florida economy are considered to be conservative. For this analysis, only items which are known to be available locally were considered. Some expenditures are made to out-of-state businesses and are not measured as a direct source of income or employment for the local economy.

In addition, the impact estimates are conservative because they did not consider the indirect contribution made by the snapper industry (i.e., sales and expenditures between the support industry and secondary support industries). The contribution to the economy also did not include that of the private sport fishermen or of sport fishermen using charter boats.

IMPORTANCE OF THE COMMERCIAL INDUSTRY

The cost and expenditure estimates developed previously for the red snapper-grouper fishery represent the segment of the industry from which the majority of Florida red snapper landings come. Average costs per pound of fish landed are presented for major items purchased from the local economy (Table 10). Assuming the cost-per-pound estimates were representative of the total industry, total expenditures in the state economy were estimated by multiplying the per-pound cost times the number of pounds landed in Florida (Table 10). Preliminary data indicated Florida landings in 1974 were 5,168,918 pounds

Table 10. Itemized Costs per Pound of Fish Landed and Estimated Total Expenditures for Selected Cost Items in the Florida Commercial Red Snapper-Grouper Industry, 1974.

Item	Costs per Pound 1/	Total Industry Expenditures 2/
	------------------Dollars	----------------------
Fuel and oil	0.032	379,812
Groceries	0.041	486,634
Bait	0.041	486,634
Ice	0.018	213,644
Repair and maintenance	0.066	783,363
Salaries and wages	0.286	3,394,575
Marketing charges 3/	0.150	1,780,372

1/ Costs per pound are based on Table 6.

2/ Estimated by multiplying the cost per pound by the 1974 Florida total landings of red snapper and groupers. The assumptions are that (1) costs per pound in the snapper-grouper budgets are the same for either snappers or groupers individually, and, thus, costs per pound are the costs of catching either a snapper or a grouper. To determine total industry expenditures, it was assumed that the average budget estimates represent the average for all red snapper-grouper boats in Florida. Expenditures are only for the items believed to be spent in the state.

3/ Represents only local fishhouse charges for variable inputs, such as ice, labor, etc.

of red snapper and 6,700,227 pounds of groupers, for a total of 11,869,145 pounds.

Salaries and wages were the most significant contribution at $3.4 million. These items represent income to individuals in the red snapper-grouper industry. This income is spent locally through traditional consumer-household spending patterns. Repair and maintenance expenditures were $783,363. Other expenditures, in order of importance, were: bait, $486,634; groceries, $486,634; fuel and oil, $379,812; and ice, $213,644.

In addition to the contributions by the fishing firms, fish dealers generate revenue from handling and marketing the catch. Interviews with fish dealers handling snappers and groupers resulted in an estimate of 15¢ per pound marketing cost for boxes, ice, etc. This cost represents payments to the fish dealer for his services. The dealer in turn purchases supplies and services from the local economy. If all fish dealers charged 15¢ per pound, the total local marketing bill could be estimated at $1,780,372 for handling Florida's red snapper and grouper catch. This does not include the part of the marketing costs that go to the dealer for his management functions.

IMPORTANCE OF THE PARTY BOAT INDUSTRY

Operating procedures of party boats vary from region to region, depending on the kinds of fish available, distance to fishing grounds, weather, number of paying customers, etc. Therefore, the economic importance of the party boat industry refers to only the northwest Florida Gulf coast, since budget estimates were based on that region. The Florida Department of Natural Resources (no date) estimated that there were 48 party boats operating in the eight counties on Florida's northwest Gulf coast. Using data for the average party boat presented in Table 9, estimates of the economic impact, resulting from party boat operations in Florida's eight most western counties, were developed (Table 11).

A total of 322,272 fishermen trips were made in 1974. This estimate is slightly larger than the number of fishermen, since a few fishermen made more than one trip in 1974. Approximately 6.5 million pounds were landed by these fishermen. To land this catch, fishermen spent over $6.7 million for tickets to fish on party boats.

Party boat owners, in turn, spend substantial amounts in the region for fuel, oil, salaries and wages, bait, tackle, and repairs. Salaries and wages earned by captains, crewmen, and office personnel were estimated at approximately $1.7 million annually. Approximately $760,000 was spent annually with the petroleum industry. Tackle shops made sales of $779,664 annually to party boat owners. Bait sales to the industry amounted to $441,600 each year. These figures suggest the party boat industry provides a substantial contribution to the total economy of the northwest Florida Gulf coast.

Table 11. Estimated Economic Impact of Party Boats on the Northwest Florida Gulf Coast, 1974.

Item	Regional Total[1/]
Number of fishermen trips	322,272
Catch:	-----Pounds-----
Red snapper	2,413,728
Groupers	2,358,864
Others	1,673,136
Total	6,445,728
Expenditures:	-----Dollars-----
Fishermen's tickets	6,777,600
Fuel and oil purchases	757,728
Salaries and wages	1,675,248
Bait	441,600
Tackle	779,664
Repairs	582,864

1/ Totals are based on averages developed in this paper multiplied by 48, the estimated number of party boats in the eight coastal counties from Escambia to Wakulla.

FISHERIES MANAGEMENT

Theoretical models of fishery population dynamics, in association with theoretical catch rates at various levels of fishing effort, provide a means by which conclusions can be made about the maximum sustained yield of a given fish population. These conclusions, however, are not sufficient for optimum management of fisheries for several reasons. Neither the exact number of recruits nor the size of the parent population is known, nor is the relationship between current and future fish populations known. Furthermore, the actions of an individual fisherman may not noticeably affect the dynamics of fishery populations. This fact often leads to the opinion by individual fishermen that management programs or independent management efforts are unnecessary. More importantly, fishermen consider their individual costs and returns in determining fishing effort before they consider the biological effects, which they, acting alone, cannot influence.

Biological factors and fishermen's costs are reflected in industry supply functions. These supply functions, together with consumer demand, determine the market prices and the quantities ultimately landed. However, the quantities landed do not necessarily correspond to those suggested by the biological models as optimum in any one year. To provide effective tools for fishery management, bioeconomic models need to be empirically estimated. A biological or economic model alone is not sufficient to analyze accurately the consequences of alternative management programs. Prochaska and Baarda (1975) discussed a bioeconomic model.

It is hoped that one of the outcomes of this colloquium, where biologists, economists, policy makers, and industry members have interacted, is the encouragement of model estimation. Both biological and economic variables should be considered in these models from which management alternatives can be analyzed. The remainder of this paper is devoted to reporting comments made by industry members with respect to management needs.

Fishermen on relatively small boats, who fish from 50 to 100 miles offshore, noted a decline in the average size of fish from approximately 3 pounds 5 years ago to less than 3 pounds currently. Fishermen operating in more distant waters observed that the average fish size has declined from approximately 5 pounds to about 2 or 3 pounds currently. Party boat owners observed the same trend and believe that the dockside value of the customer's average catch no longer equals the cost of the ticket. In addition to noting the smaller size of the fish, boat captains state that longer fishing days and trips are necessary to catch the same poundage.

Some of the reasons, expressed as a cause of these problems, are: (1) repeated trips to the same grounds by party, charter, and private sport boats, until the local fish population is depleted; (2) destruction of immature fish caught in the nets of shrimp trawlers; and (3) an increase in the past two decades in the number of commercial boats equipped with better navigational equipment, as well as the increase in the fishing pressure in general. Some fishermen believe that a closed season in certain months is necessary to protect spawning fish. The involvement of sport fishermen, together with commercial fishermen, will add a new challenge to fisheries management.

LITERATURE CITED

Camber, C. I.
1955. A survey of the red snapper fishery of the Gulf of Mexico, with special reference to the Campeche Banks. Fla. Board Conserv., Tech. Ser. No. 12, 64 p.

Deuel, D. G.
1973. 1970 salt-water angling survey. U. S. Dep. Commer., NOAA, NMFS, Curr. Fish. Stat. No. 6200, 54 p.

Florida Department of Natural Resources.
No date. Your Florida head and party boats, charter boats, piers. Fla. Dep. Nat. Resour., Educ. Ser. No. 15, 18 p.

Prochaska, F. J. and J. R. Baarda.
1975. Florida's fisheries management programs: their development, administration, and current status. Univ. Fla. Agric. Exp. Stn. Bull. 768.

Waugh, F., Jr. and V. J. Norton.
1969. Some analyses of fish prices. Univ. R.I. Agric. Exp. Stn. Bull. 401.

DISTRIBUTION OF SNAPPERS AND GROUPERS IN THE GULF OF MEXICO AND CARIBBEAN SEA AS DETERMINED FROM EXPLORATORY FISHING DATA [1/]

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ABSTRACT

A review of 24 years of exploratory fishing and resource assessment activities on the Gulf of Mexico and Caribbean Sea provide an overview of the geographical and bathymetric distributions of 18 species of snappers (Lutjanidae) and 14 species of groupers (Serranidae). Bottom temperature data are given,where available. Information is also provided on average size and size range where data permit.

Lutjanus synagris, the lane snapper, shows the widest geographical range among all snapper species and *Epinephelus morio*, the red grouper, has the broadest distribution among groupers.

Ten of the 33 species,reviewed reach their maximum abundance on the Campeche Bank area of the southern Gulf of Mexico. The second major area of snapper/grouper abundance is the bank area off Honduras and Nicaragua in Central America.

Recent trawl surveys in the north-central Gulf of Mexico show that large numbers of small Gulf red snapper, *Lutjanus campechanus*, occur throughout the year between 10 and 40 fathoms, despite the apparent reduction in numbers of commercially acceptable sized snapper in the northern Gulf.

[1/] Contribution No. 444, Southeast Fisheries Center, Pascagoula Laboratory, National Marine Fisheries Service, NOAA, Pascagoula, MS 39567 and MARMAP Contribution No. 114.

INTRODUCTION

Snappers and groupers comprise the single most valuable edible fish resource of the Southeastern United States. In recent years, serious declines in production, a decrease in average fish size, and marked shifts in fishing grounds have demonstrated downward trends in stocks. The situation is complicated by the paucity of literature on early life history, age, growth, and population dynamics relative to many of the species included in the resource. For that reason, a review of the faunal data inventory of the National Marine Fisheries Service, Southeast Fisheries Center Laboratory, Pascagoula, Miss. is timely. This data library represents 25 years of exploratory fishing and resource assessment effort in the Gulf of Mexico, Caribbean Sea, and adjacent waters. Excepting a review of the genus *Lutjanus* by Rivas (1970a) and a synopsis of the Caribbean explorations by Carpenter and Nelson (1971), these data have not been presented in their complete form.

This paper provides an analysis of the records pertaining to the major commercial species of snappers and groupers represented by the family Lutjanidae and the serranid genera *Epinephelus* and *Mycteroperca*. An itemization of species, including scientific and common names (in accordance with the 3rd edition of "A List of Common and Scientific Names of Fishes from the United States and Canada," American Fisheries Society, Special Publication No. 6), is as follows:

Lutjanidae:	Snappers:
Apsilus dentatus	black snapper
Etelis oculatus	queen snapper
Lutjanus analis	mutton snapper
L. apodus	schoolmaster
L. buccanella	blackfin snapper
L. campechanus	Gulf red snapper
L. cyanopterus	cubera snapper
L. griseus	gray snapper
L. jocu	dog snapper
L. mahogoni	mahogany snapper
L. purpureus	Caribbean red snapper
L. synagris	lane snapper
L. vivanus	silk snapper
Ocyurus chrysurus	yellowtail snapper
Pristipomoides aquilonaris	wenchman
P. freemani	wenchman
P. macrophthalmus	wenchman
Rhomboplites aurorubens	vermilion snapper

Serranidae:	Groupers:
Epinephelus adscensionis	rock hind
E. drummondhayi	speckled hind
E. flavolimbatus	yellowedge grouper
E. guttatus	red hind
E. itajara	jewfish
E. morio	red grouper
E. mystacinus	misty grouper
E. nigritus	Warsaw grouper
E. niveatus	snowy grouper
E. striatus	Nassau grouper
Mycteroperca bonaci	black grouper
M. interstitialis	yellowmouth grouper
M. microlepis	gag
M. phenax	scamp
M. venenosa	yellowfin grouper

The data were collected during cruises of the research vessels OREGON, OREGON II, SILVER BAY, COMBAT, PELICAN, and GEORGE M. BOWERS during the period 1950 - 75. Data were largely gathered during exploratory fishing operations, the purpose of which was to delineate areas of high yield and develop maximum catch rates through gear optimization and selective fishing. Consequently, the data do not always lend themselves to quantitative analysis as well as they do to zoogeographical analysis. Therefore, the data base is used to provide geographical and bathymetrical summaries on a species basis. Where possible, size ranges and averages are provided and the number of observations used in the calculations is given in parentheses. Water temperatures are shown wherever possible. Recent findings by Kawaguchi (1974) and Sal'nikov (1965) are used to supplement the discussion.

Data were collected primarily with shrimp and fish trawls and with handlines. Traps, gill nets, and bottom setlines were used to a lesser extent. Details on these techniques are provided by Rathjen (1959); Captiva (1960); Cummins, Rivas, and Struhsaker (1962a and b); Struhsaker (1969), and Nelson and Carpenter (1968). Handlines were similar to those described by Carpenter (1965) for the commercial fishery.

A measure of total effort can be determined from Springer and Bullis (1965), Bullis and Thompson (1959), and Berry and Frummond (1967). Recent efforts by the OREGON II have not been compiled, though the station lists disseminated in conjunction with cruise reports provide total effort by gear type and locality. The number of stations per zone where records occurred is provided in the Tables.

Geographical distribution is keyed throughout the text to a zonation scheme shown in Table 1. These "faunal" zones were established by the data management unit at the Pascagoula Laboratory to facilitate data processing and to support zoogeographical analyses. The boundaries chosen were based on several considerations, including topography, geography, faunal assemblages, and ecozones. In a few instances they were selected to facilitate data processing.

Table 1. Faunal Zone Descriptions and Boundaries as Referred to in the Text. North and South Boundaries in Degrees and Minutes Latitude; East and West Boundaries in Degrees and Minutes Longitude Unless Otherwise Stated.

Zone	North	South	East	West	Geographical Area
2	35°00'N	32°00'N	65°00'W	Shoreline	North & South Carolina
3	32°00'N	28°15'N	65°00'W	Shoreline	Georgia-Cape Canaveral
4	28°30'N	24°15'N	79°30'W	81°00'W	Cape Canaveral-Straits
28	25°00'N	24°00'N	81°00'W	85°00'W	Florida Straits
5	Shoreline	25°00'N	Shoreline	85°00'W	Florida-west coast
6	Shoreline	25°00'N	85°00'W	89°15'W	Cape San Blas-Miss. River
7	Shoreline	25°00'N	89°00'W	Shoreline	Miss. River-Texas
8	25°00'N	Shoreline	93°00'W	Shoreline	Texas-Gulf of Campeche
9	25°00'N	Irregular	85°00'W	93°00'W	Campeche Bank
10	21°15'N	15°00'N	85°00'W	Shoreline	Yucatan Channel
11	19°00'N	11°00'N	80°00'W	85°00'W	Honduras-Costa Rica
12	11°00'N	Shoreline	80°00'W	Shoreline	Panama
13	15°00'N	Shoreline	74°00'W	80°00'W	W. Colombian coast
14	15°00'N	Shoreline	71°30'W	74°00'W	E. Colombian coast
15	15°00'N	Shoreline	63°30'W	71°30'W	Venezuela-Trinidad
16	11°30'N	5°00'N	51°00'W	63°30'W	Guianas
17	9°00'N	0°00'	38°00'N	51°00'W	N.E. Brazil-Belem
18	0°00'	7°00'S	30°00'W	Shoreline	Belem-Recife
20	28°30'N	Irregular	64°00'W	Irregular	Bahamas
21	Irregular	Irregular	Irregular	85°00'W	Cuba
22	19°00'N	15°00'N	75°00'W	80°00'W	Jamaica
23	20°15'N	15°00'N	67°30'W	75°00'W	Hispaniola
24	20°15'N	15°00'N	64°00'W	67°30'W	Puerto Rico
25	20°15'N	15°00'N	60°00'W	64°00'W	Leeward Islands
26	15°00'N	11°30'N	51°00'W	63°00'W	Windward Islands

Data for each species are given by zone in tabular form emphasizing geographical distribution. A written description precedes each Table.

Depths are given in meters, temperatures in °C, and weights in kilograms per individual ("Ind"). An "n.d." is shown wherever no data were collected, and an "n/c" is given where data were too few to calculate averages. "Specimens (No.)" refers to the number of specimens used to determine "Size Range."

DISTRIBUTION ANALYSES

Apsilus dentatus (black snapper)

Apsilus was found distributed throughout the region from Georgia to Brazil, but the data are too sparse to indicate areas of high density. The depth range shown is 38 - 285 m. Apparently, black snapper have a wide temperature tolerance since the data range was 16° to 27°C. Individuals ranged in size from 0.02 to 1.93 kg. Kawaguchi (1974) recorded *Apsilus* from Hispaniola (zone 23) and the Leeward Islands (zone 25).

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean.	
3	1	285	285	n/c	n.d.	--	--	0.02	0.02	n/c	1
7	1	189	189	n/c	16	16	n/c	n.d.	--	--	--
10	4	132	170	144	n.d.	--	--	0.57	1.14	0.61	4
11	2	47	142	n/c	n.d.	--	--	0.45	1.93	1.45	3
16	2	57	60	n/c	n.d.	--	--	n.d.	--	--	--
17	4	66	83	74	22	22	n/c	0.06	0.06	n/c	1
22	1	38	38	n/c	27	27	n/c	n.d.	--	--	--
24	1	85	85	n/c	n.d.	--	--	1.14	1.14	n/c	1

Etelis oculatus (queen snapper)

All the exploratory records for *Etelis* were taken in the Caribbean Sea and Bahamas. None came from the eastern coast of the United States or from the Gulf of Mexico. The data indicate the species is widespread throughout its range, though the majority of exploratory catches came from zones 11 and 20. Bathymetric data show that queen snapper do inhabit considerable depths throughout the Caribbean (the 38 m in zone 22 is suspect), the exhibited range being 95 - 680 m. Most records came from depths exceeding 180 m.

Available temperature data ranged from 11° to 18°C, except for a 27°C data point accompanying the zone 22 catch. Only one average (zone 20) was computed at 17°C.

Maximum size taken was 2.27 kg; minimum size was 0.18 kg. Averages of 2.25 kg and 0.45 kg were computed for zones 10 and 20.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
10	1	270	270	n/c	15	15	n/c	n.d.	--	--	--
11	6	200	299	238	16	18	n/c	1.36	2.27	2.25	3
12	1	189	189	n/c	n.d.	--	--	n.d.	--	--	--
13	1	95	95	n/c	n.d.	--	--	n.d.	--	--	--
14	1	189	189	n/c	n.d.	--	--	n.d.	--	--	--
20	1	197	680	414	17	18	17	0.18	0.73	0.45	6
21	1	387	387	n/c	n.d.	--	--	n.d.	--	--	--
22	1	38[1/]	38	n/c	27	27	n/c	0.45	n/c	n/c	1
23	2	113	113	n/c	n.d.	--	--	n.d.	--	--	--
24	1	284	284	n/c	n.d.	--	--	n.d.	--	--	--
25	1	463	463	n/c	11	11	n/c	n.d.	--	--	--
26	2	236	416	n/c	n.d.	--	--	n.d.	--	--	--

[1/] Questionable record.

Lutjanus analis (mutton snapper)

Mutton snapper records are widely distributed from the Carolinas to the Guianas, excepting the northern Gulf of Mexico. Campeche Bank (zone 9), the Georgia-north Florida area (zone 3), and the eastern coast of Columbia (zone 14) produced the highest number of records. The depth range was 8 - 151 m, though the average distribution varied between 34 and 66 m. Corresponding bottom temperatures extended from 19° to 28°C, but too few records were available for analysis. Maximum size taken was 10.0 kg, with considerable variation noted among zone averages.

Zone	Stations (No.)	Depth Range (m) Min.	Max.	Mean	Temperature Range (oC) Min.	Max.	Mean	Size Range (kg/Ind) Min.	Max.	Mean	Specimens (No.)
2	3	55	62	57	n.d.	--	--	6.80	10.00	8.95	3
3	12	30	60	38	19	23	n/c	0.91	2.73	1.77	10
4	2	36	81	n/c	n.d.	--	--	0.45	0.45	n/c	1
8	1	68	68	n/c	n.d.	--	--	1.82	1.82	n/c	1
9	206	32	89	51	26	28	27	1.36	10.00	4.36	28
11	2	47	151	n/c	n.d.	--	--	2.27	2.72	2.59	3
12	1	28	28	n/c	n.d.	--	--	n.d.	--	--	--
13	10	23	113	59	25	27	n/c	0.45	2.72	1.50	6
14	12	13	53	34	26	26	n/c	0.45	1.59	0.86	11
15	2	57	62	n/c	n.d.	--	--	0.91	3.64	1.59	3
16	4	57	85	66	26	26	n/c	2.72	7.73	5.23	3
22	1	8	8	n/c	n.d.	--	--	n.d.	--	--	--
24	1	29	29	n/c	n.d.	--	--	n.d.	--	--	--

Lutjanus apodus (schoolmaster)

Most exploratory records for schoolmaster came from Campeche Bank (zone 9), but the geographical scatter of the remaining records (zones 3, 5, 13, and 24) indicated the species is generally distributed throughout the entire area wherever broken bottom occurs. No records were found for the northern Gulf of Mexico and the northeastern coast of South America. Depth records ranged from 19 to 89 m, with an average near 50 m. Temperature data are incomplete. Largest size recorded was 13.63 kg and the smallest was 0.22 kg; averages ranged between 0.55 and 6.8 kg.

Zone	Stations (No.)	Depth Range (m) Min.	Max.	Mean	Temperature Range (^{o}C) Min.	Max.	Mean	Size Range (kg/Ind) Min.	Max.	Mean	Specimens (No.)
3	1	36	36	n/c	21	21	n/c	2.27	2.27	n/c	1
5	17	19	60	47	n.d.	--	--	0.34	1.36	0.55	14
9	62	32	89	51	28	28	n/c	0.22	13.63	1.18	7
13	3	25	76	59	n.d.	--	--	0.91	6.82	6.80	3
24	1	55	55	n/c	n.d.	--	--	n.d.	--	--	--

Lutjanus buccanella (blackfin snapper)

Blackfin snapper were taken throughout the region except for the eastern and northern Gulf of Mexico, Cuba, Hispaniola, and Jamaica. The majority of records came from Puerto Rico. A wide depth distribution of 8 - 197 m was given, but the available temperature range was not wide (18° to 25°C). Maximum size taken was 5.0 kg. Average size range was 1.05 - 3.36 kg. Kawaguchi listed L. buccanella from zones 11, 15, 16, 22, 23, 24, 25, and 26.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
2	1	55	55	n/c	n.d.	--	--	5.00	5.00	n/c	1
4	1	70	70	n/c	n.d.	--	--	--	--	--	--
8	1	68	68	n/c	n.d.	--	--	0.91	0.91	n/c	1
9	6	47	95	68	23	23	n/c	1.36	5.00	3.36	5
10	5	66	189	140	n.d.	--	--	1.00	1.82	1.27	5
11	7	49	197	123	18	19	n/c	0.59	1.64	1.05	5
13	5	23	113	55	22	25	n/c	0.45	0.45	n/c	1
14	3	62	136	110	23	23	n/c	0.91	1.82	1.50	3
15	2	34	57	n/c	n.d.	--	--	0.09	0.09	n/c	1
16	1	28	28	n/c	n.d.	--	--	n.d.	--	--	--
18	1	53	53	n/c	n.d.	--	--	0.11	0.11	n/c	1
20	3	8	25	19	n.d.	--	--	1.14	1.45	1.36	3
24	12	49	189	113	n.d.	--	--	0.45	2.18	1.32	9
25	5	34	174	121	n.d.	--	--	1.14	1.23	1.18	4

Lutjanus campechanus (Gulf red snapper)

Rivas (1966) separated L. campechanus from L. purpureus (Caribbean red snapper) and provided geographical ranges for each species. The Pascagoula Laboratory adopted this nomenclature and subsequently catalogued red snapper from zones 2 through 9 and 28 as L. campechanus and those from zones 10 to 26 as L. purpureus. This distinction may be somewhat erroneous as transition areas occur (e.g., zones 10 and 21) where the two species are extremely difficult to separate by meristics. Regardless, the species are separated in this paper by the above described geographical division, which is substantially supported by field identification.

In addition to the distribution analysis provided for each species, I have also separately examined trawl data from zones 6 and 7 (the northern Gulf of Mexico). In excess of 1,500 red snapper records are contained in that data file, derived from trawl surveys conducted since 1950. The purpose of this exercise was to seek out changes in average size or availability that might indicate trends in stock status.

The data were divided into two time periods (1950- 65 and 1966- 75), representative of the ascent and decline periods in the U.S. snapper fishery.

Table 2 provides a summary, by time period and by month, of the trawl-derived catch data from zones 6 and 7. Two factors are evident in zone 6 data: (1) the year-round presence of small red snapper on the trawl grounds; and (2) the difference in mean size (annually) of snapper taken in the two time periods. A t-test conducted on the means showed significant differences (90 percentile) between the average size of red snapper taken from 1950-65 and the average size taken from 1966- 75. Small snapper are also found in zone 7 throughout the year, but no significant difference was found between time-period size means.

The significant factor demonstrated by this analysis is that quantities of young (i.e., small) red snapper are distributed over much of the north central Gulf of Mexico in 19 - 75 m, where their vulnerability to the trawl fisheries, such as shrimp and industrial bottom fish, is increased. Further, there has been a decrease in mean size of young snapper found over these areas during the past two decades. Whether or not these conditions are relatable to adult stock status and current fishery trends is not known. However, the situation is of enough importance to merit research on red snapper in the northern Gulf.

Table 2. Comparison of Monthly Range and Mean Size of *Lutjanus campechanus* in the Northern Gulf of Mexico (zones 6 and 7) for the Time Periods 1950- 65 and 1966- 75.[1/]

	ZONE 6				ZONE 7			
Month	1950- 65		1966- 75		1950- 65		1966- 75	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Jan.	0.73	0.06-12.50	0.64	0.08-10.45	0.77	0.23-7.27	0.53	0.11-10.91
Feb.	0.27	0.08- 1.09	1.36	0.30- 1.73	0.37	0.02-4.55	--	--
Mar.	0.95	0.19- 9.09	0.19	0.40- 0.90	0.06	0.06-0.06	0.16	0.03- 9.55
Apr.	--	--	0.09	0.10- 7.73	0.30	0.30-0.30	0.21	0.02- 2.68
May	0.85	0.45- 2.79	0.09	0.10- 0.23	7.50	0.45-9.09	--	--
June	0.62	0.08- 9.09	0.26	0.05- 0.45	0.48	0.06-0.64	0.32	0.15- 0.91
July	0.27	0.06- 0.45	--	--	--	--	--	--
Aug.	1.32	0.11-13.64	0.35	0.10-11.36	--	--	0.18	0.02-10.45
Sept.	2.35	0.45-11.36	0.03	0.005-0.59	0.84	0.11-7.95	0.32	0.09-10.45
Oct.	0.55	0.03- 0.90	0.03	0.01- 0.91	0.76	0.11-1.51	0.41	0.02- 7.50
Nov.	--	--	0.07	0.005-6.82	0.23	0.05-5.45	0.12	0.01- 1.36
Dec.	--	--	--	--	--	--	0.19	0.05- 0.45
Annual	0.90		0.09		0.55		0.22	

[1/] Values in kilograms.

Gulf red snapper were taken in all zones from 2 to 9, though most records came from zones 3, 6, 7, and 9. In part, this is an artifact due to the effort distribution among zones. Further, the high availability shown for zone 9 was largely due to effort expended with fish trawls in the late 1950's (Captiva, 1960), when Campeche Bank was a primary red snapper fishing ground. Similar findings may not be possible at this time, if the shift in commercial effort from Campeche to Central American grounds is any criterion of availability.

The bathymetric range of the data was 8-151 , with a mean range of 40 - 60 m. Very little variation was found in mean depths among zones, despite wide differences in total range among some zones. As expected, considering the narrow mean depth range, the mean temperature range was also narrow. The data show a mean range of 19° to 24°C, with an overall range of 13° to 28°C. No geographical trends were apparent in the data.

The data show that Gulf red snapper reach a greater size than do Caribbean red snapper. The largest *L. campechanus* taken was 14.55 kg, while the largest *L. purpureus* was 6.82 kg. Only small differences in maximum size were found among zones, despite a wide variation in averages.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
2	38	13	85	47	17	25	22	0.95	14.09	3.73	30
3	117	21	79	45	13	27	21	0.08	14.55	1.06	77
4	26	17	81	43	16	24	19	0.05	13.64	0.41	7
28	8	28	59	45	17	21	19	0.45	8.18	4.32	3
5	39	9	149	57	20	21	21	0.45	13.64	2.36	30
6	985	8	151	40	16	28	22	0.03	12.50	0.20	418
7	929	9	147	51	15	27	22	0.01	10.91	0.52	454
8	28	28	81	60	15	25	22	0.06	7.27	0.45	20
9	332	23	142	55	15	28	24	0.07	9.09	1.45	94

Lutjanus cyanopterus (cubera snapper)

Two specimens of cubera snapper, weighing 11.36 and 13.64 kg, were taken on Campeche Bank in fish trawls. No bottom temperature data are on record.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
9	2	43	47	n/c	n.d.	--	--	11.36	13.64	n/c	2

Lutjanus griseus (gray snapper)

Exploratory catches of gray snapper rarely occurred south of zone 9, with only 7 out of 95 stations occurring in the Caribbean. Most records came from the northern Florida-southern Georgia area (zone 3), the west coast of Florida, and the Campeche Bank area. The data indicate that gray snapper are not particularly deep water inhabitants, being taken in 8 - 132 m. In at least three zones (3, 5, and 6), the average depth was 36 m.

The exhibited temperature range was 18° to 27°C, but no data existed for the Caribbean records. A size range of 0.14 - 9.09 kg was recorded, though the average size was close to 1 kg.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
2	1	55	55	n/c	n.d.	--	--	n.d.	--	--	--
3	23	28	42	36	19	21	19	0.91	6.36	2.45	21
4	2	15	25	n/c	18	18	n/c	1.36	1.36	n/c	1
5	21	13	60	36	n.d.	--	--	0.34	1.36	0.54	20
6	4	15	60	36	23	24	n/c	0.14	3.18	1.05	3
9	37	17	79	51	24	27	25	0.45	9.09	1.45	9
10	4	30	132	91	n.d.	--	--	0.45	1.59	1.27	3
13	2	23	38	n/c	n.d.	--	--	n.d.	--	--	--
22	1	8	8	n/c	n.d.	--	--	n.d.	--	--	--

Lutjanus jocu (dog snapper)

Records of the distribution of L. jocu, though sparse, indicate a reasonably wide Caribbean range for the species. This is supported by Kawaguchi, who took dog snapper in zones 11, 23, and 24. No Gulf of Mexico or U.S. East Coast exploratory records were found, and the small number of records may indicate the species is not overly abundant in its range. Specimens taken were as large as 7.59 kg, the smallest being 1.36 kg. No temperature data were available.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
10	1	132	132	n/c	n.d.	--	--	5.45	5.45	n/c	1
11	4	9	151	76	n.d.	--	--	1.36	7.59	6.00	3
13	4	17	25	23	n.d.	--	--	1.36	1.36	n/c	1
14	1	38	38	n/c	n.d.	--	--	2.73	2.73	n/c	1
16	1	66	66	n/c	n.d.	--	--	6.36	6.36	n/c	1

Lutjanus mahogoni (mahogany snapper)

Only four records were found for mahogany snapper, all from widely dispersed geographical areas. Kawaguchi did not mention this species; and though mahogany snapper may be widely distributed throughout the Caribbean, they are apparently limited in abundance. The depth range was very large (2 - 473 m). Biological data were not available.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
4	1	26	26	n/c	20	20	n/c	n.d.	--	--	--
11	1	2	2	n/c	28	28	n/c	n.d.	--	--	--
16	1	30	30	n/c	n.d.	--	--	n.d.	--	--	--
21	1	473	473	n/c	n.d.	--	--	n.d.	--	--	--

Lutjanus purpureus (Caribbean red snapper)

Caribbean red snapper were recorded from Honduras to Brazil (zones 11 to 18) and from Puerto Rico and the Windward Islands. The greatest number of records (177 stations) came from off the Guianas. The data showed a bathymetric distribution of 15 - 198 m, but most catches were made in 36 - 70 m. Deepest catches were made off the Honduran coast (zone 11).

Bottom temperature data ranged from 18° to 29°C, with an average distribution in four zones of 25° to 28°C.

Caribbean red snapper may show relationships between individual size and either depth or temperature (or both, one being perhaps dependent on the other). Snapper taken from shallow, warmer water averaged less in size than those occurring in deeper, colder water. Specimens taken from all zones except 11 (excluding zones 24 and 25 for which there are no data) averaged less than 1 kg, whereas those from zone 11 averaged more than 3.0 kg. Part of this difference may have been due to the fact that the majority of Honduran catches were made with handlines, whereas specimens from the Guianas were taken with trawls. The vulnerability to trawl capture of small fish was assumed to be greater than that of large fish. The size range for all zones was 0.05 - 6.82 kg.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
11	7	95	198	142	18	18	n/c	1.36	3.95	3.07	5
13	29	26	132	66	22	28	26	0.05	1.36	0.41	12
14	15	15	95	36	n.d.	--	--	0.14	3.64	0.23	12
15	9	28	76	47	26	27	n/c	0.09	0.14	0.11	3
16	177	28	91	55	23	29	25	0.05	6.82	0.31	82
17	20	53	93	70	22	28	26	0.14	4.55	0.47	4
18	6	38	49	42	28	29	28	n.d.	--	--	--
24	5	49	79	68	n.d.	--	--	n.d.	--	--	--
25	1	66	66	n/c	n.d.	--	--	n.d.	--	--	--

Lutjanus synagris (lane snapper)

Lane snapper had the widest geographical distribution of the 18 species included in the analysis. None were taken from zones 10, 20, and 21; however, Sal'nikov (1965) reported *L. synagris* from zone 21 (Cuba). The species was assumed to be distributed throughout the Gulf of Mexico and Caribbean.

The data indicated that *L. synagris* is a shallow water species, with a bathymetric range of 4 - 132 m and a mean occurrence near 40 m. No geographical trends in depth distribution were apparent.

Lane snapper were taken over a temperature range of 16° to 29°C, with an average near 26°C. The data indicate the mean temperature of occurrence increased with decreasing latitude, but no accompanying changes in bathymetric distribution were noted.

The lane snapper is not a large lutjanid; most individuals averaged less than 0.33 kg. The largest specimen weighed 3.64 kg; the smallest, 0.01 kg. Zones 5, 6, and 7 (northern Gulf), zone 9 (Campeche Bank), zone 13 (Colombian coast), and zone 16 (Guianas) produced the highest number of records. Fewest captures were made in the Antilles.

Zone	Stations (No.)	Depth Range (m) Min.	Max.	Mean	Temperature Range (°C) Min.	Max.	Mean	Size Range (kg/Ind) Min.	Max.	Mean	Speci-mens (No.)
2	1	13	13	n/c	n.d.	--	--	n.d.	--	--	--
3	3	36	64	55	n.d.	--	--	0.91	3.64	2.27	3
4	6	17	40	28	19	20	n/c	n.d.	--	--	--
28	43	8	62	28	26	26	n/c	0.14	0.34	0.26	3
5	108	6	60	32	17	26	21	0.09	3.64	0.20	87
6	124	4	77	40	19	27	24	0.05	0.59	0.16	42
7	103	8	95	45	16	26	22	0.06	1.36	0.19	42
8	8	59	74	66	n.d.	--	--	0.16	0.45	0.27	6
9	242	23	91	51	21	28	24	0.11	2.27	0.52	42
11	9	40	59	43	26	27	26	0.05	0.07	0.06	3
12	13	15	36	25	27	27	n/c	0.14	0.14	n/c	1
13	100	11	132	53	22	28	26	0.02	0.55	0.14	47
14	43	13	91	40	24	29	26	0.32	0.52	0.33	37
15	26	28	42	47	25	27	26	0.21	1.36	0.33	21
16	173	19	81	49	23	29	26	0.02	0.91	0.26	119
17	16	60	77	66	22	28	26	0.14	0.64	0.38	13
18	19	15	57	40	27	29	28	0.03	0.23	0.11	11
22	16	8	51	30	26	29	27	0.01	0.09	0.04	7
23	1	26	26	n/c	28	28	n/c	0.23	0.23	n/c	1
24	12	23	76	47	28	28	28	0.07	0.27	0.12	5
25	2	34	40	n/c	n.d.	--	--	0.27	0.27	n/c	1

Lutjanus vivanus (silk snapper)

The silk snapper or yelloweye is a common inhabitant of the region, rivaling *L. synagris* in geographical range. No records were found for the northeastern Gulf, the Colombian coast, Cuba, or the Windward Islands, though the species was reported from Cuba by Sal'nikov.

L. vivanus is a deep water snapper, as shown by the bathymetric distribution. The minimum and maximum depths were 28 and 340 m, respectively. The data indicated the species is found the deepest off Honduras, Nicaragua, and the Bahamas, and the shallowest off the U.S. East Coast and the Guianas Shelf. Means ranged among zones from 55 to 225 m.

The available temperature records showed a very wide range of 13° to 27°C. Average temperatures were computed for only three zones: 11, 13, and 15; and the respective averages were 19°, 25°, and 25°C.

Few trawl captures were recorded for *L. vivanus*, indicating a preference for rough bottom. Size data indicated *L. vivanus* reaches at least 6.82 kg, comparable to the size attained by L. purpureus. Most zone averages were around 1 kg. The overall size range was 0.11 - 6.82 kg.

The greatest number of L. vivanus records came from the Honduran-Nicaraguan coast, while the least number of records were found in zones 17, 22, and 23.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
2	7	47	76	63	22	22	n/c	1.64	4.55	1.77	4
3	3	34	74	55	n.d.	--	--	6.82	6.82	n/c	1
4	6	28	81	55	n.d.	--	--	n.d.	--	--	--
28	2	62	76	n/c	n.d.	--	--	n.d.	--	--	--
7	3	62	284	147	13	17	n/c	0.91	0.91	n/c	1
9	5	42	189	132	21	21	n/c	2.59	3.18	2.64	3
10	6	66	189	181	16	17	n/c	0.45	1.45	1.09	5
11	38	95	265	183	17	24	19	0.23	4.55	0.95	30
12	2	85	189	n/c	21	21	n/c	n.d.	--	--	--
13	21	40	340	98	22	27	25	0.14	0.77	0.30	10
15	5	57	104	76	24	27	25	0.73	0.91	0.77	3
16	8	57	95	72	n.d.	--	--	n.d.	--	--	--
17	1	76	76	n/c	n.d.	--	--	n.d.	--	--	--
18	2	57	66	n/c	n.d.	--	--	0.11	0.11	n/c	1
20	8	95	284	225	22	22	n/c	0.45	3.64	1.09	6
22	1	43	43	n/c	27	27	n/c	n.d.	--	--	--
23	1	208	208	n/c	n.d.	--	--	n.d.	--	--	--
24	7	72	208	147	n.d.	--	--	1.05	2.64	1.55	6
25	7	66	174	123	n.d.	--	--	0.45	1.82	1.14	6

Ocyurus chrysurus (yellowtail snapper)

Ocyurus is a small-sized, widely distributed species that occurs throughout the Gulf of Mexico and Caribbean Sea. Though it has not been taken from as many zones as Lutjanus synagris, the data distribution indicated the species must occur in those zones where no exploratory records exist. Sal'nikov reported Ocyurus from Cuba, and Kawaguchi listed yellowtail snapper from zones 11, 22, 23, 24, and 25.

Despite a wide depth distribution of 8 - 170 m, the species was generally taken in waters less than 50 m. As with many lutjanids, no significant differences in bathymetric distribution were found with respect to geographical or latitudinal change.

The temperature range was 18° to 28°C, and the optimum temperature was in the mid-twenties.

Yellowtail snapper taken by exploratory fishing ranged in size from 0.01 to 1.82 kg. Mean size varied considerably among zones, but the average size range was between 0.07 and 1.18 kg. Very small Ocyurus, weighing less than 0.25 kg, were taken off French Guiana and northern Brazil (zones 17 and 18) in bottom trawls. Largest individuals came from the Southeastern United States and the Bahamas. The greatest number of captures occurred on Campeche Bank (zone 9).

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
2	2	55	95	n/c	n.d.	--	--	1.59	1.59	n/c	1
3	10	34	95	45	18	21	19	0.32	1.36	0.66	7
4	7	25	66	36	19	20	19	0.13	0.45	0.16	4
28	5	8	34	23	26	26	n/c	0.45	1.36	0.55	3
5	2	49	57	n/c	n.d.	--	--	0.23	0.91	n/c	2
6	1	62	62	n/c	n.d.	--	--	n.d.	--	--	--
7	3	19	85	55	26	26	n/c	0.01	0.01	n/c	1
8	1	68	68	n/c	n.d.	--	--	0.55	0.55	n/c	1
9	41	19	62	47	24	28	26	0.23	1.50	0.40	17
10	2	19	170	n/c	n.d.	--	--	0.68	0.68	n/c	1
11	4	10	47	32	n.d.	--	--	0.68	0.68	n/c	2
13	1	23	23	n/c	n.d.	--	--	n.d.	--	--	--
14	4	13	47	30	n.d.	--	--	0.45	0.45	0.45	3
15	3	34	62	45	n.d.	--	--	0.45	0.91	n/c	2
17	1	68	68	n/c	28	28	n/c	0.23	0.23	n/c	1
18	7	26	57	40	28	28	28	0.05	0.23	0.07	3
20	8	8	45	28	n.d.	--	--	0.59	1.82	1.18	7
22	3	8	55	30	25	26	n/c	0.05	0.05	n/c	1
23	1	26	26	n/c	28	28	n/c	0.15	0.15	n/c	1
25	3	23	66	42	n.d.	--	--	0.05	0.05	n/c	1

Pristipomoides spp. (wenchmen)

Three species of wenchmen are listed in the faunal library, P. aquilonaris, P. macrophthalmus, and P. freemani. Of these, P. aquilonaris has the widest distribution, followed by P. macrophthalmus. Pristipomoides freemani was recorded only from zones 12, 13, and 16.

Wenchmen are relatively deep water snappers of small size and little economic importance to the U.S. fisheries. P. aquilonaris was found throughout the region, though the great majority of records came from the Gulf of Mexico, where the species is a common member of the northern Gulf Shelf community between about 80 and 200 m. The species was taken as shallow as 19 m and as deep as 378 m. Catch data from the Antilles indicated P. aquilonaris is largely displaced by P. macrophthalmus; but off the Guianas, P. aquilonaris seems equally distributed with P. macrophthalmus. The latter was not recorded north of the Florida Straits and only sporadically in the Gulf and Central American areas.

Both species seem to display similar bathymetric ranges, though P. macrophthalmus was recorded to 680 m. Bottom temperatures associated with Pristipomoides ranged from 13° to 28°C, but 20°C seemed to be the optimum temperature. Records associated with P. aquilonaris suggested that off the Guianas the species is found in warmer, but not necessarily deeper, water than in other areas where recorded.

The size data emphasize the diminutive nature of the members of the genus, though no data were available for P. freemani. Specimens less than 0.1 kg are common, and only one individual over 1.0 kg was recorded.

Only four P. freemani have been identified from exploratory efforts, three coming from zones 12 and 13 and the fourth coming from off French Guiana.

Pristipomoides aquilonaris (wenchman)

Zone	Stations (No.)	Depth Range (m) Min.	Max.	Mean	Temperature Range (°C) Min.	Max.	Mean	Size Range (kg/Ind) Min.	Max.	Mean	Specimens (No.)
2	16	40	142	83	17	22	19	n.d.	--	--	--
3	10	76	132	95	13	22	19	0.05	0.05	n/c	1
4	3	51	95	70	n.d.	--	--	n.d.	--	--	--
28	2	62	236	n/c	n.d.	--	--	n.d.	--	--	--
5	2	19	189	n/c	n.d.	--	--	n.d.	--	--	--
6	170	23	378	68	14	27	22	0.005	0.45	0.03	39
7	313	55	312	83	15	24	20	0.005	0.32	0.11	107
8	30	55	284	104	14	21	17	0.02	0.13	0.10	21
9	15	38	189	106	15	26	18	0.09	1.73	0.24	6
10	2	189	189	n/c	16	17	17	n.d.	--	--	--
11	5	104	265	200	20	20	n/c	0.14	0.14	n/c	1
12	6	95	284	208	16	19	n/c	n.d.	--	--	--
13	10	57	208	119	27	27	n/c	0.05	0.05	n/c	1
14	5	91	189	121	24	24	n/c	0.07	0.07	n/c	1
15	16	49	236	110	15	27	22	0.13	0.23	0.15	3
16	49	47	232	68	22	26	24	0.005	0.06	0.01	21
17	7	64	83	76	22	28	26	n.d.	--	--	--
22	2	28	36	n/c	27	27	n/c	n.d.	--	--	--
23	2	284	321	n/c	n.d.	--	--	n.d.	--	--	--

Pristipomoides macrophthalmus (wenchman)

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
28	1	289	289	n/c	n.d.	--	--	n.d.	--	--	--
6	1	42	42	n/c	n.d.	--	--	n.d.	--	--	--
7	2	34	95	n/c	24	24	n/c	n.d.	--	--	--
8	1	36	36	n/c	25	25	n/c	n.d.	--	--	--
11	1	189	189	n/c	20	20	n/c	n.d.	--	--	--
12	1	261	261	n/c	14	14	n/c	n.d.	--	--	--
16	66	38	284	79	23	26	24	0.005	0.15	0.06	29
20	20	236	680	391	18	26	20	0.23	0.59	0.41	5
21	3	236	387	302	n.d.	--	--	n.d.	--	--	--
22	1	321	321	n/c	17	17	n/c	n.d.	--	--	--
23	2	284	321	n/c	n.d.	--	--	n.d.	--	--	--
24	1	284	284	n/c	n.d.	--	--	n.d.	--	--	--
25	1	350	350	n/c	15	15	n/c	n.d.	--	--	--

Pristipomoides freemani (wenchman)

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
12	1	189	189	n/c	19	19	n/c	n.d.	--	--	--
13	2	142	189	n/c	n.d.	--	--	n.d.	--	--	--
16	1	147	147	n/c	n.d.	--	--	n.d.	--	--	--

Rhomboplites aurorubens (vermilion snapper)

Vermilion snapper records occurred throughout the region from Cape Hatteras to Brazil, including the entire Gulf of Mexico and much of the Caribbean Sea. The species distribution undoubtedly rivals L. synagris and L. vivanus in extent, though no R. aurorubens were recorded from the Bahamas, Cuba, Hispaniola, and the Windward Islands (zones 20, 21, 23, and 26). Kawaguchi reported Rhomboplites from zones 23 through 25. Sal'nikov did not report the species from Cuba, unlike Evermann and Marsh (1902).

The bathymetric range for Rhomboplites was 13 - 236 m; the average depth was between 40 and 50 m. Records for Honduras to Costa Rica and the northeastern coast of South America (zones 14 to 16) showed deeper distribution for the species than those from the eastern United States and the Gulf of Mexico.

The temperature range was 15° to 28°C, with a 23°C average for all zones. The distribution of Rhomboplites may be strongly correlated with bottom temperature.

The data indicated that vermilion snapper are generally small, the average size near 0.15 kg. The size range for exploratory captures was 0.005 - 2.27 kg; few specimens exceeded 1.0 kg.

Zones where vermilion snapper were most abundant were 2, 3, 5, 6, 7, 9, and 16. Least availability was found in zones 10, 12, and 22.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
2	197	15	96	36	15	28	23	0.005	1.36	0.20	62
3	191	23	95	45	16	22	20	0.03	1.14	0.19	73
4	18	21	151	49	17	24	18	0.03	0.09	0.06	4
28	4	32	70	49	24	24	n/c	n.d.	--	--	--
5	140	19	95	47	16	21	19	0.01	0.45	0.10	79
6	127	15	117	57	15	24	23	0.03	2.27	0.10	58
7	138	13	189	68	16	27	21	0.04	0.91	0.38	41
8	25	59	191	41	n.d.	--	--	0.05	0.11	0.07	18
9	177	42	144	59	17	28	23	0.08	0.68	0.15	13
10	1	170	170	n/c	n.d.	--	--	n.d.	--	--	--
11	15	40	219	115	18	27	23	0.05	0.68	0.15	5
12	1	36	36	n/c	n.d.	--	--	n.d.	--	--	--
13	52	15	132	60	22	28	26	0.005	0.17	0.05	20
14	9	23	214	85	17	24	21	0.11	0.45	0.16	6
15	24	36	236	79	15	27	23	0.03	0.23	0.06	4
16	113	30	132	100	23	27	24	0.01	0.45	0.12	36
17	12	64	83	68	24	28	26	0.15	0.91	0.20	7
18	5	34	53	42	28	28	28	0.08	0.08	n/c	1
22	1	42	42	n/c	27	27	n/c	n.d.	--	--	--
24	3	23	77	42	n.d.	--	--	n.d.	--	--	--
25	2	34	180	n/c	n.d.	--	--	0.23	0.45	0.27	5

Epinephelus niveatus (snowy grouper)

Snowy grouper were caught from Cape Hatteras southward through the Gulf of Mexico, along the Central American coast, and across South America to the Guianas. No records were found in the Bahamas and Antilles. The greatest number of catches came from the Florida east coast. Kawaguchi reported catching snowy grouper in zone 17 only.

The depth range was 25 - 287 m; the bathymetric range increased with decreasing latitude. The average depth for zones 2 through 6 was approximately 60 - 65 m; whereas for zone 13, it was 132 m and for zone 7, it was 102 m. Averages could not be calculated for other zones.

Very little temperature data accompanied the records. The range given was 16° to 26°C, and most observations were between 20° and 26°C. Averages, except for zone 7, could not be calculated.

The largest snowy taken was 13.64 kg, the smallest was 0.23 kg.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
2	3	38	100	60	16	16	n/c	1.36	1.36	n/c	1
3	24	25	142	64	24	24	n/c	0.91	5.00	3.64	9
4	5	40	91	60	n.d.	--	--	0.45	0.45	n/c	1
28	5	26	76	85	n.d.	--	--	n.d.	--	--	--
6	5	38	89	62	22	23	n/c	n.d.	--	--	--
7	11	66	197	102	16	22	19	0.34	13.64	5.09	7
9	1	287	287	n/c	n.d.	--	--	7.05	7.05	n/c	1
11	1	197	197	n/c	20	20	n/c	0.45	0.45	n/c	1
13	3	66	189	132	n.d.	--	--	n.d.	--	--	--
14	1	142	142	n/c	n.d.	--	--	n.d.	--	--	--
15	2	34	76	n/c	26	26	n/c	n.d.	--	--	--
16	2	68	142	n/c	24	24	n/c	0.23	0.23	n/c	1

Epinephelus nigritus (Warsaw grouper)

Records for Warsaw grouper occurred in most zones: U.S. East Coast, Gulf of Mexico, and Central and South America, along with a single capture off Cuba. No other Antillean records were found, and there were no catches from the Florida Straits; however, Smith (1961) reported E. nigritus from the Straits, Cuba, and Hispaniola. Most records came from the northwestern Gulf. The species was taken over a depth range of 21 - 473 m; and in several zones, the mean depth exceeded 100 m.

A temperature range of 12° to $24^{\circ}C$ was observed, with the majority of records less than $20^{\circ}C$.

The great majority of Warsaw grouper were large fish taken on hook and line. The size range is 2.73 - 102.27 kg, while zone averages generally exceeded 10 kg.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
3	10	25	70	53	24	24	n/c	5.45	102.27	26.82	8
4	3	25	66	43	n.d.	--	--	102.27	102.27	n/c	1
5	7	49	284	140	14	15	14	2.73	20.45	10.45	6
6	14	21	106	76	16	21	19	4.55	90.91	20.91	11
7	26	66	197	102	16	24	19	5.45	61.36	26.36	23
8	1	473	473	n/c	14	14	n/c	54.55	54.55	n/c	1
9	7	43	340	157	12	16	14	4.09	7.73	7.45	6
11	1	189	189	n/c	n.d.	--	--	n.d.	--	--	--
13	1	350	350	n/c	n.d.	--	--	22.73	22.73	n/c	1
16	5	62	151	93	n.d.	--	--	5.45	25.91	13.32	4
17	1	64	64	n/c	n.d.	--	--	6.82	6.82	n/c	1
21	1	236	236	n/c	n.d.	--	--	n.d.	--	--	--

Epinephelus adscensionis (rock hind)

Rock hind were taken intermittently throughout the Antilles, off Central America, and on Campeche Bank. The Bahamas had the most records. No catches were made off the Southeastern United States, the northern Gulf of Mexico, or the South American coastline. All captures were made over reefs or heavily broken bottom in 11 - 302 m. Average depth values were highly variable.

Only two bottom temperatures were recorded, $13^{\circ}C$ in 302 m and $23^{\circ}C$ in 95 m (both from zone 9).

Average size and size range were remarkably similar throughout all zones; the size range was 0.45 - 1.36 kg, and the average was approximately 0.7 kg.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
9	5	38	302	58	13	23	n/c	0.68	1.36	0.73	3
10	5	11	170	79	n.d.	--	--	0.45	1.36	0.59	4
11	1	125	125	n/c	n.d.	--	--	n.d.	--	--	--
20	8	19	47	34	n.d.	--	--	0.45	0.91	0.77	8
23	1	21	21	n/c	n.d.	--	--	0.68	0.68	n/c	1
24	6	23	189	110	n.d.	--	--	0.45	1.36	0.73	4
25	2	151	174	n/c	n.d.	--	--	0.59	0.91	0.77	3

Epinephelus drummondhayi (speckled hind)

The speckled hind was not taken south of the Bahamas. Most catches occurred along the eastern seaboard of the United States from Cape Hatteras south and in the Gulf of Mexico. Like the rock hind, E. drummondhayi seems to be a common resident of reefs throughout its range.

The bathymetric range for E. drummondhayi was 9 - 180 m, and the temperature range was 17° to 24°C.

Size data show the speckled hind to be the largest of the three species of hinds collected (E. adscensionis, E. drummondhayi, and E. guttatus); at least two specimens exceeded 11.0 kg. The range was 0.34 - 11.36 kg, and most specimens were larger than 1 kg.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
2	9	38	81	53	17	17	n/c	3.64	11.36	9.00	7
3	7	25	70	55	18	24	n/c	0.91	7.73	5.91	4
4	2	38	40	n/c	n.d.	--	--	0.91	0.91	n/c	1
6	1	9	9	n/c	n.d.	--	--	n.d.	--	--	--
9	8	47	180	93	17	23	21	0.45	11.36	7.73	4
20	1	47	47	n/c	n.d.	--	--	0.34	0.34	n/c	1
21	1	23	23	n/c	n.d.	--	--	0.66	0.66	n/c	1

Epinephelus flavolimbatus (yellowedge grouper)

The yellowedge grouper is a relatively deep water species, recorded from the U.S. East Coast, the Gulf of Mexico, the northeastern coast of South America, and the Windward Islands. No captures were made off Central America, the Bahamas, or the Greater Antilles. Kawaguchi took yellowedge grouper from Hispaniola (zone 23) and Smith showed Cuban records; therefore, the species must occur intermittently throughout the Caribbean. Yellowedge grouper are abundant off the northern Texas Gulf coast (zone 7) in 200 - 300 m, occurring in association with the tilefish, Lopholatilus chamaeleonticeps, on the large "lumps" found offshore.

The depth range for E. flavolimbatus was 38 - 350 m; average depths generally exceeded 70 m. Bottom temperature records ranged from 11° to 25°C, and the data suggested the species may be found off South America in warmer water than in the Gulf. Unfortunately, the data are insufficient to draw more positive relationships.

Yellowedge grouper in the Gulf range in size from 0.45 to 15.45 kg and average in excess of 3.5 kg. Most data came from bottom setlines, which are less apt to catch small fish than trawls. However, the area where E. flavolimbatus occurs off Texas is difficult to trawl, and little effort has been expended in bottom trawl assessment. Consequently, specimens under 1 kg rarely have been taken.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
3	1	79	79	n/c	n.d.	--	--	n.d.	--	--	--
4	2	47	66	n/c	n.d.	--	--	n.d.	--	--	--
5	2	53	64	n/c	n.d.	--	--	n.d.	--	--	--
6	13	38	284	113	16	17	n/c	0.45	6.82	3.95	7
7	21	53	321	191	11	20	14	0.45	15.45	5.45	15
8	2	187	350	n/c	11	11	n/c	5.91	15.45	10.68	2
9	12	151	302	217	13	23	17	2.77	8.18	3.91	12
13	11	47	142	79	22	25	23	0.34	0.34	n/c	1
14	2	189	284	n/c	n.d.	--	--	1.36	7.27	n/c	1
15	5	60	189	113	18	25	22	1.32	1.32	1.32	2
16	8	76	98	85	n.d.	--	--	n.d.	--	--	--
26	1	132	132	n/c	n.d.	--	--	4.55	4.55	n/c	1

Epinephelus guttatus (red hind)

The red hind has a wide geographical distribution throughout the Gulf of Mexico and Caribbean Sea, though no records have been taken off the South American coastline from eastern Colombia to the Guianas. The species is very common throughout the Antilles, according to the Pascagoula records. Kawaguchi reported catches of "hinds" throughout the Antilles, many of which were presumably E. guttatus; and Smith showed the species distributed throughout that area.

The depth range for red hind was 9 - 76 m. Average depths were calculated only for zones 3, 24, and 11, where the values were 57, 60, and 32 m, respectively. No geographical variations in depth distribution were determined.

The temperature range given was 19° to 29°C, but no zone averages could be computed.

The red hind is generally small; however, one specimen recorded from the northeast coast of Florida weighed 14.55 kg. This observation is suspect and may have been an erroneous identification. With that one exception, the size range for E. guttatus from the exploratory files was 0.23 - 2.73 kg. No geographical differences were discernable, and no specific areas of high abundance or availability could be distinguished.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
3	5	45	66	57	n.d.	--	--	1.82	14.55	3.68	4
6	1	60	60	n/c	20	20	n/c	0.91	0.91	n/c	1
7	2	57	66	n/c	19	19	n/c	n.d.	--	--	--
8	1	68	68	n/c	n.d.	--	--	0.91	0.91	n/c	1
9	2	57	60	n/c	n.d.	--	--	0.91	0.91	n/c	1
10	1	11	11	n/c	n.d.	--	--	0.91	0.91	n/c	1
11	3	9	49	32	n.d.	--	--	1.36	1.36	n/c	1
13	2	40	66	n/c	n.d.	--	--	n.d.	--	--	--
20	2	19	47	n/c	n.d.	--	--	0.34	0.34	n/c	1
22	2	17	55	n/c	26	29	n/c	n.d.	--	--	--
23	1	n.d.	--	--	--	--	--	0.45	0.45	n/c	1
24	3	49	76	60	n.d.	--	--	0.23	0.45	0.27	3
25	1	36	36	n/c	n.d.	--	--	2.73	2.73	n/c	1

Epinephelus itajara (jewfish)

The few jewfish recorded were collected by fish trawls during red snapper explorations. The geographical scattering of the data indicated a wide range for the species, extending from the Gulf of Mexico throughout the Caribbean Sea. No captures were made on the U.S. East Coast. The great majority of records came from Campeche Bank (zone 9). Smith reported jewfish from the Georgia coast, Gulf of Mexico, Florida Straits, Cuba, Hispaniola, and Trinidad.

The bathymetric range given was 30 - 95 m, and the only bottom temperatures recorded were 20° and 25°C.

Specimens ranged in size from 4.54 to 181.82 kg. On Campeche Bank the average size was 50.91 kg.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
5	3	30	55	47	20	20	n/c	68.18	181.82	102.27	3
6	1	95	95	n/c	n.d.	--	--	68.18	68.18	n/c	1
9	10	43	57	49	25	25	n/c	4.54	165.91	50.91	6
13	1	85	85	n/c	n/c	n.d.	--	n.d.	--	--	--
16	1	57	57	n/c	n.d.	--	--	136.36	136.36	n/c	1
20	1	n.d.	--	--	n.d.	--	--	6.82	6.82	n/c	1

Epinephelus morio (red grouper)

The red grouper has the widest distribution of all groupers, having been caught from Cape Hatteras to Brazil, including most of the Gulf of Mexico and the Caribbean Sea. No records were found from the Bahamas, Cuba, Jamaica, or Hispaniola, but both Sal'nikov and Smith reported red grouper from Cuba,and Kawaguchi noted that the species was taken from zones 23 and 25. Smith gave a range distribution that compliments the Pascagoula findings. The greatest number of exploratory records came from Campeche Bank, but the incidence of capture indicated the species is very common throughout its range.

The bathymetric range was 8 - 189 m, but the average depth of capture varied considerably among zones. Red grouper occurred at temperatures of 15° to 30°C, but most records were obtained between 19° and 25°C. The data indicated that red grouper from the northeastern coast of South America come from warmer water than those from the U.S. East Coast or Gulf areas.

Individuals taken by exploratory efforts ranged in size from 0.23 to 26.36 kg, though most averaged 1 - 4 kg. Large fish were more common from zones 2 and 3.

Moe (1969) and Rivas (1970b) have provided further details on E. morio, including biological and ecological observations.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
2	6	26	55	47	n.d.	--	--	1.82	13.63	7.05	5
3	24	30	62	42	15	22	19	0.91	26.36	10.14	20
4	3	25	85	45	n.d.	--	--	2.73	3.64	3.06	3
28	4	8	38	25	26	26	n/c	0.91	2.14	1.82	3
5	99	8	85	36	18	30	21	0.23	11.36	1.55	84
6	13	40	170	81	17	23	20	0.45	7.73	2.86	10
7	2	66	83	n/c	19	19	n/c	11.40	11.40	n/c	1
9	144	28	110	93	23	28	25	1.36	8.86	3.27	58
10	1	170	170	n/c	n.d.	--	--	2.64	2.64	n/c	1
11	3	117	142	134	18	18	n/c	3.09	4.55	4.05	3
13	1	19	19	n/c	n.d.	--	--	1.14	1.14	n/c	1
14	1	15	15	n/c	n.d.	--	--	8.64	8.64	n/c	1
15	1	34	34	n/c	n.d.	--	--	8.18	8.18	n/c	1
16	2	57	68	n/c	26	26	n/c	6.59	6.59	n/c	1
17	3	55	72	60	28	28	28	0.45	3.18	1.50	3
24	1	189	189	n/c	n.d.	--	--	11.36	11.36	n/c	1
25	4	23	174	112	n.d.	--	--	3.77	2.14	1.82	4

Epinephelus mystacinus (misty grouper)

Epinephelus mystacinus, like E. morio, is widely distributed along the U.S. East Coast, the Gulf of Mexico, and portions of the Caribbean Sea. No exploratory records were noted for the South American coast, but the species has been taken from the Honduras coast and the Antilles. Smith showed records from Cuba and tentatively from Puerto Rico. The misty grouper does not appear to be as abundant as the red grouper and occurs in deeper water. The bathymetric range for misty grouper was 23 - 355 m, with most records taken in excess of 100 m. Catches from zones 2, 3, and 4 were made in shallower waters than those from the Gulf and Caribbean. The associated temperature data ranged between 11° and 21°C.

Individual E. mystacinus appeared to be larger than E. morio, though the maximum is not as great. The size data for misty grouper ranged between 0.91 and 22.73 kg, and the majority of specimens exceeded 4 kg. No geographical variations in size were noticed.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (^oC)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
2	1	23	23	n/c	n.d.	--	--	22.73	22.73	n/c	1
3	1	51	51	n/c	n.d.	--	--	3.64	3.64	n/c	1
4	1	66	66	n/c	n.d.	--	--	n.d.	--	--	--
7	3	289	355	321	11	12	11	11.36	20.00	17.73	3
10	1	189	189	n/c	n.d.	--	--	3.18	3.18	n/c	1
11	5	181	204	195	18	21	19	0.91	7.73	4.32	3
20	1	284	284	n/c	n.d.	--	--	18.18	18.18	n/c	1
21	1	236	236	n/c	n.d.	--	--	n.d.	--	--	--
24	5	134	189	161	n.d.	--	--	3.64	22.73	10.27	5
25	1	174	174	n/c	n.d.	--	--	9.09	9.09	n/c	1

Epinephelus striatus (Nassau grouper)

The data library contained few E. striatus records; however, as the existing data were derived from various points throughout the region, it may be safe to conclude a wide geographical range for the species. This is supported by the distribution given by Smith, which showed a Caribbean-wide range. Sal'nikov reported E. striatus from Cuba, and Kawaguchi recorded Nassau grouper from zones 23, 24, and 25; both authors supported a wide geographical distribution for E. striatus.

The bathymetric range given was 8 - 62 m. Bottom temperature data were limited (only zone 3 had data). Sizes of captured specimens ranged from 0.91 to 11.36 kg; and averages were not computed, except for zone 3 (6.73 kg).

Zone	Stations (No.)	Depth Range (m)			Temperature Range (oC)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
3	7	36	38	36	20	21	20	4.55	11.36	6.73	5
9	1	51	51	n/c	n.d.	--	--	3.64	3.64	n/c	1
16	1	62	62	n/c	n.d.	--	--	n.d.	--	--	--
20	2	19	38	n/c	n.d.	--	--	0.91	0.91	n/c	1
22	1	8	8	n/c	n.d.	--	--	n.d.	--	--	--

Mycteroperca venenosa (yellowfin grouper)

Yellowfin grouper were taken off the U.S. East Coast, throughout the Gulf of Mexico, off Honduras, in the Bahamas, and near Jamaica. None were reported from the South American coast or from the other Antillean regions. However, M. venenosa was taken by Kawaguchi in zones 23, 24, and 25; and Smith showed records throughout the Antilles, off Colombia, and off Venezuela. The species was captured in greatest quantity off Texas and on Campeche Bank.

The data for M. venenosa showed a bathymetric range of 9 - 284 m, with widely variable averages among zones. Associated bottom temperatures varied from 15° to 26°C. Individuals ranged between 0.23 and 4.55 kg.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (oC)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
3	1	284	284	n/c	n.d.	--	--	n.d.	--	--	--
5	3	9	30	19	n.d.	--	--	1.36	4.55	2.95	3
6	2	95	113	n/c	n.d.	--	--	0.23	0.23	n/c	1
7	6	60	214	106	15	21	18	0.23	4.55	1.55	4
9	4	45	66	53	19	22	n/c	n.d.	--	--	--
11	3	95	151	132	n.d.	--	--	1.81	4.55	3.64	3
20	1	23	23	n/c	n.d.	--	--	1.14	1.14	n/c	1
22	1	55	55	n/c	26	26	n/c	n.d.	--	--	--

Mycteroperca bonaci (black grouper)

Black grouper were taken in zones 2 through 9, 11, and 14. None were captured from the Bahamas, Antilles, or South America from Venezuela eastward. This species was reported to range from Florida to Brazil by Evermann and Marsh (1902), who specifically mentioned Puerto Rican catches. Smith showed a wide Gulf of Mexico and Caribbean Sea distribution. While Kawaguchi did not mention having caught M. bonaci, he did include it in his list of species. The exploratory data suggested black grouper to be primarily a Southeastern United States and Gulf species. The greatest number of specimens came from the Florida west coast and Campeche Bank.

A depth range of 9 - 151 m, with an average near 50 m, was shown; no geographical variations or trends were evident. Bottom temperatures concurrent with M. bonaci records ranged from 16° to 28°C, with averages near 20°C.

Individual size data indicated the species attains a maximum size of at least 29.55 kg. It was rarely taken less than 1 kg; the smallest fish caught weighed 0.45 kg. Average sizes ranged from 2.41 to 16.05 kg, though no geographical trends with regard to size differences were noticed.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
2	24	25	142	47	17	23	18	2.27	18.18	7.14	19
3	18	34	66	47	19	21	20	0.68	27.27	9.41	16
4	6	25	95	55	18	18	n/c	1.36	8.18	2.55	6
28	1	32	32	n/c	n.d.	--	--	n.d.	--	--	--
5	38	9	76	36	21	22	n/c	0.45	20.45	2.41	33
6	12	40	123	72	16	21	19	3.64	20.45	10.36	9
7	17	59	102	83	17	21	19	4.55	11.36	9.59	13
8	1	72	72	n/c	n.d.	--	--	n.d.	--	--	--
9	70	43	104	55	23	28	25	2.73	29.55	6.55	22
11	2	95	151	n/c	n.d.	--	--	11.82	24.55	16.05	3
14	1	38	38	n/c	n.d.	--	--	9.09	9.09	n/c	1

Mycteroperca phenax (scamp)

Scamp is one of the most highly prized food fishes in the Southeastern United States and Gulf of Mexico regions. The exploratory records showed the species was found along the U.S. East Coast, in the Gulf, and along the Guianias coast of South America. Single records came from the Bahamas (zone 20) and the Leeward Islands (zone 25) near Anguilla. The majority of scamp catches were made in zone 2 and on Campeche Bank. Neither Smith nor Kawaguchi reported M. phenax from the Caribbean Sea.

The depth range provided by the data was 15 - 189 m, though most fish were captured in 40 - 80 m. Bottom temperatures ranged from 14° to 28°C with averages between 19° and 23°C. Neither depth range nor temperature range was correlated with geographical distribution. Scamp are not exceptionally large serranids; 21.82 kg was the heaviest taken and 0.23 kg was the smallest. Most zone averages were between 1 and 3 kg. Fish from zones 2 and 3 averaged more than 5.0 kg, in contrast to other areas where the average size was usually less than 2.0 kg.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
2	44	25	66	42	14	23	19	1.82	14.00	8.41	31
3	10	30	63	59	23	24	23	1.36	21.82	5.73	10
4	1	36	36	n/c	n.d.	--	--	1.36	1.36	n/c	1
5	16	25	64	47	n.d.	--	--	0.23	1.82	1.05	15
6	17	21	95	72	16	21	19	0.91	6.82	1.82	13
7	26	57	189	87	16	24	20	0.91	4.32	1.68	23
9	119	42	95	53	23	28	n/c	0.45	4.55	1.64	24
14	1	136	136	n/c	23	23	n/c	7.63	7.63	n/c	1
15	1	189	189	n/c	18	18	n/c	n.d.	--	--	--
16	3	64	87	79	n.d.	--	--	0.91	6.82	2.86	3
20	1	15	15	n/c	n.d.	--	--	1.36	1.36	n/c	1
25	1	174	174	n/c	27	27	n/c	1.36	1.36	n/c	1

Mycteroperca interstitialis (yellowmouth grouper)

The yellowmouth grouper was taken infrequently on the East Coast of the United States, northern Gulf of Mexico, Campeche Bank, and off Puerto Rico (zones 2, 3, 7, 9, and 24). Sal'nikov did not mention this species from Cuba, but Kawaguchi reported M. interstitialis from zones 24 (Puerto Rico) and 16 (Guianas). Smith showed the species occurring off Venezuela, Trinidad, and throughout the Antilles. The majority of our records came from zones 2 and 3.

The data showed a depth range of 25 - 189 m, with a bottom temperature range of 19° to 24°C. Averages for the latter could not be computed. All individuals taken were larger than 3.0 kg, the range was 3.18 - 16.36 kg. Average sizes from zones 2 and 3 were 5.59 and 6.36 kg, respectively.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
2	5	25	76	38	24	24	n/c	3.32	6.82	5.59	3
3	7	34	66	47	19	19	n/c	3.64	7.95	6.36	6
7	2	87	106	96	22	22	n/c	16.36	16.36	n/c	2
9	2	51	98	n/c	23	23	n/c	3.18	3.18	n/c	1
24	1	189	189	n/c	n.d.	--	--	5.45	5.45	n/c	1

<u>Mycteroperca</u> <u>microlepis</u> (gag)

Exploratory data show the gag to be primarily a U.S. East Coast and eastern Gulf of Mexico species, having been taken from neither the western Gulf nor Caribbean regions. Kawaguchi did not include <u>M.</u> <u>microlepis</u> in his Caribbean species list.

Gag had an overall depth range of 11 - 110 m, with zone averages ranging from 25 to 72 m. Few temperature data were available, though a range of 14° to 25°C was recorded.

Individuals ranged in size from 0.45 to 17.27 kg, with the largest specimens coming from the East Coast. Gulf fish averaged less than 4 kg, whereas those from zones 2, 3, and 4 averaged more than 11.0 kg.

Zone	Stations (No.)	Depth Range (m)			Temperature Range (°C)			Size Range (kg/Ind)			Specimens (No.)
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	
2	13	21	70	49	14	25	n/c	2.27	12.73	11.68	12
3	16	28	72	53	18	24	22	4.09	17.27	11.14	15
4	2	40	47	n/c	n.d.	--	--	14.77	14.77	n/c	2
28	3	21	26	25	n.d.	--	--	2.72	2.72	n/c	1
5	8	11	44	32	n.d.	--	--	0.45	3.18	0.91	7
9	6	49	110	72	n.d.	--	--	0.91	7.27	3.41	6

DISCUSSION AND SUMMARY

Of the 18 species of snappers reviewed, at least 7 occurred throughout the southwestern North Atlantic, Gulf of Mexico, and Caribbean Sea: Lutjanus analis, L. buccanella, L. synagris, L. vivanus, Ocyurus chrysurus, Pristipomoides aquilonaris, and Rhomboplites aurorubens. Apsilus dentatus, Lutjanus apodus, and L. griseus may also be distributed regionwide, though voids exist in their distribution records. Neither L. apodus nor L. griseus were taken between Venezuela and Brazil, while A. dentatus was not caught in the eastern Gulf of Mexico off the Colombian and Venezuelan coasts. Etelis oculatus and Lutjanus jocu appear to be Caribbean in distribution. Three species, Lutjanus cyanopterus, L. mahogoni, and Pristipomoides freemani, are too rare to be judged. Pristipomoides macrophthalmus was not recorded from the U.S. East Coast.

Small (less than 1.0 kg) Gulf red snapper, L. campechanus, were readily taken in the northern Gulf of Mexico (zones 6 and 7) during bottom trawl surveys. No apparent seasonal variations occurred in the availability of these snapper, and the data indicated very little monthly difference in the average size captured. There was a significant difference in the average annual size taken between the time periods 1950- 65 and 1966- 75, the latter period producing much smaller fish than the former.

The year-round availability of juvenile red snapper in the northern Gulf of Mexico indicates that they are either fishery recruits or an underutilized resource. Regardless, the regional trawl fisheries (shrimp and bottomfish) must inflict heavy mortality on the stock, as evidenced by the historical trend of decreasing average size per individual. The relationship between the juvenile stock and the stock exploited by the snapper fishery should be investigated, particularly in regard to the production around oil platforms.

The grouper data were incomplete in many instances. In part, this was due to the difficulty in identifying many species, particularly small specimens. Consequently, the data file contains numerous records identified only to the familial or generic level. Since only valid, identified file entries were included, pertinent literature was used to supplement the data where necessary. Despite this support, many species were shown to be disjunctively distributed while, in fact, they may not be.

Most groupers, considering the above stated conditions, were found to be widely distributed throughout the region. Some possible exceptions were the gag, Mycteroperca microlepis, which was not caught south of the Florida Straits, and the rock hind, Epinephelus adscensionis, which was not recorded north of Campeche Bank or the Bahamas. Snowy grouper, E. niveatus, were taken in neither the Bahamas nor the Antilles. Mycteroperca bonaci, the black grouper, was caught only three times in the Caribbean, two of which occurred on the Honduran Shelf.

The red grouper, *E. morio*, was the most commonly occurring species throughout the region and appeared to be very abundant on Campeche Bank and off the west coast of Florida. The availability and average size of this species makes it one of the most commercially valuable groupers.

LITERATURE CITED

Berry, F. H. and S. B. Drummond.
1967. Geographical index to collecting stations of the exploratory fishing vessels OREGON, SILVER BAY, COMBAT, and PELICAN - 1950-65. U.S. Fish Wildl. Serv., Spec. Sci. Rep.-- Fish. No. 558, 25 p.

Bullis, H. R., Jr. and J. R. Thompson.
1959. Shrimp exploration by the M/V OREGON along the northeast coast of South America. Commer. Fish. Rev. 21 (11): 1-9.

Captiva, F. J. and J. B. Rivers.
1960. Development and use of otter-trawling gear for red snapper fishing in the Gulf of Mexico, June 1957- May 1959. Commer. Fish. Rev. 22(10): 1-14.

Carpenter, J. S.
1965. A review of the Gulf of Mexico red snapper fishery. U.S. Dep. Inter., Fish Wildl. Serv., Circ. 208, 35 p.

Carpenter, J. S. and W. R. Nelson.
1971. Fishery potential for snapper and grouper in the Caribbean area and the Guianas. In Symposium on Investigations and Resources of the Caribbean Sea and Adjacent Regions, p. 21-26. FAO, Fish. Rep. 71.2.

Cummins, R., Jr., J. B. Rivers, and P. J. Struhsaker.
1962a. Exploratory fishing off the coast of North Carolina, September 1959- July 1960. Commer. Fish. Rev. 24(1): 1-9.

____________________. 1962b. Snapper trawling explorations along the southeastern coast of the United States. Commer. Fish. Rev. 24(12): 1-7.

Evermann, B. W. and M. C. Marsh.
1902. The fishes of Porto Rico. Bull. U.S. Fish. Comm. 20: 49-350.

Kawaguchi, K.
1974. Handline and longline fishing explorations for snapper and related species in the Caribbean and adjacent waters. Mar. Fish. Rev. 36(9): 8-31.

Moe, M. A., Jr.
1969. Biology of the red grouper, *Epinephelus morio* (Valenciennes) from the eastern Gulf of Mexico. Fla. Dep. Nat. Resour., Mar. Res. Lab., Prof. Pap. Ser. No. 10, 95 p.

Nelson, W. R. and J. S. Carpenter.
1968. Bottom longline explorations in the Gulf of Mexico - A report on "OREGON II's" first cruise. Commer. Fish. Rev. 30(10): 57-62.

Rathjen, W. F.
1959. Experimental trawling for red snapper. Proc. 11th Annu. Sess., Gulf Caribb. Fish. Inst., p. 128-132.

Rivas, L. R.
1966. Review of the Lutjanus campechanus complex of red snappers. Q. J. Fla.Acad. Sci. 29(2): 117-136.

__________.
1970a. Snappers of the western Atlantic. Commer. Fish. Rev. 32(1): 41-44.

__________.
1970b. The red grouper of the Gulf of Mexico. Commer. Fish. Rev. 32 (10): 24-30.

Sal'nikov, N. E.
1965. Fishery research in the Gulf of Mexico and the Caribbean Sea. In A. S. Bogdanov (editor), Soviet-Cuban fishery research. All-Union Res. Inst. Mar. Fish. Oceanogr., Fish. Res. Cent. Natl. Piscicultural Inst. Republ. Cuba, p. 78-171. (Translated by Israel Program Sci. Transl., 1969).

Smith, C. L.
1961. Synopsis of biological data on groupers (Epinephelus and allied genera) of the western North Atlantic. FAO Fish. Biol. Synop. No. 23, 61 p.

Springer, S. and H. R. Bullis, Jr.
1956. Collections by the OREGON in the Gulf of Mexico. U.S. Fish Wildl. Serv., Spec. Sci. Rep.--Fish. No. 196, 134 p.

Struhsaker, P.
1969. Demersal fish resources: composition, distribution, and commercial potential of the Continental Shelf stocks off southeastern United States. Fish. Ind. Res. 4(7): 261-300.

AGE, GROWTH, AND REPRODUCTION OF RED SNAPPER IN FLORIDA WATERS 1/

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ABSTRACT

Investigations of the life history of red snapper, *Lutjanus campechanus*, were conducted in the Gulf of Mexico off the west coast of Florida from 1972 to 1975. Catches from party boats fishing west of Clearwater Beach, Fla. at depths of 15-30 fathoms were sampled regularly.

Two hundred and forty fish were used in age and growth analyses. Ages, derived from otolith examination, ranged from 1 to 5 years, but ages greater than 20 years can be expected. Annuli are formed on otoliths at a time coinciding with spawning season. Sexual dimorphism is not apparent in the length-weight relationship, and the equation for this relationship is Log W = 2.99420 Log FL - 4.77239. Back-calculated fork lengths are consistent with data from tagging and other studies.

Red snapper are opportunistic, polyphagous feeders, often consuming items not associated with reef-type environments.

Sexual maturity is reached at 2+ years, and spawning occurs from July through October. Spawning apparently does not occur within our study area.

Data on the fishery are presented and show that a large proportion of immature fish are being caught.

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INTRODUCTION

The red snapper, Lutjanus campechanus (Poey), has been the object of an intense commercial fishery in the Gulf of Mexico for over a century. In addition, the number of party boats and sport fishermen seeking this highly regarded food fish have increased in recent years. Declines in commercial production have caused concern about the status of this valuable resource since at least 1935. Since 1965, a record year for landings in Florida and the Gulf States, commercial production has decreased over 35% (Fig. 1).

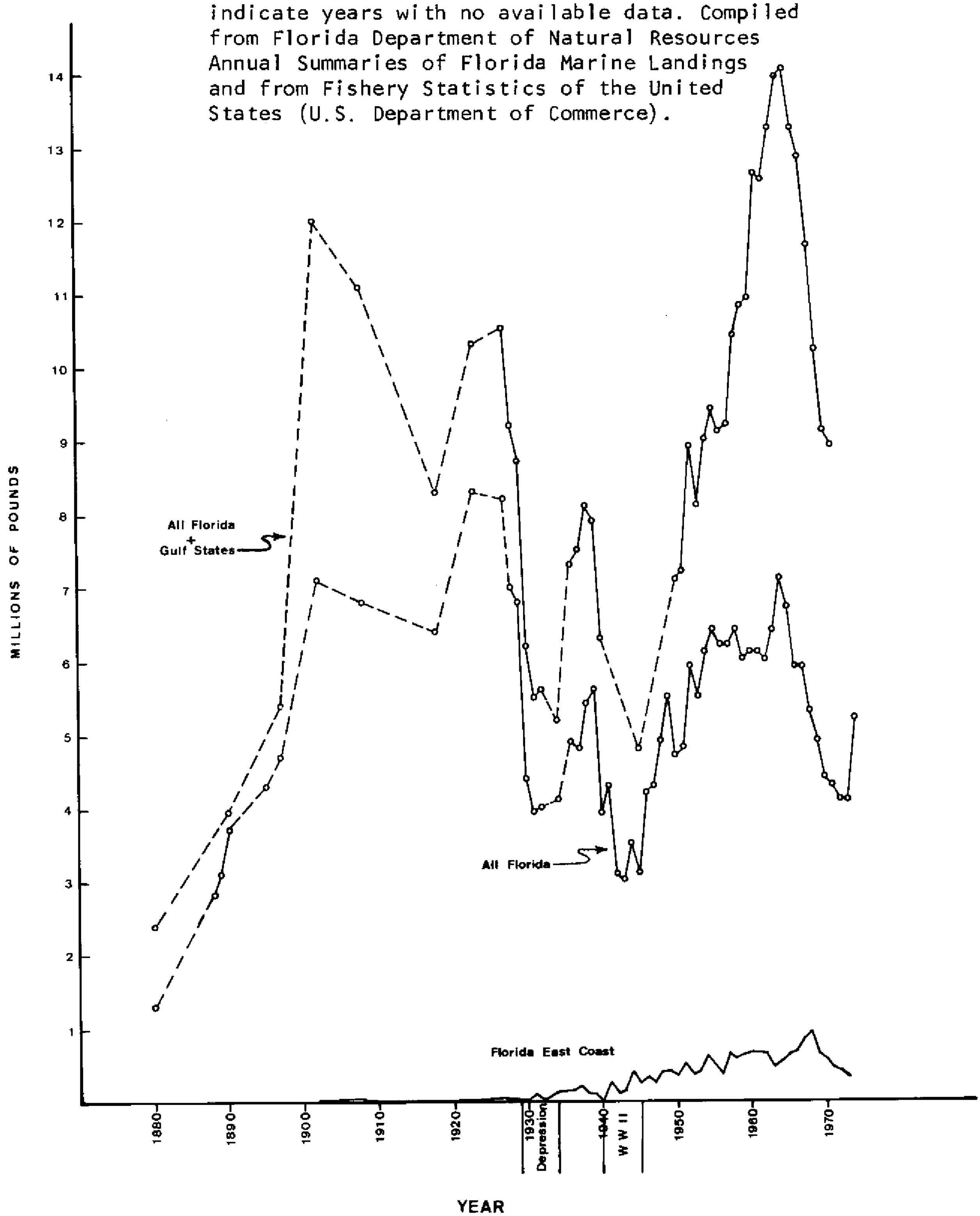
Although literature concerning red snapper is abundant, little emphasis has been placed on the life history and biology of this species until recent years. Most papers have dealt with the fishery, which has remained virtually unchanged for 100 years, and with methods for increasing its efficiency. Other papers presented at this Colloquium will provide more extensive data on the present fishery.

Camber (1955) presented limited data on length-weight relationships, size at maturity, sex ratios, food habits, and spawning of red snapper from Campeche Bank. Dawson (1963) calculated length-weight relationships of juvenile red snapper from the northern Gulf of Mexico. Limited data on snapper movement and growth, deduced from tag returns, were given by Topp (1963), Beaumariage (1964, 1969), Beaumariage and Wittich (1966), and Moe (1966). Perhaps the most extensive biological work has been done by Moseley (1965, 1966) and Bradley and Bryan (1973) along the Texas coast. However, few biological data are available for Florida stocks, which support the largest red snapper fishery among the Gulf States (Fig. 1). Therefore, the Florida Department of Natural Resources Marine Research Laboratory (FDNR/MRL) initiated a program in September 1972 to evaluate age, growth, reproduction, and food habits of a portion of Florida's red snapper stocks.

METHODS AND MATERIALS

At the outset of this program, we randomly sampled catches from party boats fishing an area west of Clearwater Beach, Fla. (Fig. 2). During the first 16 months, we were able to collect only the carcasses of filleted fish. In 1974 we weighed and measured whole fish, as well as collected their carcasses. Reproductive data were evaluated for all fish, unless otherwise indicated; age and growth data are presented only for whole fish. From all whole fish we measured standard, fork, and total lengths (SL, FL, TL) in millimeters (mm) according to Lagler's (1952) methods. Weights were measured to the nearest 5 grams (g). Otoliths, gonads, and stomachs were excised and retained for analyses. Otoliths used for age evaluations were washed in water and stored in glycerin from the time of collection until evaluation. All otolith radii were measured from the kernel point to the most posterior point of the otolith. They were read once by each investigator and a third time by joint effort to resolve previous discrepancies. Any otolith readings not agreed upon by both investigators were not used in further analyses. One reading was made approximately 6 months before the second reading; the joint reading was made 1 year after the first. We found that greatest clarity was achieved when otoliths were stored for at least 1 year, preferably longer. Gonads were fixed whole, most in Davidson's fixative and some in Bouin's

Figure 1. Commercial red snapper landings 1880-1974. Broken lines indicate years with no available data. Compiled from Florida Department of Natural Resources Annual Summaries of Florida Marine Landings and from Fishery Statistics of the United States (U.S. Department of Commerce).



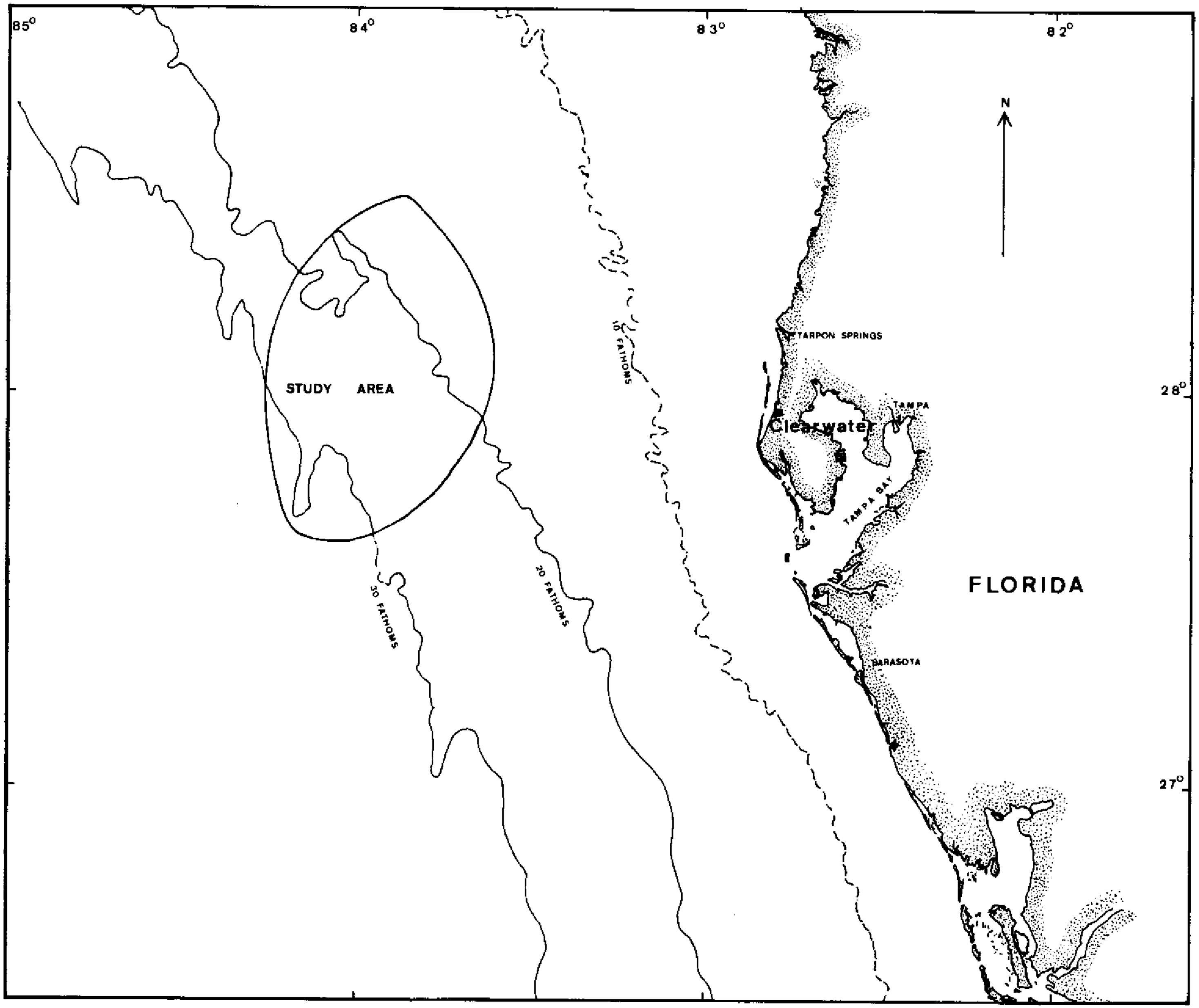


Fig. 2. Study area off west coast of Florida frequented by Clearwater Beach party boat fishery.

fixative. Midsection pieces were dehydrated, cleared, embedded in paraffin, sectioned at 6 micrometers (μm), and stained with Harris hematoxylin/eosin Y. Analysis of reproductive status follows Moe (1969), except for our grouping of immature and resting stages. In addition, we designated a category for "ripe" gonads, indicated by the presence of mature oocytes.

RESULTS AND DISCUSSION

AGE AND GROWTH

Of 240 sets of otoliths examined, 200 sets (83.3%) were readable, and agreement could not be reached on the remainder (16.7%). To demonstrate proportionality between otolith radius and fork length, a regression line was fitted to the 240 data pairs. This relationship is given by the equation $Y = 8.3187\ X - 67.0435$, where Y is FL and X is otolith radius in ocular micrometer units (1 omu = 0.0815 mm). The calculated correlation coefficient is sufficiently high ($r = 0.9047$) to demonstrate proportionality between the variables (otolith radius range, 35-78 omu).

From 200 legible sets of otoliths, we aged snapper from I to V years. We collected fish considerably larger and presumably older, but their otoliths were illegible.

The formation of annuli on hard parts of fish at a specific time of year is a criterion that must be satisfied before an aging technique is considered valid (Van Oosten, 1929). Hypotheses concerning annulus formation in fishes inhabiting tropical waters are varied (Chevey, 1933; Menon, 1953; Voss, 1953, Voss, 1954; Clancey, 1956; de Sylva, 1963; Beardsley, 1967; Moe, 1969; Beaumariage, 1973; Bruger, 1974). Although data were limited, Moseley concluded that red snapper formed annuli during the spawning season.

Marginal increments on aging structures have been widely used to show time of annulus formation in many fishes (Tabb, 1961; de Sylva, 1963; Moe, 1969; Beaumariage, 1973). Table 1 presents these data for red snapper collected during 1974 and shows that snapper form annuli from June to October, a time coinciding with their spawning season. However, spawning would not account for annulus formation in age I fish, which are apparently still immature (see Reproduction section).

Table 2 presents back-calculated fork lengths of ages I-V derived from 200 sets of otolith readings. Lengths were calculated using the direct proportion method described by Van Oosten (1929) and the equation $Fl_a = \frac{R_a(FL_c)}{R_c}$, where FL_a = calculated fork length at any year, R_a = otolith radius to any annulus, FL_c = fork length at capture, and R_c = otolith radius at capture. There is a wide range of size within a particular age. This has also been observed in length frequency-age data by Moseley (1965) and can be expected for a fish which has a protracted spawning season.

Analyses of L. campechanus (Moseley, 1965) and its closely allied congener L. purpureus Poey (Menezes and Gesteira, 1974) indicate that the

Table 1. Monthly Marginal Increments from Red Snapper Otoliths.

Month	Number	Mean Increment (omu)	Range (omu)	Standard Deviation (omu)
Jan.	32	11.47	6-17	3.62
Feb.	19	9.53	6-16	3.39
Mar.	20	10.50	5-20	3.33
Apr.	18	11.56	6-18	4.30
May	16	10.44	6-15	2.87
June	14	7.07	0-18	5.40
July	16	2.44	0-15	4.43
Aug.	11	3.55	0-11	3.45
Sept.	5	2.80	0- 5	2.17
Oct.	17	2.82	0-11	2.79
Nov.	14	5.00	3-14	1.52
Dec.	5	7.25	5-11	2.87

Table 2. Back-calculated Fork Lengths of Red Snapper, Ages I through V.

Age	Mean FL at Capture (mm)	Number	Annulus I (mm)	II	III	IV	V
I	242	6	200				
II	389	83	147	306			
III	415	83	130	286	373		
IV	459	27	129	285	375	444	
V	523	1	112	291	366	441	516
Number of back-calculations		200	200	194	111	28	1
Grand mean back-calculated fork length (mm)			139	294	373	444	516
Average annual increment (mm)			139	155	79	71	72
Range of back-calculated fork lengths (mm)			79-250	218-396	255-493	373-558	
Standard deviation (mm)			33.3	34.1	37.3	48.4	

first annulus does not form until maturity and spawning, at an age of 2+ years. However, both studies were based on ages obtained from scale readings. Growth rate data reported by Moseley (1965), Bradley and Bryan (1973), and unpublished data cited by Bradley and Bryan suggest that mean growth during the first year is approximately 200 mm SL. This compares favorably with our back-calculated data (Table 2).

Ontogenetic and seasonal inshore-offshore movement (Moseley, 1965) and non-random sampling (caused by hook size) may have contributed to "Rosa Lee's phenomenon" (Tesch, 1968) apparent in our back-calculated data. Fishing is done offshore, and uniform hook size is probably selective for the faster growing, age I fish; slower growing, smaller fish either are not in the same area or simply cannot bite the hook. As these fish are recruited into the fishery, they create a wide size range within age groups, thus inducing "Rosa Lee's phenomenon." Despite the fact that this factor is apparent in our back-calculations, we feel that the aforementioned growth rates, from other studies and from our work, show that an age I fish (with annulus) will be approximately 200 mm.

Our calculated annual increments between ages II and V are consistent with data from tag returns and with data from Moseley (1965) and Bradley and Bryan (1973).

Data from red snapper returns compiled from Topp (1963), Beaumariage (1964, 1969), and Beaumariage and Wittich (1966) yield a mean annual growth of 78.0 mm TL and 62.6 mm SL for fish 205-419 mm SL at time of release. In addition, we have one return of a snapper at liberty 1 day less than 10 years (Table 3). Growth averaged 44.4 mm TL per year; a large portion of this growth probably occurred in the first 3 or 4 years following release.

Table 3. Data for One Long-Term Red Snapper Tag Recovery.

	Date	SL (mm)	TL (mm)
Release	20 July 1962	238	291
Recapture	19 July 1972	620	735
Total growth		382	444
Mean growth per year		38.2	44.4

Length-weight relationships were calculated from 240 fish ranging from 228 to 676 mm FL (8.98-26.61 inches) and from 495 to 5175 g (1.09-11.41 lb). Ninety-five males, 118 females, and 27 fish of undetermined sex were used in the calculations. Sexes were considered separately to evaluate possible dimorphism. The equations are:

Males: $W=1.54728\times10^{-5}FL^{3.00777}$ or $\text{Log } W=3.00777 \text{ Log } FL - 4.81043$;

Females: $W=1.37477\times10^{-5}FL^{3.02834}$ or $\text{Log } W=3.02834 \text{ Log } FL - 4.86177$.

At the $\alpha = 0.05$ level, there was no significant difference between males and females (Table 4). Therefore, sexes were combined and this relationship can be expressed by the equation $W = 1.68892\times10^{-5}FL^{2.99420}$ or $\text{Log } W = 2.99420 \text{ Log } FL - 4.77239$ (Fig. 3) for fish ranging from 200 to 676 mm FL.

Table 4. Statistical Comparison of Male and Female Red Snapper Length-Weight Regression Lines.

Residual variances:		26187.1933 Males 24279.1866 Females
$F_{.05}$	(calculated) 98,116 df = 1.0786 n.s. (tabulated) 120,120 df = 1.43 1/	
Slopes (b)	Males:	3.00777
	Females:	3.02834
$t_{.05}$	(calculated) ∞ df = 0.17219 n.s. (tabulated) ∞ df = 1.96	
Elevations:		
$F_{.05}$	(calculated) 1,210 df = 0.1688 n.s. (tabulated) 1, ∞ df = 3.84	

1/ Two-tailed F-test from Snedecor and Cochran (1967).

Table 5. Comparison of Length-Weight Relationships of Red Snapper Less Than 300 mm.

Camber (1955)		Dawson (1963)	Futch/Bruger
Juvenile $W=1.614 \times 10^{-5} FL^{3.01}$	Adult $W=2.98 \times 10^{-5} FL^{2.917}$	Juvenile $W=1.1715 \times 10^{-4} TL^{2.6051}$	All $W=1.6889 \times 10^{-5} FL^{2.9942}$
	g		
0.26		0.51	0.26
2.10		3.12	2.06
7.11		8.98	6.95
16.90		19.01	16.40
33.08		33.99	32.08
57.27		54.66	55.37
91.09	104.03	81.67	87.84
136.15	153.58	115.65	131.02
	216.54	157.19	186.43
	294.45	206.83	255.57
	388.82	265.12	339.98
	501.16	332.58	441.16

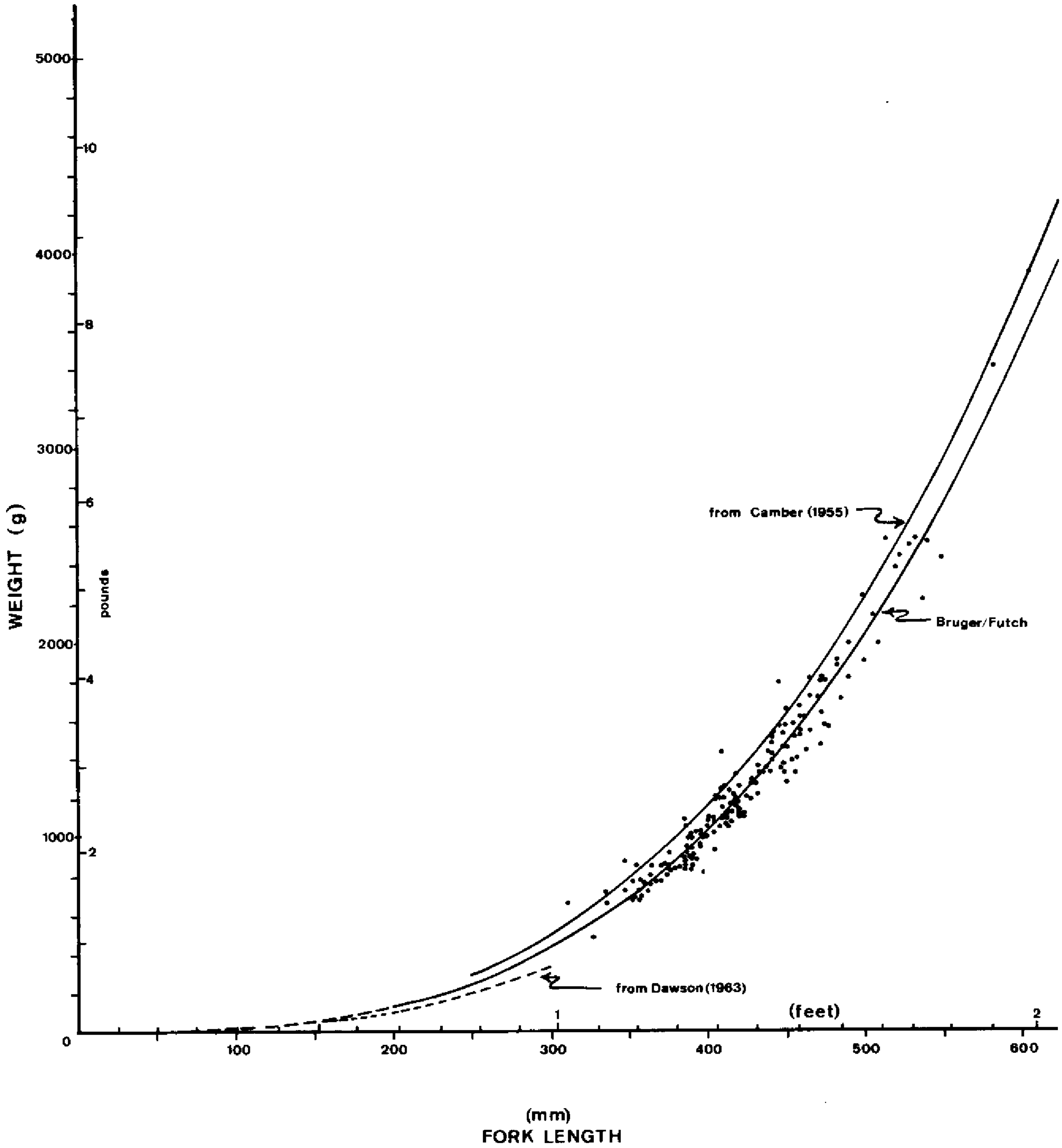


Figure 3. Length-weight relationship of 240 red snapper collected in the present study, compared with data from Camber (1955) and Dawson (1963).

Camber's (1955) length-weight relationships for fish between 290 and 750 mm FL produce higher weights for a given length than does our equation (Fig. 3). However, Camber sampled fish primarily from Campeche Bank.

Camber (1955) also presented a length-weight relationship for juvenile red snapper of 90-190 mm FL and Dawson (1963) gave a relationship for 252 juveniles from the northern Gulf, ranging from 37 to 354 mm TL (only 31 specimens were larger than 155 mm TL). These data, when compared with an extrapolation of our length-weight relationship to include fish less than 200 mm FL, are similar (Table 5) up to approximately 150 mm, where weights from Camber's and Dawson's equations begin to diverge. Both Camber and Dawson felt that a change in growth rate occurred when fish reached 155 mm TL and 160 mm FL, respectively. Our equation may, therefore, be more representative of snapper growth over a greater size range.

The relationships of standard to fork and fork to total lengths are highly correlated and can be expressed by the equations:

$$FL = 1.1585\ SL + 13.2697\ (r = 0.9981,\ N = 21) \text{ and}$$
$$TL = 1.0678\ FL + 3.4637\ (r = 0.9975,\ N = 100).$$

FOOD HABITS

Moseley (1965) and Bradley and Bryan (1973) gave excellent accounts of food habits of juvenile and adult red snapper from the northwestern Gulf of Mexico.

Previous studies of red snapper food habits have been hampered by stomach eversion when fish ascend from the depths (Stearns, 1884; Adams and Kendall, 1891; Camber, 1955; Moseley, 1965; Bradley and Bryan, 1973). This was also evident in our study, as 117 of 213 stomachs examined were empty or everted. Table 6 lists items found in stomachs. Forty of 96 stomachs with food contained only bait. Fish and squid bait were equally represented (26 contained one or the other, exclusively, and 14 contained both), indicating that snapper have no preference for either bait.

Camber (1955), Moseley (1965), and Bradley and Bryan (1973) found that fish constituted a majority of the adult snapper diet. Although invertebrates were represented slightly more than fish in our samples, this was probably due to fish being more thoroughly digested before stomachs were examined. Dietary items varied, indicating that red snapper are polyphagous and opportunistic (Moseley, 1965; Bradley and Bryan, 1973). Most invertebrates encountered are sand-shell dwellers (Williams, 1965; Lyons, 1970; D. K. Camp, pers. comm. 3/). One hemichordate worm encountered is probably of the class Enteropneusta, described by Barnes (1968) as shallow water inhabitants, some living under

3/ David K. Camp, Florida Department of Natural Resources, Marine Research Laboratory, St. Petersburg, FL 33701, pers. comm.

Table 6. Items Found in the Stomachs of Red Snapper.

Item	Number
Mollusca	
Gastropoda	
Tonnidae	
Tonna galea (Linne)	1 1/
Pelecypoda	
Cardiidae	
Laevicardium pictum (Ravenel)	1 2/
Arthropoda	
Crustacea	12
Stomatopoda	3
Squillidae	
Squilla deceptrix Manning	3
Squilla rugosa Bigelow	1
Decapoda	
Penaeidae	
Trachypeneus similis (Smith)	1
Alpheidae	2
Palinuridae	
Scyllarus chacei Holthuis	1
Leucosiidae	
Iliacantha intermedia Miers	1
Raninidae	
Raninoides sp.	1
Majidae	3
Portunidae	4
Portunus sp.	1
Goneplacidae	
Prionoplax atlantica Kendall	1
Hemichordata	1
Chordata	
Vertebrata	
Anguilliformes	
Ophichthidae	1
Clupeiformes	
Clupeidae	2
Gasterosteiformes	
Syngnathidae	1
Periciformes	
Serranidae	
Diplectrum formosum (Linne)	2
Fish remains	26
Fish bait only	13
Squid bait only	13
Both fish and squid bait only	14
Unidentifiable remains	3

1/ Larval stage.
2/ In gullet of fish with everted stomach.

stones and shells, but many common species burrowing in mud and sand. Presence of the larva of the gastropod Tonna galea suggests water-column feeding. None of the food organisms encountered are obligate rock dwellers, though party boat captains fish primarily on rock ledges or other areas of high relief. One captain noted, however, that a "sand bar" with a "show" of fish on the fathometer almost always yielded snapper.

Most accounts classifying snapper habitats have emphasized hard, rocky bottoms or reefs. Smiley (1885:92) quoted Mr. Silas Stearns of Pensacola, Fla. as saying, "In any part of the northern Gulf of Mexico where there is a rock coral or gravel there is a certainty of there being red snappers. Sometimes there are kinds of food on shelly bottoms which attract the snappers." Jarvis (1935) indicated that snapper are only caught in narrowly restricted areas of favorable bottom, usually depressions or gullies on coral or rock bottoms. He attributed this restriction to the fact that food material for snappers (mainly crustaceans and small fishes) settles more abundantly in these spots than in surrounding areas. Camber (1955:28) reported that most animals found in snapper stomachs inhabit coral reefs "...where red snappers presumably feed." Other researchers (Moe, 1963; Carpenter, 1965) mentioned that hard bottoms and rocky reefs are primary habitats, with areas of high relief producing the best catches; but fishermen also reported catches of snappers from areas of mud and sand bottoms. Moseley (1965:19) cited several reports of stomach contents, noting that many food organisms are sand dwellers. He concluded, "...red snappers are probably not as confined to reefs or rocky areas as previously believed." Sand and shell or mud bottoms typified 8 of 12 locations where snappers were caught off southwest Florida (Adams and Kendall, 1891). G. B. Smith (pers. comm.) 4/ noted while SCUBA diving that red snapper congregate over rocky bottom, but will feed up to 500-1000 ft away, thereby explaining the presence of sand-shell dwellers in snapper diets.

REPRODUCTION

Slides of 559 gonads were analyzed (results are summarized in Figures 4 and 5), gonadal activity presented in Table 7 was derived from examining the tissue from only those whole fish contributing legible otoliths to the age analysis. Spawning appears to occur from July through October, with a peak in August-September. Males show considerably more gonadal maturation during a greater part of the year than females. Spawning, therefore, must be coincident with the time that females are in ripe condition, July through October (Fig. 5). Ripe females are more indicative of spawning time than spent females, since the spent state may persist for several weeks after actual spawning. Adams and Kendall (1891) found no developing gonads between 15 February and 10 April off southwest Florida. Jarvis (1935) dressed 100 red snapper from Campeche Bank on 3 November and found partially developed milt or roe in each. Snapper from Campeche Bank purportedly spawn between early July and mid-September, with a peak in July-August (Camber, 1955). Moseley

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4/ Gregory B. Smith, Florida Department of Natural Resources, Marine Research Laboratory, St. Petersburg, FL 33701, pers. comm.

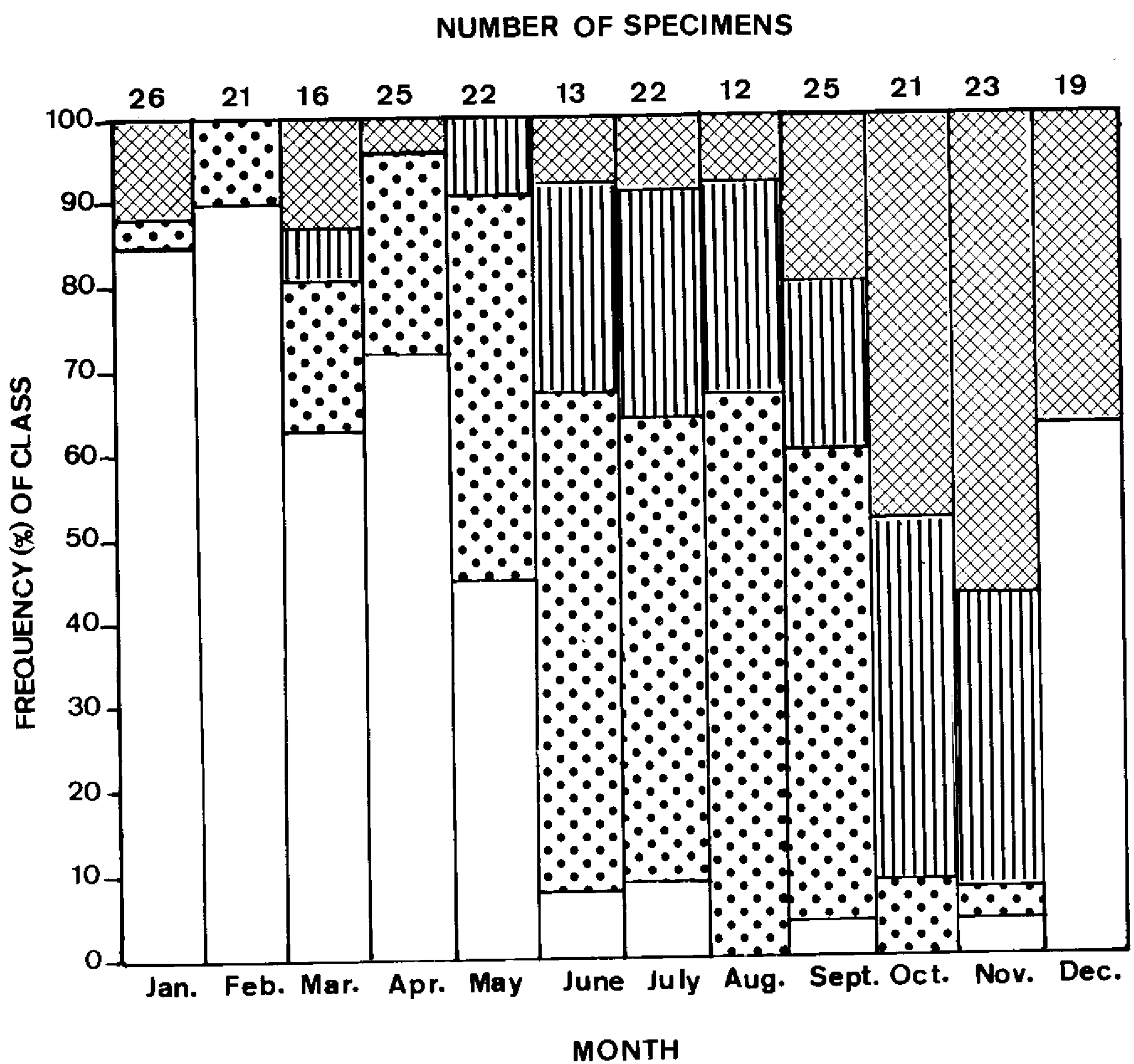

Fig. 4. Monthly gonadal state of male red snapper. White: resting or immature. Dots: active (developing). Lines: ripe. Cross-hatched: spent.

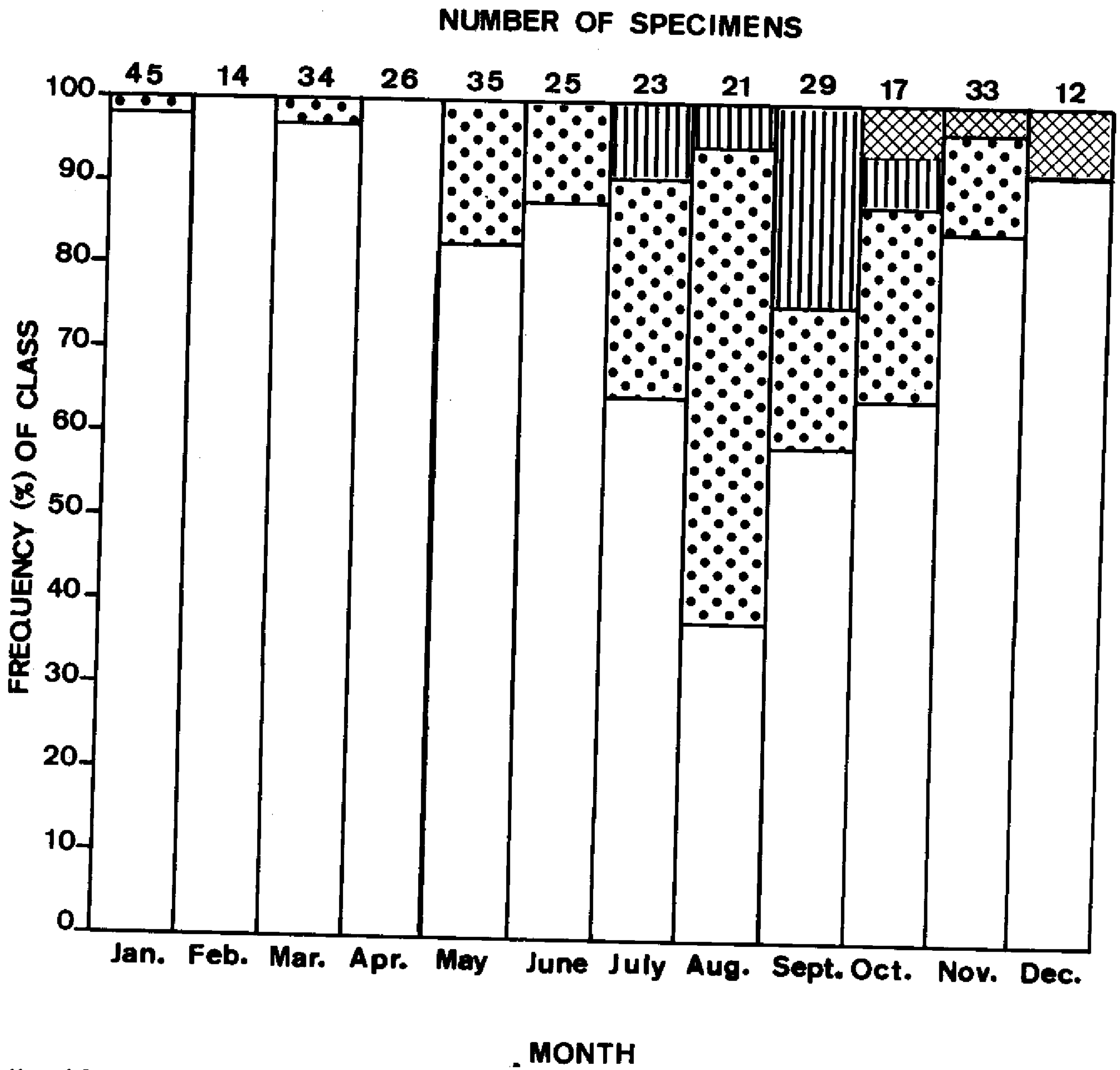

Fig. 5. Monthly gonadal state of female red snapper. White: resting or immature. Dots: active (developing). Lines: ripe. Cross-hatched: spent.

Table 7. Gonadal Activity of Red Snapper at Each Age 1/

Age	Sex	Number	Gonadal Condition: Resting	Active 2/	Ripe	Spent
I	Male	2	2			
II	Male	34	18	8	1	7
	Female	47	41	6		
III	Male	39	15	15	6	3
	Female	44	30	9	3	2
IV	Male	10	2		7	1
	Female	17	8	6	2	1
V	Male	1		1		

1/ Six fish which were accurately aged could not be used in analysis.
2/ "Active" (Moe, 1969) refers to developing gonads.

(1965) reported that snapper spawn off Texas from early June through mid-September. Yet, Bradley and Bryan (1973) believed that the presence of small snapper (34-70 mm SL) off Texas in January, March, June through October, and December suggests a more protracted spawning season. In May, June, July, September, and November, they noted snapper gonads were developing, most ripening in June and July and a lesser number ripening in November. Baughman (1943:214) noted a large female L. blackfordii (=L. campechanus) "full of partly developed spawn" caught off Texas on 3 May.

Paucity of age I individuals and preponderance of individuals ages II-V in resting condition make it difficult to determine exact age of maturity. Nevertheless, an increase in gonadal activity of age III fish, compared to age II fish (Table 7), indicates that maturity is probably reached after the second year (ageII+). The 194 individuals presented in Table 7 appear to be representative, with regard to gonadal development, of all individuals shown in Figures 4 and 5. This estimate of maturity compares favorably with Camber's (1955) conclusion that maturity is attained at approximately 300-320 mm FL and with Moseley's (1965) statement that a sudden change in condition factor at 190-300 mm SL reflects attainment of sexual maturity. In addition, Moseley's (1965) work on L. campechanus and that by Menezes and Gesteira (1974) on the closely allied species, L. purpureus Poey, substantiate the age of maturity and first spawning as 2+ years.

Reports of definite spawning locations of red snapper are few. Moe (1963) described two areas south of Panama City, Fla. in 13-16 fathoms where snapper formed large schools and, when caught, released eggs or milt on the deck without external pressure. These areas had been fished for only a few years, so little was known about the frequency of this occurrence. Moseley (1965) hypothesized that red snapper utilize similar areas off Texas. The intense fishing pressure of the Clearwater Beach party boats which fish inshore of 30 fathoms and the scarcity of active (developing) and ripe females in our collection indicate that red snapper do not spawn in the area we studied.

The histological examination to which the gonadal tissue was subjected in our study is a more precise technique than the gross examination or condition factor used by other authors. Our study was concentrated in an area which has not been of classical concern; however, the results of our work compare favorably with those conducted in other areas.

THE FISHERY

Ten major processors of red snapper from Sarasota to Port Richey, Fla., were contacted to determine the approximate number of commercial snapper boats now engaged in the fishery in this area. There are a minimum of 116 boats from Sarasota, Manatee, Pinellas, and Pasco Counties now fishing between the Dry Tortugas and Panama City at depths of 10-100 fathoms. Moe (1963) reported only 61 boats in these counties; therefore, the number of commercial boats has increased by at least 90% in 12 years. During this period,the exboat price of snapper has increased at least 300% (Carpenter, 1965,and personal observation).

Methods of fishing have not changed appreciably since Moe's (1963) excellent account.

Sarasota, St. Petersburg, and Clearwater all have party boat fisheries approximately the same size as reported by Moe (1963). Newer boats, however, are larger, faster, and capable of fishing productive areas farther offshore.

The large increase in the number of private boats capable of traveling the distances required to catch snapper has created an additional pressure on the resources. The number of private boats that actually do fish for snapper is not known, but many sport-caught fish end up on the commercial market (personal observations).

SUMMARY AND CONCLUSIONS

(1) Commercial red snapper production has declined, especially since the peak-production year of 1965, despite constant or increased effort.

(2) Increased pressure by the sport fishery (party boat and private) is evident. The magnitude of this pressure is not known. Therefore, the decline in commercial production may be due in part to competition from sport fishermen, even though some percentage of the sport catch reaches the commercial market.

(3) A large proportion of the total red snapper production (commercial and sport) consists of fish which have not reached sexual maturity and,

therefore, cannot perpetuate the species. Further evaluation of this finding is recommended and,if necessary, appropriate measures should be taken to insure continued availability of this resource.

(4) Examination of 240 otolith pairs produced 200 sets (83.3%) suitable for age and growth evaluations. Ages I-V are represented; otoloths from older fish were not legible. However, tag returns and infrequent examples of exceptionally large fish indicate that ages greater than 20 years may be attained.

(5) Annuli are formed yearly at a time coinciding with spawning season. Other factors may also influence annulus formation; therefore, a cause and effect relationship is not implied. Proportional growth between otolith radius and fish length is apparent.

(6) Back-calculated growth rates computed for ages I-V are consistent with estimates from tagging and other studies.

(7) The equation $W = 1.68892\text{x}10^{-5}FL^{2.99420}$ expresses the length-weight relationship of red snapper. No sexual dimorphism was evident.

(8) Red snapper are opportunistic, polyphagous feeders, often foraging up to 1,000 ft away from reefs and consuming food items not associated with a reef-type environment.

(9) Spawning occurs from July through October, with a peak in August-September. There is no evidence that fish spawn within the study area; therefore, a spawning migration is indicated.

(10) Our work and that of other authors indicate that sexual maturity is reached at an age of 2+ years.

LITERATURE CITED

Adams, A. C. and W. C. Kendall.
1891. Report upon an investigation of the fishing grounds off the west coast of Florida. Bull. U. S. Fish. Comm. 9:289-312.

Barnes, R. D.
1968. Invertebrate zoology. 2nd Edition. W. B. Saunders Co., Philadelphia, 743 p.

Baughman, J. L.
1943. The Lutianid fishes of Texas. Copeia 1943:212-215.

Beardsley, G. L., Jr.
1967. Age, growth, and reproduction of the dolphin, *Coryphaena hippurus*, in the Straits of Florida. Copeia 1967:441-451.

Beaumariage, D. S.
1964. Returns from the 1963 Schlitz tagging program. Fla. Board Conserv. Mar. Lab., Tech. Ser. No. 43, 34 p.

__________.
1969. Returns from the 1965 Schlitz tagging program, including a cumulative analysis of previous results. Fla. Dep. Nat. Resour., Mar. Res. Lab., Tech. Ser. No. 59, 38 p.

__________.
1973. Age, growth, and reproduction of king mackeral, *Scomberomorus cavalla*, in Florida. Fla. Mar. Res. Pulb. No. 1, 45 p.

Beaumariage, D. S. and A. C. Wittich.
1966. Returns from the 1964 Schlitz tagging program. Fla. Board Conserv. Mar. Lab., Tech. Ser. No. 47, 50 p.

Bradley, E. and C. E. Bryan, III.
1973. Northwestern Gulf of Mexico marine fisheries investigation--Study No. 2, 1970-1973. Project No. 2-109-R, U. S. Dep. Commer., NOAA,NMFS, St. Petersburg, Fla., 134 p.

Bruger, G. E.
1974. Age, growth, food habits, and reproduction of bonefish, *Albula vulpes*, in south Florida waters. Fla. Mar. Res. Publ. No. 3, 20 p.

Camber, C. I.
1955. A survey of the red snapper fishery of the Gulf of Mexico, with special reference to the Campeche Banks. Fla. State Board Conserv., Tech. Ser. No. 12, 64 p.

Carpenter, J. S.
1965. A review of the Gulf of Mexico red snapper fishery. U. S. Dep. Inter., Fish Wildl. Serv., Circ. 208, 35 p.

Chevey, P.
1933. The method of reading scales and the fish of the intertropical zone. Pac. Sci.Congr. Proc. 5:3817-3829.

Clancey, J.F.
1956. A contribution to the life history of the fish, Bregmaceros atlanticus Goode and Bean, from the Florida current. Bull. Mar. Sci. Gulf Caribb. 6:233-260.

Dawson, C. E.
1963. Length and weight relationships of young red snappers from the northern Gulf of Mexico. Trans. Am. Fish. Soc. 92(3):310-311.

de Sylva, D. P.
1963. Systematics and life history of the great barracuda, Sphyraena barracuda (Walbaum). Stud. Trop. Oceanogr. (Miami) 1:128-179.

Jarvis, N. D.
1935. Fishery for red snappers and groupers in the Gulf of Mexico. U. S. Dep. Commer., Bur. Fish., Invest. Rep. 26, 29 p.

Lagler, K. F.
1952. Freshwater fishery biology. Wm. C. Brown Co., Dubuque, 360 p.

Lyons, W. G.
1970. Memoirs of the Hourglass Cruises: Scyllarid lobsters (Crustacea, Decapoda). Fla. Dep. Nat. Resour., Mar. Res. Lab., Vol. I, Pt. IV, 74 p.

Menezes, M. F. and T. C. V. Gesteira.
1974. Idade e crescimento do pargo, Lutjanus purpureus Poey, do norte e nordeste do Brasil. Arq. Cienc. Mar. 14(2):81-85.

Menon, M. D.
1953. The determination of age and growth of fishes of tropical and sub-tropical waters. J. Bombay Nat. Hist. Soc. 51:823-835.

Moe, M. A., Jr.
1963. A survey of offshore fishing in Florida. Fla. State Board Conserv. Mar. Lab., Prof. Pap. Ser. No. 4, 117 p.

———— 1966. Tagging fishes in Florida offshore waters. Fla. Board Conserv. Mar. Lab., Tech. Ser. No. 49, 40 p.

———— 1969. Biology of the red grouper Epinephelus morio (Valenciennes) from the eastern Gulf of Mexico. Fla. Dep. Nat. Resour., Mar. Res. Lab., Prof. Pap. Ser. No. 10, 95 p.

Moseley, F. N.
1965. Biology of the red snapper Lutjanus aya Bloch, of the northwestern Gulf of Mexico. Master's Thesis, Univ. Texas, Austin, 53 p.

_______. 1966. Biology of the red snapper Lutjanus aya Bloch, of the northwestern Gulf of Mexico. Publ. Inst. Mar. Sci. Univ. Tex. 11:90-101.

Smiley, C. W.
1885. Notes upon fish and the fisheries. Bull. U. S. Fish Comm. 5:65-96.

Stearns, S.
1884. On the position and character of the fishing grounds of the Gulf of Mexico. Bull. U. S. Fish Comm. 4:289-290.

Tabb, D. C.
1961. A contribution to the biology of the spotted seatrout, Cynoscion nebulosus (Cuvier), of east-central Florida. Fla. State Board Conserv., Tech. Ser. No. 35, 22 p.

Tesch, F. W.
1968. Age and growth. In W. E. Ricker (editor), Methods for assessment of fish production in fresh waters, p. 93-123. Blackwell Scientific, Oxford.

Topp, R. W.
1963. The tagging of fishes in Florida 1962 program. Fla. Board Conserv. Mar. Lab., Prof. Pap. Ser. No. 5, 76 p.

Van Oosten, J.
1929. Life history of the lake herring (Leucichthys artedi Le Sueur) of Lake Huron as revealed by its scales, with a critique of the scale method. Bull. Bur. Fish. 44:265-428.

Voss, G. L.
1953. A contribution to the life history and biology of the sailfish, Istiophorus americanus Cuv. and Val., in Florida waters. Bull. Mar. Sci. Gulf Caribb. 3:206-240.

Voss, N. A.
1954. The postlarval development of the fishes of the family Gempylidae from the Florida current. I. Nesiarchus Johnson and Gempylus Cuv. and Val. Bull. Mar. Sci. Gulf Caribb. 4:120-159.

Williams, A. B.
1965. Marine decapod crustaceans of the Carolinas. Fish. Bull. 65:1-298.

THE IMPACT OF FISH-KILLING PHYTOPLANKTON BLOOMS UPON MIDEASTERN GULF OF MEXICO REEFFISH COMMUNITIES [1/]

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ABSTRACT

A 1971 spring-summer Red Tide (Gymnodinium breve) and associated stress conditions resulted in the near extirpation of patch reef biotas from at least 1,536 km^2 of the central West Florida Shelf off Sarasota, Florida. Reeffishes, corals, sponges, polychaetous annelids, mollusks, decapod crustaceans, ascidean urochordates, echinoderms, and benthic algae all sustained heavy mortalities at reefs in 13-30 m, approximately 13-52 km offshore. An estimated 80 - 90% of the fish species inhabiting offshore, deep reefs (18-30m) and 77% (45 of 58) of the fish species occupying inshore, shallow reefs (13-18 m) perished during the Red Tide. Of the commercially important reeffishes, the red grouper (Epinephelus morio) and hogfish (Lachnolaimus maximus) were completely exterminated, but the gag (Mycteroperca microlepis), scamp (M. phenax), jewfish (Epinephelus itajara), and gray snapper (Lutjanus griseus) survived as remnant populations at scattered reef localities.

Certain reeffishes colonized shallow reefs almost immediately after Red Tide conditions abated; others did not appear for 10-12 months afterward. Several fishes previously rare or absent at shallow mideastern Gulf reefs (e.g., red snapper, Lutjanus campechanus) temporarily colonized there in abundance following the Red Tide.

High organic content arising from unusually heavy land run-off, elevated sea temperatures, water column stagnation, and dense phytoplankton blooms (especially Prorocentrum) contributing to anoxia in bottom waters, resulted in nearshore (8-24 km) reeffish kills along 97 km of the Florida west-central coast during July-September 1974.

The possible impact of these fish-killing phytoplankton blooms upon mideastern Gulf of Mexico reef fisheries is discussed.

1/ Contribution No. 266, Florida Department of Natural Resources, Marine Research Laboratory, St. Petersburg, FL 33701.

INTRODUCTION

Waters overlying the central West Florida Shelf frequently support dense phytoplankton blooms which sometimes cause or contribute to marine animal mass mortalities. Although the Red Tide organism *Gymnodinium breve* is usually implicated in these mass mortalities, other plankton species are occasionally responsible. During summer 1966, a bloom of the toxic dinoflagellate *Gonyaulax monilata* produced fish kills in coastal and nearshore waters along the southwest Florida coast (Williams and Ingle, 1972). Unpublished analyses of mollusk and echinoderm collections taken by the Florida Board of Conservation during 1965-67 indicate that this *G. monilata* bloom resulted in at least limited reef kills. Dense blooms of the dinoflagellate *Prorocentrum* were thought to be at least partially responsible for a lowered oxygen content in bottom waters, resulting in nearshore (8-24 km) reef kills along the Florida west-central coast during July-September 1974 (Smith, 1975a).

A 1971 spring-summer *G. breve* Red Tide in the mideastern Gulf of Mexico provided a unique opportunity to document and evaluate its impact upon selected reef communities studied since May 1970. Accumulation of baseline information at specific study reefs off Sarasota, Florida, allowed the unprecedented opportunity to record the degree of faunal and floral mortality and to study patterns of recolonization and succession of reef biotas for several years thereafter (Smith, 1975b).

Patches of discolored water and fish kills were reported between Naples and St. Petersburg along Florida's west coast during April through August 1971. Fish kills and a short-lived Red Tide occurred within Sarasota Bay during April (Steidinger and Ingle, 1972). Coastal and offshore fish kills were initially detected in southern areas of this region, but by early June, moderate fish kills and *G. breve* concentrations occurred between Sarasota and Ft. Myers, Florida (Steidinger and Ingle, 1972; Smith, 1975b). Subsequently, Red Tide blooms were transported inshore, resulting in massive fish kills within Tampa Bay and Charlotte Harbor (Steidinger and Ingle, 1972; Steidinger and Joyce, 1973). Red Tide conditions persisted in Tampa Bay and adjacent Gulf waters until September.

RESULTS AND DISCUSSION

OFFSHORE REEF KILLS DURING THE 1971 RED TIDE

SCUBA observations at widely scattered localities following the 1971 Red Tide revealed reeffish kills over at least 1,536 km^2 of central West Florida Shelf (Smith, 1975b). Fish kills were not limited to the smaller benthic fishes but included large jewfish and groupers (Serranidae), snappers (Lutjanidae), triggerfishes and filefishes (Balistidae), porgies (Sparidae), and grunts (Pomadasyidae) (Table 1). Although reeffish species demonstrated different tolerances to progressive Red Tide conditions, representatives of virtually every species common on the reefs were observed dead on the bottom and/or surface. Certain reeffishes with reduced or nonexistent swim bladders (e.g., gobiids and blenniids) were not visible in surface kills but were abundant on the bottom.

Table 1. List of Common and Scientific Names of Fishes Mentioned in the Text.

Scientific name	Common name
Family Serranidae	
Epinephelus morio	Red grouper
E. cruentatus	Graysby
E. itajara	Jewfish
Mycteroperca microlepis	Gag
M. phenax	Scamp
Serranus subligarius	Belted sandfish
Centropristis melana	Southern sea bass
Family Labridae	
Lachnolaimus maximus	Hogfish
Halichoeres bivittatus	Slippery dick
H. caudalis	Painted wrasse
Family Scaridae	
Scarus croicensis	Striped parrotfish
Family Lutjanidae	
Lutjanus griseus	Gray snapper
L. campechanus	Red snapper
Family Pomacentridae	
Pomacentrus variabilis	Cocoa damselfish
P. partitus	Bicolor damselfish
Family Grammistidae	
Rypticus maculatus	Whitespotted soapfish
Family Ephippidae	
Chaetodipterus faber	Atlantic spadefish
Family Blenniidae	
Blennius marmoreus	Seaweed blenny
Family Sparidae	
Archosargus probatocephalus	Sheepshead
Family Batrachoididae	
Opsanus pardus	Leopard toadfish
Family Pomadasyidae	
Haemulon plumieri	White grunt
Family Balistidae	
Balistes capriscus	Gray triggerfish
Family Chaetodontidae	
Chaetodon ocellatus	Spotfin butterflyfish
C. striatus	Banded butterflyfish
C. capistratus	Foureye butterflyfish

Reeffishes were not the only biotic elements to be adversely affected by the Red Tide. Corals, ascidean urochordates, mollusks, decapod crustaceans, sponges, echinoderms, and benthic algae all suffered heavy mortalities within the Red Tide area. Invertebrate mortalities were presumably due to secondary stresses (e.g., anoxia and hydrogen sulphide poisoning) rather than the direct action of G. breve toxin(s).

An estimated 80 -90% of the fish species inhabiting offshore, deep reefs (18-30 m) perished during the Red Tide. At inshore, shallow reefs (13-18 m), 77% (45 of 58) of the resident fish species probably perished. Fishes surviving as remnant populations at certain shallow reefs included the serranids Mycteroperca microlepis, M. phenax, Epinephelus itajara, and Serranus subligarius; the lutjanid Lutjanus griseus; the pomacentrid Pomacentrus variabilis; the ephippid Chaetodipterus faber; the grammistid Rypticus maculatus; the blenniid Blennius marmoreus; the sparid Archosargus probatocephalus; the batrachoidid Opsanus pardus; the pomadasyid Haemulon plumieri; and the balistid Balistes capriscus. Territoriality and thigmotaxis exhibited by most reeffishes certainly contributed to their nearly complete annihilation during the Red Tide. Fishes not ethologically or physiologically confined to bottom waters (e.g., L. griseus and B. capriscus) survived in greatest numbers, possibly by moving above the thermocline into more oxygenated waters. Reeffishes most susceptible to the Red Tide, as indicated by the early and complete eradication, were benthophilic sciaenids, chaetodontids, pomacanthids, labrids, and the serranid Epinephelus morio.

RECOLONIZATION AND SUCCESSION OF REEFFISHES

Certain reeffishes colonized shallow reefs almost immediately after Red Tide conditions abated (e.g., Chaetodon ocellatus, Epinephelus cruentatus, and Acanthurus chirurgus); others did not appear for 10-12 months thereafter (e.g., Halichoeres bivittatus, H. caudalis, Lutjanus campechanus, and E. morio). The early appearance of species of chaetodontids and acanthurids probably reflects their ability to utilize ocean current transport mechanisms due to their protracted planktonic larvae.

Several fishes previously rare (e.g., Chaetodon capistratus, C. striatus, and Acanthurus chirurgus) or absent (e.g., E. cruentatus, Scarus croicensis, Pomacentrus partitus, and L. campechanus) at shallow reefs colonized there following the Red Tide. Many of these latter fishes are deep water members of species pairs demonstrating bathymetric exclusion prior to the Red Tide. The shoreward expansion of species' ranges possibly reflects relaxed competition from congeneric and ecologically similar species exterminated or decimated at shallow reefs during the Red Tide. For example, juvenile red snapper (L. campechanus) became established only at shallow water reefs unoccupied by remnant populations of gray snapper (L. griseus).

IMPACT OF PREVIOUS RED TIDES ON MIDEASTERN GULF REEF COMMUNITIES

Direct SCUBA observations at mideastern Gulf reefs, both before and after the 1971 Red Tide, indicated that, under the appropriate environmental situation, certain G. breve blooms are capable of exterminating reef biotas. Seasonal progression and true ecological succession following reef kills result in a procession of qualitatively and quantitatively distinct ichthyofaunas. Despite this, earlier speculations assumed that the effects of Red Tides are "negligible and short-lived" (Springer and Woodburn, 1960), they "only temporarily affect inshore and nearshore reef fisheries" (Steidinger and Ingle, 1972), and the "percentage kill is undoubtedly low" (Rounsefell and Nelson, 1966).

The severity of the 1971 Red Tide is probably not unprecedented. The present study, as well as Project Hourglass (Joyce and Williams, 1969) indicates that thermoclines may persist late into the year, particularly in deep water, and that isothermy may not occur until late summer. Accordingly, hydrological conditions have probably favored oxygen depletion in waters overlying reefs during past Red Tides, particularly those starting or re-initiated during spring and summer (e.g., 1947, 1954, and 1967).

Eyewitness reports and indirect evidence also suggests that events similar to those observed during the 1971 Red Tide have occurred in the past. Springer and Woodburn (1960) related reports that the southern sea bass (Centropristis melana) was common at nearshore reefs off Tampa Bay prior to the 1957-58 Red Tide, but rarely caught thereafter. Local fishermen also noted the red grouper (E. morio) to be more abundant than the gag (M. microlepis) prior to the 1957-58 Red Tide. Two years later, however, Springer and Woodburn (1960) found M. microlepis to be more abundant at local reefs. This seeming discrepancy is consistent with differential mortalities of E. morio and M. microlepis following the 1971 Red Tide. At shallow water reefs, E. morio populations were completely exterminated while M. microlepis survived as remnant populations. Capt. Andrew Rasmussen (pers. comm.)2/ recollected that the hogfish (Lachnolaimus maximus) was not represented in inshore party boat catches off Cortez, Florida for 3-4 years following the 1957 Red Tide. Local fishermen have reported that certain reef areas "have the characteristics of productive (i.e., hard) bottom" in fathometer traces but are "nortoriously unproductive," possibly representing "dead bottom" areas devastated by Red Tides (Moe, 1963). A considerable quantity of dead sponges and alcyonarian corals observed at a reef site off Tarpon Springs, Florida, was thought to be linked to Red Tide conditions and fish kills persisting from November 1946 to August 1947 (Anonymous).3/

Nearshore (8-24 km) reeffish kills occurred along 97 km of Florida's west-central coast between Bayport and Sarasota during July-September 1974 (Smith, 1975a). However, G. breve was not implicated in these particular reef kills. High organic content, arising from unusually heavy land run-off, elevated sea temperatures, water column stagnation, and dense phytoplankton blooms (particularly Prorocentrum), undoubtedly facilitated oxygen depression in bottom waters overlying reefs.

2/ Andrew S. Rasmussen, party boat operator, 2600 Gulf Drive, Bradenton Beach, FL 33510, pers. comm.

3/ Anonymous, 1948. Survey of the sponge grounds north of Anclote Light. Unpublished report prepared by the University of Miami for the Florida State Board of Conservation, 21 p. Marine Research Laboratory, Florida Department of Natural Resources, St. Petersburg, FL 33701.

RED TIDES AND GULF REEF FISHERIES

Data analysis for two severe Red Tides (1947 and 1953) revealed landings of commercial and sport fishes to be largely unaffected (Springer and Woodburn, 1960; Steidinger and Ingle, 1972). However, the relationship of Red Tide to Gulf reef fisheries requires re-evaluation (Smith, 1975b). Following the 1971 Red Tide, for example, Sarasota-based party boats expended greater fishing effort farther offshore at unaffected reefs, thereby maintaining catches satisfactory to their clientele. Since these offshore, deep water fishes yielded more fishes and a greater incidence of larger fishes, the local sportfishing catch may even have increased after the Red Tide. Most commercial bottom fishermen are not immediately affected since most Red Tides occur inshore of their regular fishing grounds. Some fishermen, however, believe their future fishing success will be adversely affected by Red Tides, due to reduced recruitment through extermination of small groupers or depletion of breeding stock at shallower, inshore reefs (Moe, 1963). Catch statistics should be analyzed to see whether major Red Tides are accompanied 2-3 years later by reduced catches of groupers and gray snapper, due to diminished recruitment to the offshore, deep water commercial fishery of those species affected at inshore, shallow water reefs. Examination of hogfish (L. maximus) commercial landings from the Florida west coast between 1950 and 1974 reveals that the Red Tides of 1953, 1957, 1959-60, and 1971 were followed 1-2 years later by significantly reduced catches. The hogfish is particularly vulnerable to Red Tides because juveniles prefer inshore, shallow reefs and are acutely sensitive to early Red Tide conditions. During the 1971 Red Tide, the hogfish and all other labrid species were completely annihilated at shallow reefs.

Differential species tolerances during Red Tides and successional advantages of certain species thereafter may contribute greatly to year class fluctuations in reeffish populations. It is predicted, for example, that the expanded habitat available to juvenile red snapper following the 1971 Red Tide will be reflected by increased catches when these fish recruit to the deep water commercial fishery.

CONCLUSION

Compelling evidence has been presented to suggest that the occurrences of Red Tides and certain other phytoplankton blooms are important and hitherto underestimated phenomena, regulating composition, abundance, and distribution of reeffish assemblages on the central West Florida Shelf.

LITERATURE CITED

Joyce E. A., Jr. and J. Williams.
1969. Memoirs of the Hourglass cruises: rationale and pertinent data. Fla. Dep. Nat. Resour., Mar. Res. Lab., Vol. 1, Pt. 1, 50 p.

Moe, M. A., Jr.
1963. A survey of offshore fishing in Florida. Fla. Board Conserv. Mar. Lab., Prof. Pap. Ser. No. 4, 117 p.

Rounsefell, G. A. and G. Nelson.
1966. Red tide research summarized to 1964, including an annotated bibliography. U. S. Dep. Inter., Fish Wildl. Serv., Spec. Sci. Rep. 535, 85 p.

Smith, G. B.
1975a. Phytoplankton blooms and reef kills in the mid-eastern Gulf of Mexico. In E. A. Joyce, Jr. (editor), Proceedings of the Florida Red Tide Conference, 10-12 October 1974, Sarasota, Fla. Fla. Mar. Res. Publ. No. 8, 20 p.

________.
1975b. The 1971 red tide and its impact on certain reef communities in the mid-eastern Gulf of Mexico. Environ. Lett.9(2):141-152.

Springer, V. G. and K. D. Woodburn.
1960. An ecological study of the fishes of the Tampa Bay area. Fla. Board Conserv. Mar. Lab., Prof. Pap. Ser. No. 1, 104 p.

Steidinger, K. A. and R. M. Ingle.
1972. Observations on the 1971 summer red tide in Tampa Bay, Florida. Environ. Lett. 3(4): 271-278.

Steidinger, K. A. and E. A. Joyce, Jr.
1973. Florida red tides. Fla. Dep. Nat. Resour., Mar. Res. Lab., Educ. Ser. No. 17, 26 p.

Williams, J. and R. M. Ingle.
1972. Ecological notes on Gonyaulax monilata (Dinophyceae) blooms along the west coast of Florida. Fla. Dep. Nat. Resour., Mar. Res. Lab., Leafl. Ser., Vol. 1, Pt. 1, No. 5, 12 p.

OFFSHORE BOTTOM FISHERIES OF THE UNITED STATES SOUTH ATLANTIC COAST 1/

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ABSTRACT

Commercial fishing for snappers and groupers began off North Carolina, South Carolina, and Georgia in the 19th century, virtually ceased during the 1930's and 1940's, and resumed during the mid-1950's. Georgia's landings were greatest during the early 20th century, exceeding 1 million pounds in 1908; whereas those for North Carolina and South Carolina have been much greater since 1956 than before and totalled 291,000 pounds in 1957. North Carolina's 1974 grouper landings, 70,008 pounds, were the largest ever. A recreational head boat fishery, that began in the 1920's and now consists of about 37 boats operating from 11 ports in North Carolina and South Carolina and one boat in Georgia, takes about 1,500,000 pounds of groupers, snappers, and associated semitropical fishes, and allows over 50,000 angler-days of recreation annually. Red porgy, vermilion snapper, white grunt, and groupers are the most important species by weight. Recreational catches of groupers and snappers currently exceed commercial catches by a factor of five. Concern about fish populations and the welfare of the more valuable recreational fishery precludes encouragement of a larger commercial fishery.

1/ MARMAP Contribution No. 115.

INTRODUCTION

The bottomfish community that supports handline fisheries for snappers and groupers in the Gulf of Mexico and Caribbean Sea extends northward along the U. S. south Atlantic coast to Cape Hatteras, N. C. (approximately 35° N). Irregular rocky topography at the Continental Shelf edge and rock outcroppings and coral patches on the Outer Shelf in combination with warm Gulf Stream water, allow year-round occupancy of the Outer Continental Shelf by many tropical and subtropical fishes (Huntsman, In press).

Research cruises, conducted by the Federal Government aboard the ALBATROSS III, OREGON, COMBAT, and SILVER BAY from 1949 through 1964, and exploratory fishing by the marine fishery agencies of North Carolina and South Carolina in the late 1960's suggested existence of substantial stocks of offshore bottom fishes (Buller, 1951; Bullis and Thompson, 1965; North Carolina,1969; Struhsaker,1969; Bearden and McKenzie, 1971). Examination of catches in a recreational fishery, and experimental fishing aboard the research vessels ONSLOW BAY and EASTWARD from 1972 through 1974 by personnel of the Atlantic Estuarine Fisheries Center of the National Marine Fisheries Service, NOAA, confirmed the existence of a semitropical fish community apparently dominated by red porgy, vermilion snapper, white grunt, black sea bass, gag, scamp, speckled hind, snowy grouper, gray tilefish, and gray triggerfish (Huntsman, In press) (Tables 1 and 2). Red,silk, and blackfin snappers are also occasionally caught.

In this paper I relate the history of recreational and commercial snapper and grouper fishing off Georgia and the Carolinas, examine the relationship of recreational and commercial fisheries, and describe factors limiting development of these fisheries.

THE COMMERCIAL FISHERY

HISTORY

Commercial fishing for groupers and snappers north of Florida has occurred sporadically since the late 19th century, but it is difficult to obtain an adequate description of this fishery. Early fishery statistics were collected infrequently and were often incomplete.

Interpreting records of landings made since 1950 is also difficult. Because vessel propulsion was primitive and refrigeration practically non-existent at the turn of the century, catches landed in a state could be assumed to have been made somewhere near that state; conversely, catches made from the Continental Shelf off a given state could be assumed to have been landed in that or an adjacent state. Now modern vessels travel hundreds or thousands of miles to fish. Florida and Gulf Coast vessels occasionally fish off the Carolinas and Georgia and then unload at their home port or an intermediate port. Catches made in one area may be credited as landings in another. Also, vessels may fish off one state and unload there, but ship their catch by truck to a port where prices are better without any record being made in the state of landing. For these reasons recent

Table 1. Species Commonly Caught by the Carolina Head Boat Industry.

Common name	Scientific name	Usual size caught (pounds)	Depth (fathoms)	Remarks
Sea basses:	Serranidae:			
Rock hind	*Epinephelus adscensionis*	2-5	15-30	
Speckled hind	*Epinephelus drummondhayi*	4-12	25-55	
Yellowedge grouper	*Epinephelus flavolimbatus*	8-16	35-80	
Red hind	*Epinephelus guttatus*	2-5	15-30	
Red grouper	*Epinephelus morio*	10-20	20-35	
Warsaw grouper	*Epinephelus nigritus*	23-40	30-60	
Snowy grouper	*Epinephelus niveatus*	6-12	30-60	
Gag	*Mycteroperca microlepis*	3-6 (inshore) 12-40(offshore)	15-55	
Scamp	*Mycteroperca phenax*	15-20	20-55	mid-Onslow Bay southward
Black sea bass	*Centropristis striata*	0.5-2.0	7-30	
Porgies:	Sparidae:			
Red porgy	*Pagrus sedecim*	1.75-2.5(inshore) 2.5 -5.0(offshore)	10-55	
Knobbed porgy	*Calamus nodosus*	3-5	10-30	most common off South Carolina
Whitebone porgy	*Calamus leucosteus*	1-3	10-25	
Spottail pinfish	*Diplodus holbrooki*	1-2	10-20	
Scup	*Stenotomus* sp.	0.5-1.5	20-55	

Table 1. (Continued).

Common name	Scientific name	Usual size caught (pounds)	Depth (fathoms)	Remarks
Snappers:	Lutjanidae:			
Red snapper	*Lutjanus campechanus*	18-22	20-55	
Silk snapper	*Lutjanus vivanus*	18-22	25-55	
Vermilion snapper	*Rhomboplites aurorubens*	0.5-1.5 (inshore) 1.6 (offshore)	15-55	
Grunts:	Pomadasyidae:			
White grunt	*Haemulon plumieri*	1-2	10-25	
Tomtate	*Haemulon aurolineatum*	0.25-0.75	10-25	
Tilefishes:	Branchiostegidae:			
Gray tilefish	*Caulolatilus microps*	6-10	30-70	
Jacks and Pompanos:	Carangidae:			
Almaco jack	*Seriola rivoliana*	15-30	25-100	
Greater amberjack	*Seriola dumerili*	15-30	25-100	
Triggerfishes and Filefishes:	Balistidae:			
Gray triggerfish	*Balistes capriscus*	2-7	10-30	

Table 2. Some Fishes of the Outer Continental Shelf of North Carolina, Taken by National Marine Fisheries Service, NOAA Sampling or Occasionally by Head Boats.

Common name	Scientific name	Depth (fathoms)
Requiem sharks:	Carcharhinidae:	
Silky shark	*Carcharhinus falciformis*	15-70
Hammerhead sharks:	Sphyrnidae:	
Scalloped hammerhead	*Sphyrna lewini*	45-50
Guitarfishes:	Rhinobatidae:	
Atlantic guitarfish	*Rhinobatos lentiginosus*	39-78
Skates:	Rajidae:	
Skate (unidentified)	*Raja* sp.	39-78
Stingrays:	Dasyatidae:	
Stingray (unidentified)	*Dasyatis* sp.	39-78
Morays:	Muraenidae:	
Blackedge moray	*Gymnothorax nigromarginatus*	15-60
Reticulate moray	*Muraena retifera*	47
Conger eels:	Congridae:	
Conger eel	*Conger oceanicus*	40-55
Margintail conger ?	*Paraconger caudilimbatus* ?	33
Snake eels:	Ophichthidae:	
Palespotted eel	*Ophichthus ocellatus*	15-57
Anchovies:	Engraulidae:	
Anchovy (unidentified)	*Anchoa* sp.	15-20
Lizardfishes:	Synodontidae:	
Inshore lizardfish	*Synodus foetens*	13
Red lizardfish	*Synodus synodus*	37-58
Snakefish	*Trachinocephalus myops*	15-40
Batfishes:	Ogcocephalidae:	
Pancake batfish	*Halieutichthys aculeatus*	39-78
Roughback batfish	*Ogcocephalus parvus*	39-78
Batfish (unidentified)	*Ogcocephalus* sp.	39-78

Table 2. (Continued).

Common name	Scientific name	Depth (fathoms)
Cusk-eels:	Ophidiidae:	
Striped cusk-eel	*Rissola marginata*	15-20
Squirrelfishes:	Holocentridae:	
Squirrelfish	*Holocentrus ascensionis*	28
Longspine squirrelfish?	*Holocentrus rufus* ?	28
Cornetfishes:	Fistulariidae:	
Red cornetfish	*Fistularia villosa*	50
Pipefishes and seahorses:	Syngnathidae:	
Lined seahorse	*Hippocampus erectus*	15-60
Pipefish (unidentified)	*Syngnathus* sp.	15-60
Sea basses:	Serranidae:	
Bank sea bass	*Centropristis ocyurus*	15-60
Sand perch	*Diplectrum formosum*	15-60
Marbled grouper	*Dermatolepis inermis*	—
Yellowfin grouper	*Mycteroperca venenosa*	—
Roughtongue bass	*Ocyanthias martinicensis*	39-78
Creole-fish	*Paranthias furcifer*	—
Tattler	*Serranus phoebe*	40-70
Bigeyes:	Priacanthidae:	
Bigeye	*Priacanthus arenatus*	—
Short bigeye	*Pristigenys alta*	18-23
Cardinal fishes:	Apogonidae:	
Twospot cardinalfish	*Apogon pseudomaculatus*	18
Tilefishes:	Branchiostegidae:	
Atlantic golden-eyed	*Caulolatilus chrysops*	40-70
Sand tilefish	*Malacanthus plumieri*	28-50
Cobias:	Rachycentridae:	
Cobia	*Rachycentron canadum*	28
Jacks and pompanos:	Carangidae:	
Round scad	*Decapterus punctatus*	15-18
Snappers:	Lutjanidae:	
Blackfin snapper	*Lutjanus buccanella*	30-50
Wenchman	*Pristipomoides aquilonaris*	—
Yellowtail snapper	*Ocyurus chrysurus*	—

Table 2. (Continued).

Common name	Scientific name	Depth (fathoms)
Drums:	Sciaenidae:	
Jackknife-fish	Equetus lanceolatus	18
Cubbyu	Equetus umbrosus	37-60
Goatfishes:	Mullidae:	
Spotted goatfish	Pseudupeneus maculatus	18
Butterflyfishes:	Chaetodontidae:	
Spotfin butterflyfish	Chaetodon ocellatus	18
Blue angelfish	Holacanthus bermudensis	18
Damselfishes:	Pomacentridae:	
Yellowtail reeffish ?	Chromis enchrysurus ?	18
Dusky damselfish ?	Pomacentrus fuscus ?	40-50
Wrasses:	Labridae:	
Yellowhead wrasse?	Halichoeres garnoti ?	40-50
Pearly razorfish	Hemipteronotus novacula	30-50
Barracudas:	Sphyraenidae:	
Great barracuda	Sphyraena barracuda	28
Stargazers:	Uranoscopidae:	
Southern stargazer ?	Astroscopus y-graecum ?	39-78
Scorpionfishes:	Scorpaenidae:	
Spinythroat scorpionfish	Pontinus nematophthalmus	39-78
Barbfish	Scorpaena brasiliensis	18-70
Deepreef scorpionfish	Scorpaenodes tredecimspinosus	18
Searobins:	Triglidae:	
Northern searobin	Prionotus carolinus	13-20
Lefteye flounders:	Bothidae:	
Eyed flounder	Bothus ocellatus	23
Summer flounder	Paralichthys dentatus	28
Dusky flounder	Syacium papillosum	15-23
Triggerfishes and filefishes:	Balistidae:	
Orange filefish	Aluterus schoepfi	18
Fringed filefish	Monacanthus ciliatus	23
Planehead filefish	Monacanthus hispidus	23

Table 2. (Continued)

Common name	Scientific name	Depth (fathoms)
Puffers:	Tetraodontidae:	
Marbled puffer	*Sphoeroides dorsalis*	23
Bandtail puffer	*Sphoeroides spengleri*	18

landing records for North Carolina, South Carolina, and Georgia underestimate the commercial production of groupers and snappers between Cape Hatteras and Florida.

North Carolina

Grouper and red snapper landings (of unknown quantities) were recorded for North Carolina, South Carolina, and Georgia in 1880, the earliest year for which records are available. In 1897 and 1908, North Carolina produced catches of 34,000 and 13,000 pounds of snappers, respectively. From 1908 to 1956, catches rarely were more than a few thousand pounds per year. North Carolina grouper landings were virtually non-existent until 1956 (Power, 1959) (Table 3).

In 1956 Lloyd Reed and John Chivas made the first modern attempt at handline snapper fishing from a North Carolina port. Fishing from the 38-foot PANDION, they landed 130,000 pounds of "red snapper" (actually mixed red, silk, and blackfin snappers) and 27,000 pounds of groupers at Beaufort, N. C. In 1957 they produced 225,100 pounds of red snapper and 64,900 pounds of groupers. In the winter of 1957-58, water temperature in outer Onslow Bay was the lowest in the 20-year period of 1948-67 (McLain, Mayo, and Owen 2/). The cold water severely affected red snapper stocks and, as this was the only species which had high market value, the incipient commercial fishery essentially ended. From 1958 to 1973, North Carolina landings were small, with the greatest landings in 1958 when 31,000 pounds of groupers and 28,000 pounds of snappers were landed. Resurging interest in offshore fishing resulted in a record landing of 70,008 pounds of groupers in 1974. Apparently snapper populations have never rebounded from the 1957-58 mortality and, even with the effort expended to take the record catch of groupers, only 21,076 pounds of snappers were produced.

South Carolina

South Carolina had moderate grouper and snapper landings from 1880 through 1908. Virtually no landings were recorded from 1908 until 1956. As in North Carolina, South Carolina local interest in offshore fishing revived in 1956, and snapper and grouper landings have been recorded every year since. Snapper landings were larger in the late 1950's and early 1960's; 137,000 pounds were landed in 1961, but only 14,790 pounds in 1974. Groupers are now much more important, and a record 82,723 pounds were landed in 1973 and 62,124 pounds in 1974.

2/ McLain, D. R., F. V. Mayo, and M. J. Owen. Monthly maps of sea surface temperature anomalies in the northwest Atlantic Ocean and Gulf of Mexico, 1948-1967. Unpublished manuscript. Pacific Environmental Group, NMFS, NOAA, Monterey, CA 93940.

Table 3. Commercial Landings of Snappers and Groupers for North Carolina, South Carolina, and Georgia (1880-1974).

Year	North Carolina Groupers (pounds)	North Carolina Snappers (pounds)	South Carolina Groupers (pounds)	South Carolina Snappers (pounds)	Georgia Groupers (pounds)	Georgia Snappers (pounds)
1880	1/	1/	1/	1/	1/	1/
1887	1/	1/	1/	1,000	1/	1/
1888	1/	1/	1/	1,000	1/	3,000
1889	1/	1/	1/	1/	1/	1/
1890	1/	1/	1/	18,000	1/	-----
1897	---	34,000	33,000	54,000	---	-----
1902	---	---	41,000	10,000	---	125,000
1908	---	13,000	40,000	12,000	160,000	880,000
1918	---	---	---	---	28,000	112,000
1923	---	1,000	8,000	2,000	11,000	105,000
1927	---	1,000	---	---	26,000	64,000
1928	---	2,000	---	---	8,000	22,000
1929	---	15,000	---	---	8,000	33,000
1930	---	5,000	---	---	7,000	30,000
1931	---	2,000	---	---	----	-----
1932	---	---	---	---	----	-----
1934	---	---	---	---	----	-----
1936	---	---	---	---	----	-----
1937	---	---	---	---	----	-----
1938	---	1,000	---	---	----	-----
1939	---	2,000	2,000	---	----	-----
1940	---	---	2,000	---	----	-----
1945	---	4,000	---	---	----	-----
1950	---	---	15,000	5,000	----	-----
1951	2/	8,000	---	---	----	-----
1952	---	5,000	---	---	----	-----
1953	---	---	---	---	----	2,000
1954	---	---	---	---	----	3,000
1955	---	---	---	---	----	-----
1956	26,700	130,400	---	12,000	----	2/
1957	64,900	225,100	---	1,000	----	2/
1958	31,000	28,000	1,000	2/	----	-----
1959	10,000	15,000	2,000	18,000	----	-----
1960	2/	2/	7,000	2,000	2,000	8,000
1961	1,000	6,000	6,000	137,000	4,000	3,000
1962	1,000	2,000	---	62,000	2/	3,000
1963	2/	2,000	---	10,000	2/	2,000
1964	1,000	2/	2/	8,000	2/	1,000
1965	---	---	51,000	34,000	----	2/

Table 3. (Continued).

Year	North Carolina Groupers (pounds)	North Carolina Snappers (pounds)	South Carolina Groupers (pounds)	South Carolina Snappers (pounds)	Georgia Groupers (pounds)	Georgia Snappers (pounds)
1966	7,000	11,000	2/	---	----	2/
1967	9,000	4,000	---	4,000	92,000	55,000
1968	25,000	42,000	2/	37,000	17,000	17,000
1969	2/	2/	10,000	33,000	12,000	14,000
1970	---	2/	14,000	12,000	50,000	16,000
1971	14,000	17,000	9,570	11,470	43,093	54,571
1972	---	121	17,261	20,405	58,305	52,338
1973	16,483	6,784	82,723	22,467	37,331	19,929
1974	70,008	21,076	62,124	14,790	43,913	42,532

1/ Data not available.

2/ Less than 500 pounds.

Sources: Compiled from Fishery Statistics of the United States, U. S. Department of the Interior, Fish and Wildlife Service (to 1967) and U. S. Department of Commerce, NOAA, NMFS (after 1967); and North Carolina, South Carolina, and Georgia Landings (1973-74), Current Fishery Statistics, U. S. Department of Commerce, NOAA, NMFS, Washington, D. C.

Georgia

Georgia landings have displayed the same historical pattern as those of the Carolinas, but early landings were much larger and they continued for a longer period. Georgia reported grouper and snapper landings from 1880 through 1930 and experienced a combined catch of 1,040,000 pounds in 1908. By comparison, Florida east coast grouper and snapper landings were only 105,000 pounds in 1908. Georgia landings were essentially non-existent from 1930 to 1967. Since then, annual landings have ranged from 147,000 pounds (1967) to 26,000 pounds (1969) and averaged 76,600 pounds annually.

THE PRESENT FISHERY

Vessels

Local and transient vessels fish commercially for snappers and groupers north of Florida. There are probably, at most, a dozen local, full-time, handline fishing boats in North Carolina, South Carolina, and Georgia. Additionally, there are a few dozen crews which occasionally engage in handline fishing when they are not operating head boats or charter boats or trapping black sea bass.

The number and home port of transient vessels fishing the southeast Atlantic Shelf north of Florida is not known. Most vessels observed were from the west coast of Florida, although Florida east coast vessels undoubtedly fish the area. The Florida east coast vessels are more likely to return to their home port to unload, while Florida west coast vessels are more likely to use Georgia and Carolina ports.

Gear

Most fish are taken with hook, line, and electrically driven reel . A few snappers, groupers, porgies, and grunts are taken in traps set for black sea bass. Experimental roller trawling has produced some good catches of groupers and vermilion snapper, but commercial fishermen have shown little interest in this technique (North Carolina, 1969). Of nine commercial roller trawling cruises made from Georgetown, S. C. during the winter of 1973-74, three yielded a total catch of 20,000 pounds and the other six were unsuccessful. Damage to gear and bad weather precluded further fishing,and the operators plan no more trawling on rough bottom.

Species Sought

"Red snapper," including red,silk, and blackfin snappers, are always the principal target of commercial fishermen. However, the Georgia-Carolina area produces far more groupers than snappers, and it is the former which attracts transient boats to the area. Scamp, the most valuable grouper,is abundant from mid-Onslow Bay southward in depths of 20-35 fathoms. The gag, a larger but less valuable grouper, is common in the same depths from Cape Hatteras south. In deeper water, 25-80 fathoms,speckled hind, and Warsaw, snowy, and yellowedge groupers provide excellent fishing at certain locations.

Fishermen from the Gulf States and the Florida east coast discard, or use as bait, species other than snappers or groupers. However, seafood dealers, who ship to the New York Fulton Fish Market or sell retail, pay good prices for such species as vermilion snapper, red porgy, and white grunt.

THE RECREATIONAL FISHERY

Three categories of vessels participate in the recreational fishery for groupers, snappers, and associated bottom fishes in the Georgia-Carolina region: head boats, charter boats, and private boats. Private boats, because so few are capable of the long offshore run, allow the least angler effort, while head boats allow by far the most. This discussion will cover the head boat fishery only.

HISTORY

The offshore head boat fishery began in the early 1900's, when coastal fishermen took parties bottom fishing for $1 to $2 or, perhaps, an equivalent amount of agricultural products. By the late 1920's and early 1930's, head boats,as we know them, had appeared. The JOSEPHINE, captained by Lawrence Long at Little River, S. C.; Luther Smith's KATHERINE, at Murrells Inlet, S. C.; and Carl Winner's boat, at Carolina Beach, N. C., were among the very first to operate off the Southeast Coast. These early operators sought black sea bass on nearshore reefs and rock outcroppings, used the sounding lead to locate fishing sites, and fished with handlines.

The end of World War II brought a supply of inexpensive and relatively high-powered boats and an overwhelming improvement in marine electronic technology. War surplus vessels equipped with depth recorders and loran, which greatly eased the finding and relocation of fish, were important in the fishery for over 15 years. Sea bass grounds farther offshore were exploited, and some vessels occasionally made the long 24-hour trip to the edge of the Continental Shelf for snappers and groupers. Most second generation vessels are now retired, but a few, including the CAROLINA PRINCESS, at Atlantic Beach, N. C.; the PIRATE, at Snead's Ferry, N. C.; and the THUNDERBIRD II, at Little River, S. C., continue operation.

Head boat operations were sufficiently lucrative to engender construction of a third generation of vessels in the 1960's. These boats also were wooden-hulled, but were sleeker than the second generation. They were driven by two, or even three, V-12 or V-16 engines and commonly attained speeds of 18 - 21 knots. This allowed, at last, anglers to fish the tropical offshore waters for groupers and snappers and return in a single day. Most third generation vessels are still active in the offshore fishery. The CAPTAIN STACY and CAPTAIN STACY III, at Morehead City, N. C., and BUDDY's PIRATE, at Topsail Beach, N.C., are good examples of this vessel class. By the 1960's, depth recorders were sufficiently sophisticated to earn the name "fish-finder," and almost every captain had and relied upon this instrument for a successful fishing day.

By the late 1960's, vessel speed had become a predominant element in competition for anglers and in producing fish, because the "good" fishing was occurring farther and farther offshore. The demand for speed brought the introduction of high-speed, aluminum or steel "crewboats " developed in the offshore oil industry. These vessels are extremely seaworthy and fast but are narrow, lack fishing space, and roll more than some earlier vessels. Crewboats are now the backbone of the offshore head boat industry in South Carolina, and one crewboat operates from Wrightsville Beach, N. C. Simultaneous to arrival of the crewboats was acceptance of such advanced electronic gear as the fish scope and side-scan sonar.

A fifth generation of head boat, that originated in Florida, is now appearing in the Carolinas. An all-aluminum, 85-foot catamaran operates from Carolina Beach, N. C. Catamarans seem the ideal head boat. They are fast, luxuriously roomy, very seaworthy, and they roll little. However, catamarans are expensive and can be profitably operated only where there is a large volume of business.

THE PRESENT FISHERY

The current fishery consists of about 36 head boats carrying between 30 and 150 anglers apiece and operating from 11 ports in North Carolina and South Carolina (Table 4). One head boat has operated part-time in Savannah, Ga. since 1972.

We have divided head boats into two major classes according to the habitat they fish: (1) inshore vessels, which fish the inshore rocks and coral patches from 15 to 25 fathoms, and (2) offshore vessels, which fish the Shelf-break zone and the extreme Outer Continental Shelf from 25 to 80 fathoms. Inshore boats in South Carolina could be subdivided further into those boats which fish almost entirely for black sea bass and those which seek porgies and vermilion snapper; but, this subdivision is not clear-cut.

Handlines were standard on Carolina head boats until the early 1950's when rods and reels became common. In the late 1960's, increased emphasis on deep water fishing led many operators to furnish electrically powered sport reels to ease the labor of retrieving heavy sinkers. Currently, 5- to 6-foot solid fiberglass rods, with the rod blank extending through the butt, are preferred. Reels are from size 4/0 to 9/0, either manual or electrical; line is 60- to 120- pound test monofilament nylon. The bottom rigs are usually made of 80- pound test monofilament and two 6/0 to 8/0 hooks. Depending on the current and the depth fished, 6- to 50- ounce lead sinkers are used.

A typical fishing day begins at daybreak and lasts 10-14 hours. After a 2- to 4- hour trip to the fishing ground and a brief search either for fish or bottom topography likely to produce fish, anglers spend 4- to 6- hours fishing and then return to port.

Table 4. Head Boats of North Carolina, South Carolina, and Georgia (1972-75).

Location	Head Boat	Fishing Area	Operated during			
			1972	1973	1974	1975
NORTH CAROLINA						
Hatteras	SHADY LADY	Offshore	-	X	X	X
Morehead City	CAPT. STACY	Offshore	X	X	X	X
Morehead City	CAPT. STACY III	Offshore	X	X	X	X
Morehead City	DEEP BLUE	Offshore	X	X	X	-
Atlantic Beach	CAROLINA PRINCESS	Inshore	X	X	X	X
Sneads Ferry	PIRATE	Inshore	X	X	X	X
Topsail Island	BUDDY'S PIRATE	Inshore	X	X	X	X
Topsail Island	BUCCANEER	Inshore	X	X	X	X
Wrightsville Beach	CAPT. SKIPPY WINNER	Offshore	X	X	X	X
Carolina Beach	STEW BIRD II	Inshore	X	X	X	X
Carolina Beach	CARL WINNER QUEEN	Inshore	X	-	-	-
Carolina Beach	CHEERIO II	Inshore	X	X	X	X
Carolina Beach	FLYING SQUIRREL	Inshore	X	X	-	-
Carolina Beach	PIRATE II	Inshore	X	X	X	X
Carolina Beach	CAPT. WINNER II	Inshore	-	-	X	X
Carolina Beach	CAPT. WINNER IV	Offshore	-	X	X	X
Southport	SKIPPER	Inshore	X	X	X	X
SOUTH CAROLINA						
Little River	CAPT. JUEL I	Offshore	X	X	X	X
Little River	HELEN JEAN	Inshore	X	X	X	X
Little River	HURRICANE	Inshore	X	X	X	X
Little River	GULF QUEEN	Offshore	X	-	-	-
Little River	NEW RASCAL	Inshore	X	X	X	X
Little River	THUNDERBIRD II	Inshore	X	X	X	X
Little River	BONITA	Inshore	-	X	X	X
Murrells Inlet	FLYING FISHER	Inshore	X	X	X	X
Murrells Inlet	FLYING FISHER II	Offshore	X	X	X	X
Murrells Inlet	CAPT. ALEX	Offshore	X	X	X	X
Murrells Inlet	INLET PRINCESS	Inshore	X	X	X	X
Murrells Inlet	NEW INLET PRINCESS	Inshore	-	X	X	X

Table 4. (Continued).

Location	Head Boat	Fishing Area	Operated during			
			1972	1973	1974	1975
SOUTH CAROLINA						
Murrells Inlet	ROCKET	Inshore	X	-	-	-
Murrells Inlet	TOM-A-GATOR	Inshore	X	-	-	-
Murrells Inlet	CAROLINA PRINCESS 1/	Offshore	X	X	-	-
Murrells Inlet	CAROLINA PRINCESS 1/	Inshore	-	-	X	X
Murrells Inlet	CAPT. BILL	Offshore	-	X	X	X
Charleston	GULF STREAM II	Offshore	X	X	X	X
Charleston	MUSTANG II	Inshore	X	X	X	X
Charleston	COMANCHE	Inshore	X	-	-	-
Charleston	JJ	Inshore	X	X	X	X
GEORGIA						
Savannah	CITATION	Inshore	X	X	X	X

1/ Operated offshore during 1972-73 and inshore, 1974-75 .

Fishing occurs at depths of 10-80 fathoms. Generally, captains dislike fishing at depths greater than 35 fathoms, because tangling is frequent and strong currents often prevent lines from reaching the bottom. Depending on conditions, captains may either drift or anchor. According to some head boat captains, anchoring produces the best catches of groupers and drifting allows the best catches of porgies and grunts.

CATCHES, EFFORT, AND ANGLING QUALITY

Since 1972, through a program of dockside sampling and collection of catch information, we have estimated the catch in numbers and pounds of each species taken by the head boat fishery (Huntsman, In press).

To facilitate the estimation and presentation of catch values, we divided the fishing area from Cape Hatteras through South Carolina into four districts: Cape Hatteras, Cape Lookout, Cape Fear, and Cape Romain (Fig.1). Cape Hatteras vessels fish in the northern part of Raleigh Bay; Cape Lookout vessels, in the southern part of Raleigh Bay, and the northern half of Onslow Bay; Cape Fear vessels, in southern Onslow Bay and the northern third of Long Bay; and Cape Romain vessels, in southern Long Bay and south to Savannah. Within each of the four districts, we designated inshore and offshore subdistricts. We divided the fishing season into five time units: Spring (March-May), June, July, August, and Autumn (September-November). There is little fishing from December through February. The catches are presented by year, district, subdistrict, and time unit (Tables 5-10).

Catch and Effort

In 1972, 48,989 angler-days provided a catch, exclusive of black sea bass, of 489,570 fish weighing 1,313,247 pounds. 3/ In 1973, 59,515 angler-days produced 513,174 fish, weighing 1,595,229 pounds; and in 1974, 85,608 angler-days produced 531,414 fish, weighing 1,345,423 pounds. Angler effort is not completely comparable for 1972, 1973, and 1974, because in 1973 we had incomplete coverage of Cape Romain inshore head boats and in 1974 we included, for the first time, many Cape Romain 3/4-and 1/2-day head boats that specialize in catching black sea bass.

We did not estimate the black sea bass catch in 1972. When we began this study, we were primarily interested in the tropical offshore species (grunts, snappers, groupers, and porgies) and, therefore, did not ask mates to keep records of black sea bass catches. It was evident after one season, however, that the black sea bass was an important member of the ecosystem at the

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3/ An angler-day is a unit of fishing effort representing the involvement of one rod-and-reel angler in the head boat fishery for an entire 10- to 14-hour fishing trip. Some Cape Romain sea bass boats make trips of less than a full day. Effort for these vessels is prorated on the basis of the length of the fishing trip (i. e., two half-day trips equal one full trip).

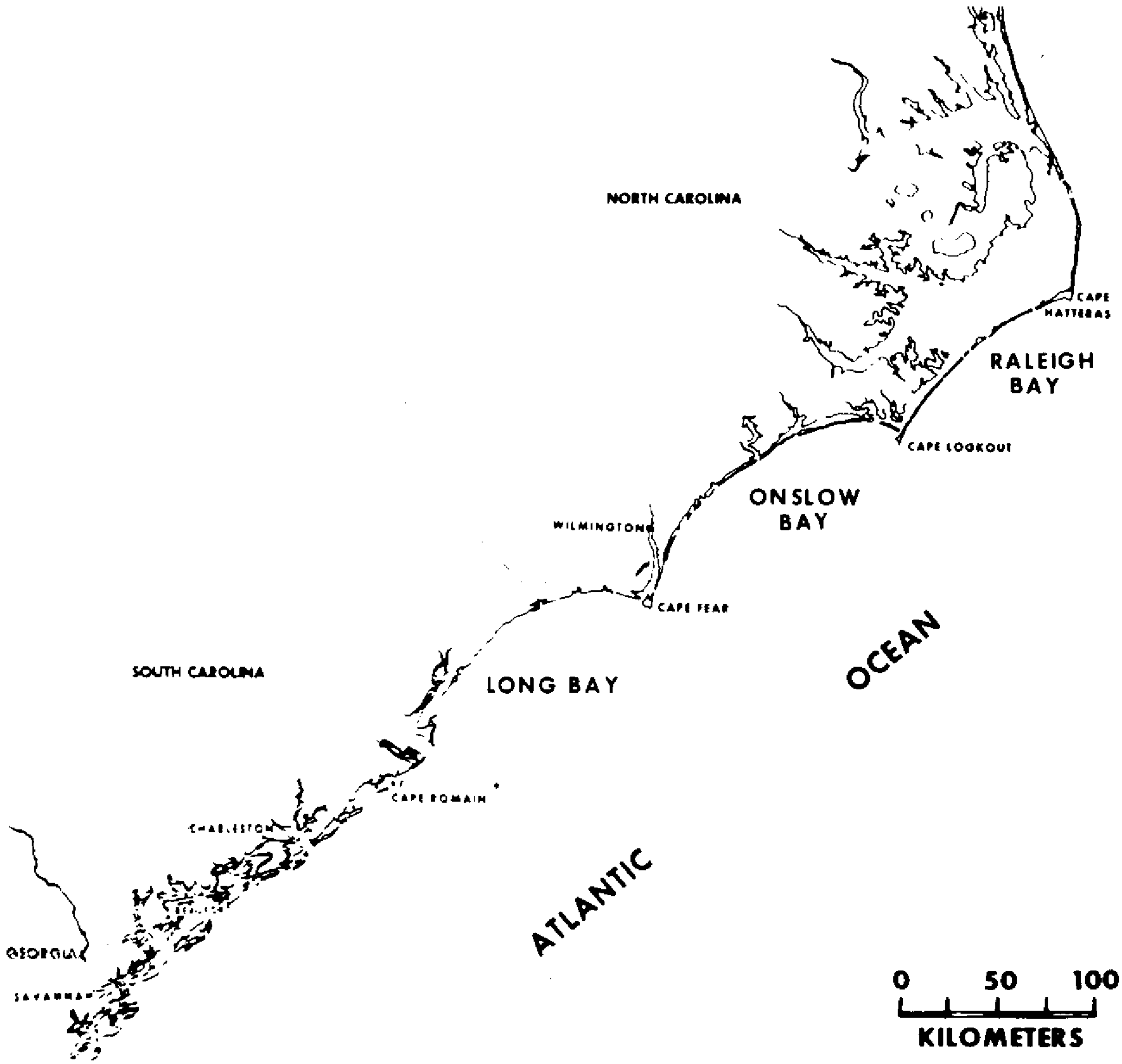

Figure 1. Areas fished by Carolina head boats.

Table 5. Catches by Carolina Head Boats during the 1972 Fishing Season. 1/ 2/

Species		Cape Lookout, N. C. Inshore	%	Cape Lookout, N. C. Offshore	%	Cape Fear, N. C. Inshore	%	Cape Fear, N. C. Offshore	%	Cape Romain, S.C. Inshore	%	Cape Romain, S.C. Offshore	%	TOTAL Inshore	%	TOTAL Offshore	%	GRAND TOTAL (Inshore and Offshore)	%
Porgies	No.	10,431	33.2	31,055	55.9	44,459	32.4	5,087	37.4	4,605	8.0	120,321	62.0	79,495	26.3	156,463	59.4	215,958	44.1
	Wt	21,052	28.9	94,878	32.6	80,688	35.3	11,399	22.8	10,135	14.3	300,706	50.1	111,875	30.0	406,983	43.3	518,857	39.5
Grunts	No.	11,752	37.4	664	1.2	54,739	39.9	3,273	24.1	23,566	40.8	42,144	21.7	90,057	39.8	46,081	17.5	136,138	27.8
	Wt	19,646	27.0	1,498	0.5	88,159	38.5	7,252	14.5	36,148	51.0	75,510	12.6	143,953	38.6	84,260	9.0	228,213	17.4
Vermilion Snapper	No.	5,828	18.6	11,126	20.0	22,966	16.7	1,245	9.2	29,108	50.4	10,571	5.4	57,902	25.6	22,942	8.7	80,844	16.5
	Wt	9,371	12.9	33,735	11.6	21,916	9.6	1,795	3.6	23,219	32.7	17,054	2.8	54,506	14.6	52,584	5.6	107,090	8.2
Groupers: *Epinephelus*	No.	859	2.7	2,323	4.2	537	0.4	1,154	8.5	9	0.1	2,908	1.5	1,405	0.6	6,385	2.4	7,790	1.6
	Wt	11,236	15.4	28,395	9.8	4,573	2.0	11,564	23.2	34	0.1	36,168	6.0	15,843	4.3	76,127	8.1	91,970	7.0
Groupers: *Mycteroperca*	No.	402	1.3	5,223	9.4	623	0.5	1,991	14.7	118	0.2	10,764	5.5	1,143	0.5	17,978	6.8	19,121	3.9
	Wt	1,997	2.7	96,654	33.2	4,771	2.1	15,803	31.7	528	0.7	118,345	19.7	7,296	2.0	230,802	24.5	238,098	18.1
"Red" Snapper 3/	No.	155	0.5	816	1.5	218	0.2	33	0.2	16	0.1	949	0.5	389	0.2	1,798	0.7	2,187	0.4
	Wt	2,553	3.5	14,801	5.1	4,352	1.9	291	0.6	118	0.2	18,754	3.1	7,023	1.9	33,846	3.6	40,869	3.1
Others	No.	1,955	6.2	4,330	7.8	13,696	10.0	804	5.9	317	0.5	6,430	3.3	15,968	7.1	11,564	4.4	27,532	5.6
	Wt	6,963	9.6	20,941	7.2	24,412	10.7	1,815	3.6	760	1.1	33,259	5.5	32,135	8.6	56,015	6.0	88,150	6.7
TOTAL Number		31,382	99.9	55,537	100.00	137,238	100.1	13,587	100.0	57,739	99.9	194,087	99.9	226,359	100.1	263,211	99.9	489,570	99.0
TOTAL Weight		72,818	100.0	290,902	100.00	228,871	100.1	49,919	100.0	70,942	100.0	599,796	99.8	372,631	100.0	940,617	100.1	1,313,247	100.0

1/ No vessels operated in the Cape Hatteras District in 1972.
2/ Weight (Wt) is in pounds.
3/ Includes other species of snappers, as well as red snapper.

Table 6. Catches by Carolina Head Boats during the 1973 Fishing Season. 1/

Species		Cape Hatteras, N. C.			Cape Lookout, N. C.					Cape Fear, N. C.					Cape Romain, S. C.			GRAND TOTAL	
		Offshore	%		Inshore	%		Offshore	%		Inshore	%		Offshore	%		Offshore	%		(Inshore and Offshore)	%
Porgies	No.	2,727	28.6	No.	18,900	33.9	No.	25,272	43.5	No.	51,834	46.7	No.	56,257	78.5	No.	142,764	68.9	No.	297,754	58.0
	Wt	9,060.1	21.1	Wt	34,020.0	31.8	Wt	78,121.4	22.8	Wt	94,204.2	46.2	Wt	173,690.2	65.5	Wt	356,576.8	55.1	Wt	705,672.7	46.4
Grunts	No.	562	5.9	No.	19,064	34.2	No.	1,208	2.1	No.	40,681	36.7	No.	8,389	11.7	No.	9,520	4.6	No.	79,424	15.5
	Wt	1,240.0	2.9	Wt	32,408.8	30.3	Wt	3,176.1	0.1	Wt	64,149.2	31.4	Wt	19,220.3	7.2	Wt	22,658	3.5	Wt	142,852.6	8.9
Vermilion Snapper	No.	2,498	26.2	No.	14,718	26.4	No.	18,241	31.4	No.	15,641	14.1	No.	512	0.7	No.	32,030	15.5	No.	83,640	16.3
	Wt	7,450.8	17.4	Wt	19,672.8	18.4	Wt	60,056.7	17.5	Wt	24,091.2	11.8	Wt	1,721.7	0.6	Wt	43,844.7	6.8	Wt	156,837.9	9.7
Groupers: *Mycteroperca*	No.	34	0.4	No.	1,048	1.8	No.	6,217	10.7	No.	1,415	1.2	No.	2,475	3.5	No.	6,373	3.1	No.	17,562	3.4
	Wt	834.7	1.9	Wt	8,677.7	8.1	Wt	127,449.8	37.2	Wt	12,944.9	6.3	Wt	27,432.7	10.3	Wt	85,547.8	13.2	Wt	262,887.6	16.3
Groupers: *Epinephelus*	No.	44	5.7	No.	228	0.4	No.	2,099	3.6	No.	206	0.2	No.	1,321	1.8	No.	6,218	3.0	No.	10,616	2.1
	Wt	5,381.3	12.5	Wt	1,451.0	1.4	Wt	26,803.3	7.8	Wt	1,975.4	1.0	Wt	11,167.4	4.2	Wt	52,692.7	8.1	Wt	99,471.1	6.2
"Red" Snapper 2/	No.	100	1.1	No.	9	0.1	No.	1,886	3.2	No.	101	0.1	No.	271	0.4	No.	1,615	0.8	No.	3,982	0.8
	Wt	1,452.8	3.6	Wt	135.2	0.1	Wt	27,023.4	7.9	Wt	830.3	0.4	Wt	3,018.6	1.1	Wt	27,762.5	4.3	Wt	60,222.8	3.7
Others	No.	3,054	32.1	No.	1,801	3.2	No.	3,146	5.4	No.	1,038	0.9	No.	2,431	3.4	No.	8,726	4.2	No.	20,196	3.9
	Wt	17,413.3	40.0	Wt	10,682.2	10.0	Wt	20,217.0	5.9	Wt	5,896.4	2.9	Wt	15,592.6	10.9	Wt	57,483.2	8.9	Wt	127,284.7	8.7
TOTAL Number		9,519	100.0		55,768	99.9		58,069	99.9		110,916	99.9		71,656	100.0		207,246	100.1		513,174	100.0
TOTAL Weight		42,833.0	100.0		107,047.7	100.1		342,847.7	99.2		204,091.6	100.0		251,843.5	99.8		646,565.9	99.9		1,595,229.4	99.9

1/ Weight (Wt) is in pounds.
2/ Includes other species of snappers, as well as red snapper.

Table 7. Catches by Carolina Head Boats during the 1974 Fishing Season. 1/

Species		Cape Hatteras, N. C.		Cape Lookout, N. C.				Cape Fear, N. C.				Cape Romain, S. C.				GRAND TOTAL (Inshore and Offshore)	
		Offshore	%	Inshore	%	Offshore	%	Inshore	%	Offshore	%	Inshore	%	Offshore	%		%
Porgies	No.	2,758	12.1	11,548	31.2	16,505	44.6	39,624	47.3	31,063	48.7	62,860	36.4	72,002	62.0	236,360	44.5
	Wt	9,155.4	17.9	13,418.6	22.5	51,483.6	25.9	86,622.3	43.6	85,486.3	37.1	98,418.6	43.1	179,188.3	47.4	523,773.1	38.9
Grunts	No.	0	0	10,515	28.4	1,438	3.9	30,295	36.2	16,906	26.5	60,816	35.3	4,518	3.9	124,488	23.4
	Wt	0	0	20,514.8	34.3	3,396.0	1.7	56,655.7	28.5	36,418.1	15.8	41,980.0	18.4	11,390.0	3.0	170,354.6	12.6
Vermilion Snapper	No.	16,731	73.5	12,206	33.0	9,268	25.0	9,105	10.9	4,351	6.8	38,174	22.1	18,120	15.8	107,955	20.3
	Wt	14,215.7	27.8	7,509.6	12.6	22,979.6	11.6	11,406.8	5.7	7,791.7	3.4	31,110.1	13.6	24,332.1	6.4	119,345.6	8.8
Grouper: <u>Epinephelus</u>	No.	653	2.9	159	0.4	962	2.6	618	0.7	619	1.0	768	0.4	5,070	4.4	8,849	1.7
	Wt	3,375.0	6.6	731.4	1.2	10,409.1	5.2	5,066.9	2.6	3,092.8	1.3	6,071.2	2.7	54,332.7	14.4	83,079.1	6.1
Grouper: <u>Mycteroperca</u>	No.	8	0.1	793	2.1	4,515	12.2	2,297	2.7	7,201	11.3	751	0.4	3,608	3.2	19,173	3.6
	Wt	161.2	0.3	9,902.1	16.6	81,049.8	40.7	28,404.3	14.3	76,218.0	33.1	9,750.7	4.3	47,751.4	12.6	253,237.5	18.8
"Red" Snapper 2/	No.	446	2.0	78	0.2	795	2.1	348	0.4	218	0.3	243	0.1	1,268	1.1	3,396	0.6
	Wt	6,407.8	12.5	365.6	0.6	11,586.0	5.8	2,401.2	1.2	1,971.5	0.9	2,624.4	1.1	11,457.2	3.0	36,813.7	2.7
Gray Triggerfish	No.	1,693	7.4	1,701	4.6	2,949	8.0	1,433	1.7	2,799	4.4	8,899	5.2	7,617	6.7	27,091	5.1
	Wt	10,421.2	20.4	6,541.9	11.0	15,840.5	8.0	7,766.4	3.9	17,685.7	7.7	38,589.2	16.9	35,160.8	9.3	132,005.7	9.8
Blackline Tilefish	No.	44	0.2	0	0	569	1.5	8	0.1	0	0	4	0.1	2,153	1.9	2,778	0.5
	Wt	166.4	0.3	0	0	2,128.0	1.1	29.5	0.1	0	0	31.2	0.1	12,628.5	3.3	14,985.7	0.8
Others	No.	436	1.9	40	0.1	2	0.1	72	0.1	627	1.0	0	0	147	0.1	1,324	0.2
	Wt	7,237.3	14.2	740.0	1.2	42.0	0.1	307.0	0.2	1,900.3	0.8	0	0	1,601.3	0.4	11,827.9	0.8
TOTAL Number		22,769	100.0	37,040	100.0	37,003	99.9	83,800	100.0	63,784	100.0	172,515	99.9	114,503	100.0	531,414	99.9
TOTAL Weight		51,142.0	100.0	59,724.0	100.0	198,914.6	100.0	198,660.1	100.0	230,564.4	100.1	228,575.4	100.1	377,842.2	99.8	1,345,422.9	99.6

1/ Weight (Wt) is in pounds.
2/ Includes other species of snappers, as well as red snapper.

Table 8. Catch and Effort by Carolina Head Boats during the 1972 Fishing Season. 1/ 2/

Time	Cape Lookout, N. C.		Cape Fear, N. C.		Cape Romain, S. C.		TOTAL	
	Inshore	Offshore	Inshore	Offshore	Inshore	Offshore	Inshore	Offshore
Spring:								
Angler-days	754	1,192	1,536	110	352	736	2,642	2,038
Fish/day	3.3	6.7	14.9	6.4	14.5	14.0	11.6	9.3
Wt/day	10.87	30.92	22.94	26.36	15.16	49.74	18.46	37.47
Wt/fish	3.2	4.6	1.5	4.1	1.0	3.5	1.6	4.0
June:								
Angler-days	767	1,757	3,162	379	1,137	3,186	5,066	5,322
Fish/day	4.6	5.3	10.6	7.8	12.8	15.7	10.2	11.7
Wt/day	9.98	31.49	17.3	32.73	12.9[illegible]	46.92	15.11	40.82
Wt/fish	2.2	6.0	1.6	4.2	[illegible]	3.0	1.5	3.5
July:								
Angler-days	1,346	2,566	3,743	518	1,590	3,451	6,679	6,535
Fish/day	4.4	4.7	5.7	7.7	15.6	13.3	7.8	9.5
Wt/day	10.66	25.23	10.30	32.05	20.50	39.60	12.80	33.36
Wt/fish	2.4	5.4	1.8	4.2	1.3	3.0	1.6	3.5
August:								
Angler-days	1,449	2,582	2,640	402	2,007	3,080	6,096	6,064
Fish/day	8.1	6.4	9.0	7.8	6.6	12.9	8.0	9.8
Wt/day	18.38	32.37	14.59	24.94	9.09	43.38	13.68	37.47
Wt/fish	2.3	5.1	1.6	3.2	1.4	3.4	1.7	3.8
Autumn:								
Angler-days	964	1,857	2,462	473	- - -	2,791	3,426	5,121
Fish/day	8.0	5.3	14.5	5.9	- - -	17.2	12.7	11.8
Wt/day	16.56	27.11	25.32	16.86	- - -	51.37	22.86	39.38
Wt/fish	2.1	5.1	1.7	2.9	- - -	3.0	1.8	3.3
Season TOTAL:								
Angler-days	5,280	9,954	13,543	1,882	5,086	13,244	23,909	25,080
Fish/day	5.9	5.6	10.1	7.2	11.4	14.7	9.5	10.5
Wt/day	13.79	29.22	16.89	26.52	13.94	45.28	15.58	37.50
Wt/fish	2.3	5.2	1.7	3.7	1.2	3.1	1.6	3.6

1/ Weight (Wt) is in pounds.
2/ Excludes black sea bass.
3/ Angler-days (see footnote 2 in text).

Table 9. Catch and Effort by Carolina Head Boats during the 1973 Fishing Season. 1/ 2/

Time	Cape Hatteras, N. C.	Cape Lookout, N. C.		Cape Fear, N. C.		Cape Romain, S. C.		TOTAL	
	Offshore	Inshore	Offshore	Inshore	Offshore	Inshore	Offshore	Inshore	Offshore
Spring:									
Angler-days 3/	---	1,494	2,741	2,041	452	---	3,422	3,535	6,615
Fish/day	---	8.1	5.0	15.5	9.6	---	9.9	12.3	7.9
Wt/day	---	14.8	29.8	30.5	27.4	---	34.2	23.8	31.9
Wt/fish	---	1.8	5.9	2.0	2.9	---	3.5	1.9	4.1
June:									
Angler-days	---	1,516	2,341	2,251	501	---	3,638	3,767	6,480
Fish/day	---	8.0	4.5	11.81	9.6	---	11.3	10.3	8.7
Wt/day	---	14.4	23.9	21.2	35.6	---	33.1	18.5	29.9
Wt/fish	---	1.8	5.3	1.8	3.7	---	2.9	1.8	3.4
July:									
Angler-days	560	1,924	2,459	2,102	1,826	---	4,489	4,026	9,334
Fish/day	5.4	7.6	4.5	10.8	8.3	---	10.4	9.3	8.4
Wt/day	24.9	16.7	25.4	20.0	34.0	---	34.7	18.6	32.5
Wt/fish	4.7	2.2	5.6	1.9	4.1	---	3.3	2.0	3.9
August:									
Angler-days	695	1,140	2,107	948	1,815	---	3,666	2,088	8,283
Fish/day	5.4	5.3	4.8	14.2	9.6	---	9.3	9.3	7.9
Wt/day	22.3	8.8	27.7	23.1	33.1	---	30.4	15.3	29.6
Wt/fish	4.2	1.7	5.8	1.6	3.5	---	3.3	1.6	3.8
Autumn:									
Angler-days	343	1,721	3,694	1,108	2,899	---	5,622	2,829	12,558
Fish/day	8.2	6.4	3.4	15.0	9.6	---	9.1	9.8	7.5
Wt/day	40.0	11.9	22.9	27.2	31.1	---	25.3	17.9	26.3
Wt/fish	4.8	1.9	6.8	1.8	3.3	---	2.8	1.8	3.5
Season TOTAL:									
Angler-days	1,598	7,795	13,342	8,450	7,493	---	20,837	16,245	43,270
Fish/day	6.0	7.2	4.4	13.1	9.6	---	10.0	10.3	8.0
Wt/day	26.9	13.7	25.7	24.2	35.4	---	31.0	19.2	29.7
Wt/fish	4.9	1.9	5.9	1.8	3.7	---	3.1	1.9	3.7

1/ Weight (Wt) is in pounds.
2/ Excluding sea bass.
3/ Angler-days (see footnote 2 in text).

Table 10. Catch and Effort by Carolina Head Boats during the 1974 Fishing Season. 1/ 2/

Time	Cape Hatteras, N. C.	Cape Lookout, N. C.		Cape Fear, N. C.		Cape Romain, S. C.		TOTAL	
	Offshore	Inshore	Offshore	Inshore	Offshore	Inshore	Offshore	Inshore	Offshore
Spring:									
Angler-days 3/	14	929	1,954	1,698	888	4,488.5	2,253	7,115.5	5,109
Fish/day	35.2	4.7	3.2	8.7	10.5	4.1	11.9	5.3	8.4
Wt/day	138.2	8.1	19.0	15.0	30.9	3.9	38.0	7.1	29.8
Wt/fish	3.9	1.7	6.0	1.7	2.9	1.0	3.2	1.3	3.5
June:									
Angler-days	212	908	1,913	1,799	1,214	6,899.75	2,908	9,606.75	6,247
Fish/day	19.6	5.6	3.0	9.4	8.8	3.7	8.9	5.0	7.4
Wt/day	30.6	11.5	17.2	22.6	33.7	4.7	29.0	8.7	26.4
Wt/fish	1.6	2.1	5.7	2.4	3.8	1.3	3.3	1.8	3.5
July:									
Angler-days	408	1,354	2,187	2,783	1,409	10,917.75	2,706	15,054.75	6,710
Fish/day	24.7	7.2	3.1	7.7	10.7	4.2	7.6	5.1	7.8
Wt/day	35.4	11.6	16.8	19.5	37.8	5.4	27.0	8.6	26.5
Wt/fish	1.4	1.6	5 4	2.5	3.5	1.3	3.5	1.7	3.4
August:									
Angler-days	374	1,127	1,788	2,026	1,120	9,588.25	2,600	12,741.25	5,882
Fish/day	11.4	8.1	3.8	8.4	13.0	4.1	6.3	5.1	7.1
Wt/day	48.9	11.6	18.6	23.3	50.6	5.4	24.6	8.8	29.3
Wt/fish	4.3	1.4	4.9	2.8	3.9	1.3	3.9	1.7	4.1
Autumn:									
Angler-days	168	1,365	2,762	1,335	1,488	7,354.25	2,669	10,054.25	7,087
Fish/day	22.6	6.4	4.2	10.3	9.5	5.9	9.3	6.6	7.6
Wt/day	59.6	9.5	21.3	23.3	35.2	9.1	26.5	11.0	27.1
Wt/fish	2.6	1.5	5.1	2.3	3.7	1.5	2.9	1.7	3.5
Season TOTAL:									
Angler-days	1,176	5,683	10,604	9,641	6,119	39,248.5	13,136	54,572.5	31,035
Fish/day	19.4	6.4	3.5	8.7	10.4	4.4	8.7	5.4	7.7
Wt/day	43.5	10.5	18.8	20.6	37.7	5.8	28.8	8.9	27.7
Wt/fish	2.2	1.6	5.4	2.4	3.6	1.3	3.3	1.7	3.5

1/ Weight (Wt) is in pounds.
2/ Excludes black sea bass.
3/ Angler-days (see footnote 2 in text).

shoreward limit of distribution of the more tropical fishes and that the angling success on inshore boats could not be adequately represented without including black sea bass. The estimated black sea bass catch in 1973 was 211,000 pounds in North Carolina, and we believe an equal or greater amount was landed in South Carolina. In 1974, 150,904 pounds of black sea bass were landed by North Carolina head boats and 439,229 pounds by head boats in South Carolina, for a total catch of 590,133 pounds.

Angling Quality

Angling quality is a concept that relates to the satisfaction experienced by an angler as a result of his fishing trip. This satisfaction is derived from both objective components that relate to the catch, such as number and size of fish caught, and subjective components, such as the fellowship experienced and the pleasure of being at sea. For this discussion, we measured angling quality in terms of the number and weight of fish caught per angler and the average weight per fish caught (Tables 8, 9, and 10).

Anglers aboard offshore head boats took large catches and large fish. Weight of the catch per angler-day in 1972 averaged 37.5 pounds for offshore boats, and season averages for offshore subdistricts ranged from 26.5 to 45.3 pounds. In 1973 the overall offshore average was 29.7 pounds, and offshore subdistrict averages ranged from 25.7 to 35.4 pounds. Average offshore catch per angler-day was 27.7 pounds in 1974, and the range was from 18.8 to 43.5 pounds. For all offshore subdistricts, average weights of fish ranged from a high of 5.9 pounds at Cape Lookout in 1973 to a low of 2.2 pounds at Cape Hatteras in 1974.

Catches on the inshore boats consisted of more and smaller fish than those on offshore boats, although poundage per angler was about the same. For instance, in 1973 Cape Lookout and Cape Fear anglers averaged about 32 pounds (19.2 pounds, excluding black sea bass) per day on inshore vessels versus 28.5 pounds per day offshore, but the inshore catch was composed of much smaller fish than those offshore. Nearly half the inshore catch was of black sea bass, and these rarely exceeded 1 pound. In all inshore areas in 1972, 1973, and 1974, species other than black sea bass averaged 1.6, 1.9, and 1.7 pounds, respectively; in all offshore areas, they averaged 3.6, 3.7, and 3.6 pounds, respectively. The average size of inshore fish was smaller, not only because there were fewer large species available, but because fish of the same species were usually smaller inshore than offshore (Tables 5, 6, and 7).

Species Caught

Like commercial handline fishermen head boat captains desire most to catch "red snapper" (including red,silk, and balckfin snappers) and groupers. Head boat captains state that in the early 1960's offshore catches were almost entirely snappers and groupers. This is not the situation today, even though most operators advertise snapper fishing trips. Now, red porgy, vermilion snapper, white grunt, and groupers are the most numerous fishes caught, other than black sea bass (Tables 5, 6, and 7).

Porgies, the most commonly caught being the red porgy (also called "silver snapper"), provided the largest catch in number and weight in all years, and is one of the most important recreational fishes of our Southeast Atlantic Coast. In the Carolinas alone, approximately 216,000 porgies, weighing nearly 519,000 pounds, were taken in 1972; 298,000, weighing 746,000 pounds, in 1973; and 236,000, weighing 524,000 pounds, in 1974. Red porgy are also taken off Georgia, the east coast of Florida, and in the eastern Gulf of Mexico.

The black sea bass, taken almost entirely by inshore boats, is by weight as important as the red porgy.

Groupers (including scamp, gag, and hinds) collectively by weight rank third in the catch, although their contribution in numbers is small. The species composition of the grouper catch varies over the Southeast Coast. Scamp occurred only irregularly north of central Onslow Bay but were extremely important to vessels fishing south of there. Gag were important throughout the fishery but were most abundant in the Cape Lookout catches. Snowy and yellowedge groupers seemed abundant in deep water (60 - 80 fathoms) throughout the area. The speckled hind, a large fish that has been caught as large as 45 pounds in South Carolina and 38 pounds in North Carolina, was common throughout the area and, with the gag, appears to have the most northern distribution. Warsaw grouper attain prodigious weights but were caught only occasionally. The records for Warsaw grouper are 245 pounds in North Carolina and 310 pounds in South Carolina. Several 100-pound Warsaw grouper are caught each year.

Vermilion snapper, often erroneously called "red snapper" aboard head boats, and grunts, principally white grunt, shared ranking as the fourth and fifth most productive species and were more numerous in the catch than groupers. More pounds of grunts were caught in 1972 and 1974 and more pounds of vermilion snapper in 1973. Vermilion snapper, caught from both offshore and inshore boats, were usually larger offshore. In 1972 those taken offshore averaged 2.3 pounds versus 0.9 pounds for those taken inshore.

Grunts were extremely important to inshore boats; but, they also commonly occurred in the catches of offshore boats in South Carolina and southern North Carolina, where the fishing subdistricts seem less distinct than in the north. White grunt were often found with scamp, on rocks in 18-25 fathoms southward from mid-Onslow Bay, and with black sea bass, porgies, and vermilion snapper, northward of this area.

Red, yelloweye (or silk), and blackfin snappers, all commonly known as "red" snapper, were not abundant even though head boats advertise "red snapper fishing." Only 2,187 "red" snapper were taken in 1972; 3,982, in 1973; and 3,396, in 1974. They are, however, usually large, averaging over 18 pounds per fish in 1972, over 15 pounds in 1973, and over 10 pounds in 1974. Because of their large size, relative scarcity, and fine tasting flesh, fishermen prize them highly.

Our category of "other fishes" includes greater amberjack, almaco jack, gray tilefish, and gray triggerfish. Available from 25 to over 100 fathoms, both jacks are large, fierce fighters; the greater amberjack commonly attains a weight of 50 pounds and the almaco, 30 pounds. Although the flesh is good tasting, few people eat it, possibly because 75% or more of the amberjacks carry heavy infestations of tapeworms in the flesh.

Gray tilefish, a relatively recent addition to head boat catches, are regularly taken from water deeper than 30 fathoms. Although of equally good flavor, they do not attain the size of the tilefish (Lopholatilus chamaeleonticeps), a popular sport fish of the Northeast Coast that appears to be a colder water species. In the Southeast, L. chamaeleonticeps might occur farther offshore than the gray tilefish.

Gray triggerfish, which anglers formerly discarded but now accept with enthusiasm, are common from 10 to 30 fathoms. They are good fighters, but are clever at stealing bait and are difficult to hook. Their flesh is white, sweet, very firm, and makes excellent chowder. Because tilefishes and gray triggerfish are now significant to the catch, we list them separately in the summary of 1974 catches (Table 7).

COMPARISON OF COMMERCIAL AND RECREATIONAL CATCHES

Although complete records of commercial catches from the Carolina Continental Shelf are unavailable, it appears that the head boat fishery took at least three to five times as many pounds of groupers and snappers in 1972, 1973, and 1974. Commercial grouper and snapper landings for North Carolina and South Carolina averaged 111,414 pounds per year for 1972, 1973, and 1974. Head boat grouper and snapper catches averaged 516,641 pounds per year (388,883, excluding vermilion snapper) for the same period. It is unlikely that unreported catches made by transient commercial vessels are sufficient to equal the great difference between reported commercial and head boat landings each year.

FACTORS AFFECTING CAROLINA OFFSHORE BOTTOM FISHERIES

Future development of both the commercial and recreational fisheries will depend foremost on the resource. Prospects for a larger commercial fishery are not good if it must depend only upon snappers and groupers. Red snapper are no longer abundant, and most important groupers (scamp, gag, snowy grouper, and speckled hind) have been rapidly reduced by fishing (Huntsman and Dixon, In press). Grouper and snapper populations have, historically, decreased quickly when fished intensely, and the fishery has been maintained primarily by shifts to new fishing areas (Carpenter, 1965; Bell et al., 1972; Moe, 1975). Thus, a large fishery for only snappers and groupers of the Carolina Shelf probably would be of short duration. On the other hand, snappers and groupers in this area could probably support less intense fisheries indefinitely, especially if fishermen also utilize other more abundant species, such as porgies and grunts. The current handline and head boat fisheries are of relatively low intensity, the former because there are few vessels, the latter because the time vessels spend on the fishing grounds is limited.

Also, both fisheries readily utilize all available species and seem to be in approximate equilibrium with the fish populations.

Weather influences both commercial and recreational fisheries. The Carolina Capes are notoriously windy, especially in winter. Strong winds are most prevalent off Cape Hatteras, where the Labrador Current and Gulf Stream meet, but are less frequent southward. Weather good enough for fishing may occur at any time, but it is infrequent from October through April off Cape Hatteras, November through March off Cape Lookout, and December through March off Cape Fear and Cape Romain. Even in summer it is usually far windier off Capes Hatteras and Lookout than in traditional snapper fishing areas of the Gulf of Mexico and Caribbean Sea. Commercial fishermen are most affected by weather because they need to make trips during all seasons and because they must stay at sea several days. Head boat operation is sufficiently lucrative that most vessels are tied up for the winter; but, because only one day of good weather is necessary for a trip, during any given month some operators will fish.

Currents are troublesome to fishermen, especially off Capes Hatteras and Lookout, where the Gulf Stream is nearest shore. On many days the strong and unpredictable currents completely preclude fishing in water deeper than 25 fathoms. Recreational fishermen probably are more inconvenienced by currents than commercial operators, because the latter can wait until currents cease or rig anchors; but head boats usually have neither the time nor the gear to successfully contend with currents.

Marketing is a problem to commercial fishermen in the Carolinas. Many dealers do not buy snappers and groupers, and, in general, prices for these fish are lower in the Carolinas than in the traditional marketing centers of the Gulf Coast. Thus, most transient fishermen ship or carry their catch back to their home port. On the other hand, Carolina dealers who do handle snappers and groupers will also buy other bottom fishes, allowing fishermen additional income.

Head boat and commercial operators currently face problems related to the energy crisis and economic recession. The number of head boat customers was obviously much smaller in 1975 than in earlier years, and fuel costs have doubled. Fuel is a major expense to head boat operators, to whom high speed and daily long runs are a necessity. Faced with lower business volume, several captains have reduced their scope of operations to cut fuel costs. Some offshore boats have remained inshore, and some have switched from full-to half-day trips. Commercial operators, who can operate at more efficient speeds and stay at sea longer, are less troubled by fuel costs, and fish prices have remained generally high despite the economic recession.

RECREATIONAL-COMMERCIAL CONFLICTS

Relations between Carolina commercial fishermen and head boat operators are unusually cordial, but the differing modes of operation of the two fisheries engenders occasional conflict. Commercial snapper boats will often fish on a productive site until the fish have ceased biting or are "all" caught. Often a year or more elapses before a site again provides acceptable fishing. To a commercial fisherman who is highly mobile, the consequence of "fishing out" several sites is slight. On the other hand, head boat operators are restricted to a single port and a rather stringent time schedule. They must find good fishing within a few hours of the home port. Although intensive fishing on one site probably has little effect on the population of fishes as a whole, it could handicap head boat fishermen by overexploiting accessible fishing spots.

CONCLUSIONS

If resource managers choose to preserve the present head boat fishery, they would do well to avoid the traditional management goal of maximum sustained yield and to seek instead a goal of maximum catch per unit effort. Maximum sustained yield is usually achieved at some average catch-per-unit effort that is much less (perhaps 50%) than in a virgin fishery. The success of the head boat fishery depends on a high catch-per-unit-effort of large fish that can only come from lightly exploited populations. Only if anglers are guaranteed a high quality reward, will they repeatedly pay $25 - $35 to undergo early morning departures, late returns, and a 6-to 8-hour pounding, monotonous ride for 4-6 hours of fishing. The catch-per-unit-effort of large fish is now sufficiently high to earn much repeat business for the head boats. Management to attain maximum sustained yield would probably drop the catch-per-unit-effort low enough to drive most of the sport fishermen to more rewarding and less demanding types of fishing. If managers choose to foster a commercial fishery, either in conjunction with or instead of a recreational fishery, they must recognize that intensive exploitation has brought rapid decline of snapper and grouper stocks in almost every instance. In the long run, a small fishery in balance with growth and recruitment of these fishes will furnish the greatest benefit to society.

LITERATURE CITED

Bearden, C. M. and M. D. McKenzie.
1971. An investigation of the offshore demersal fish resources of South Carolina. S. C. Wildl. Resour. Dep., Mar. Resour. Div., Tech. Rep. No. 2, 19 p.

Bell, F. E., W. E. Schaaf, E. W. Carlson, and G. Hirschorn.
1972. The extent of capitalization in United States fisheries. Administrative Report, U. S. Dep. Commer., NOAA, NMFS, Wash., D. C., 419 p.

Buller, R. J.
1951. A fishery survey of southern coastal waters. U. S. Dep. Inter., Fish Wildl. Serv., Spec. Sci. Rep. 58, 21 p.

Bullis, H. R., Jr. and J. R. Thompson.
1965. Collections by the exploratory fishing vessels OREGON, SILVER BAY, COMBAT, and PELICAN made during 1956-1960 in the southwestern North Atlantic. U. S. Dep. Inter., Fish Wildl. Serv., Spec. Sci. Rep., Fish. No. 510, 130 p.

Carpenter, J. S.
1965. A review of the Gulf of Mexico red snapper fishery. U. S. Dep. Inter., Fish Wildl. Serv., Circ. 208, 35 p.

Huntsman, G. R.
In press. Offshore headboat fishing in North Carolina and South Carolina. Mar. Fish. Rev.

Huntsman, G. R. and R. L. Dixon.
In press. Recreational catches of four species of groupers in the Carolina headboat fishery. Southeastern Association of Game and Fish Commission.

Moe, M. A.
1975. Biologist urges return to sea-fish hatcheries. Natl. Fisherman 56(6): 3-B and 15-B.

North Carolina.
1969. R/V DAN MOORE cruise report 020. N. C. Dep. Nat. Economic Resour., Div. Mar. Fish., 8 p.

Power, E. A.
1959. Fishery statistics of the United States 1957. U. S. Dep. Inter., Fish Wildl. Serv., Stat. dig. No. 44, 429 p.

Struhsaker, P.
1969. Demersal fish resources: composition, distribution, and commercial potential of the continental shelf stocks off southeastern United States. Fish. Ind. Res. 4(7): 261-300.

TRAPPING EXPERIMENTS WITH SNAPPERS IN SOUTH FLORIDA

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ABSTRACT

Experiments with a new design, low-cost, shallow-water (17 m) fish trap deployed off Boca Raton, southeastern Florida, show encouraging results. Snappers (Lutjanidae) are the target species for this rigid-frame rectangular device. Twenty units produced 4,449 kg of snappers and approximately 1,483 kg of miscellaneous fishes by thigmotropic attraction during a 6-month test. Initial catch rates of 9.26 kg/haul for 5-day soaks gradually declined with deteriorating trap condition and apparent effects of seasonality. Successful deployment requires careful placement with respect to adjacent habitat, diurnal schooling sites, and prevailing current direction. These traps constitute a practical means of producing dependable income for commercial fishing.

INTRODUCTION

Although most Colloquium participants have concentrated on problems of decline in our snapper and grouper resources, this paper documents successful results with trapping under-exploited species of snappers. Based on Munro's (1973, 1974) pioneer scientific experiments in Jamaica, an improved version of this basic funnel entrance was developed and installed in traps that yielded substantially higher catch rates. Two years of sea tests confirm many of Munro's findings, but also identify several problems and processes not previously described.

Modernization of trap construction and hauling methods, together with intelligent deployment, make it possible for commercial fishermen to supplement existing income or to establish a specialized trap fishery, where habitat conditions are suitable. A careful examination of these trapping techniques indicates the limitations are those of marketing rather than gear effectiveness.

HISTORICAL PERSPECTIVE

Traps are recognized as an ancient, if not the earliest, method of fishing. Their evolution in Europe has been extremely complex and well documented (Sirelius, 1906). In the New World, and especially in the Caribbean, Spanish explorers found aborigines trapping fish throughout the Greater and Lesser Antilles. Before details concerning these native American traps could be accurately described, the Indian population was largely destroyed and was replaced by Negro slaves who introduced new designs of West African origin. What generally are referred to as Antillean traps ("arrowhead," "S," or "Z" traps) (Buesa-Mas, 1962) are mostly cultural relics introduced into the Caribbean at an early date. In any event, trap fishing has remained solidly in the hands of ethnic groups lacking social mobility (such as the Black Carib). By association, trapping of fish and the devices themselves historically have been held in low regard.

In peninsular Florida no significant commercial fishing was conducted before the 1870's, when shad became an important resource on the lower St. Johns River (Munro, 1885). The beginning of trap fishing has gone largely unpublicized, except for an interesting account by Long (1942). This Florida west coast effort involved 50 large, wood-frame, wire mesh traps of 2.72 m^3 capacity. Although nothing is known regarding the type of habitat fished, this early experiment by a fish house owner did establish the susceptibility of the blue runner (Caranx crysos) to trapping. (See Table 2 for an equivalent contemporary event.) Godcharles (1970) has documented a more recent and rather insignificant Florida west coast trap fishery for southern sea bass conducted by a few retired fishermen.

PRESENT EXPERIMENTS

Beginning in May 1974, data were collected from four traps set on a variety of substrates and in various depths in south Florida offshore waters opposite Boca Raton. Test sites in depths of 3-40 m were chosen to sample numerous representative habitats, including open sand, "feather bottom," coral-rock rubble, and submerged water-table rock, having a dense epiphytic growth of live corals and gorgonians. Detailed descriptions and profiles of the test area are contained in Courtenay et al. (1974)and Craig (1974).

Almost immediately, it was evident from catch composition that high-relief (1-5 m) rocky areas as trap sites produced unwanted reef species such as tangs (Acanthurus spp.), parrotfishes (Scarus spp.), and angelfishes (Holacanthus spp.). Traps set on sand in very shallow (less than 10 m) water were generally unproductive or nonproductive of target species (Lutjanidae). Experiments in water deeper than 40 m were not attempted because of strong currents and the resultant difficulty with buoyage. However, it is known that seasonal concentrations of Lutjanus vivanus (silk snapper) and Lutjanus analis (mutton snapper) forage over this deeper zone, with the former species extending offshore to depths of perhaps 300 m or more. Practical techniques for exploiting this interesting area remain to be developed.

As experience was gained in manipulating and deploying these fish traps, optimum results were obtained by placing them on an open sand environment in approximately 17 m, with a spacing interval of 200-300 m.

Target species were expected to be mangrove or gray snapper (Lutjanus griseus) and the mutton snapper (L. analis). However, from the beginning most catches were dominated both in weight and numbers by lane snapper (Lutjanus synagris) to an extent that entire hauls of as much as 39 kg consisted of this species (Fig. 6). Eventually, all of the locally known Lutjanidae, including Lutjanus mahogoni (mahogany snapper) and Lutjanus buccanella (blackfin snapper), as well as the related yellowtail (Ocyurus chrysurus) and vermilion snapper (Rhomboplites aurorubens), were caught, so there is ample justification for referring to them as snapper traps.

Eventually, the study area was extended from Boca Raton Inlet to Delray Beach, Florida. Twenty traps were finally built, and catch weights were recorded for 6 months, starting in February 1975. To reduce losses from boat traffic, two separate buoy lines, supported by two buoys each, were used. Depth placement and inter-trap spacing were carefully maintained on these permanent stations in order to facilitate recovery of lost traps by divers. When conditions permitted, the complete trap string was hauled with standard hydraulic pinch-puller during a single trip to permit uniform soak times of 4 or 5 days. Statistical analysis (to be published elsewhere) was complicated by many interruptions in this ideal pattern.

TRAP DESIGN

Unlike any previously published design, traps used in this study were built to fit conveniently inside an enclosed truck that transported them from the assembly area to the dock. The result was a rectangular, welded, steel frame made from No. 4 reinforcing rods, having outside dimensions of 1.22 x 2.43 x 0.61 m and a volume of 1.80 m^3 (Figs. 1-4). The frame required 22 spot welds and took one hour to fabricate. The number of welds could not be easily reduced by available hydraulic bending.

Frames were covered by galvanized 18-gauge, hexagonal, poultry wire mesh (1.5- to 2-inch diameter), tautly stretch and secured by numerous No. 2

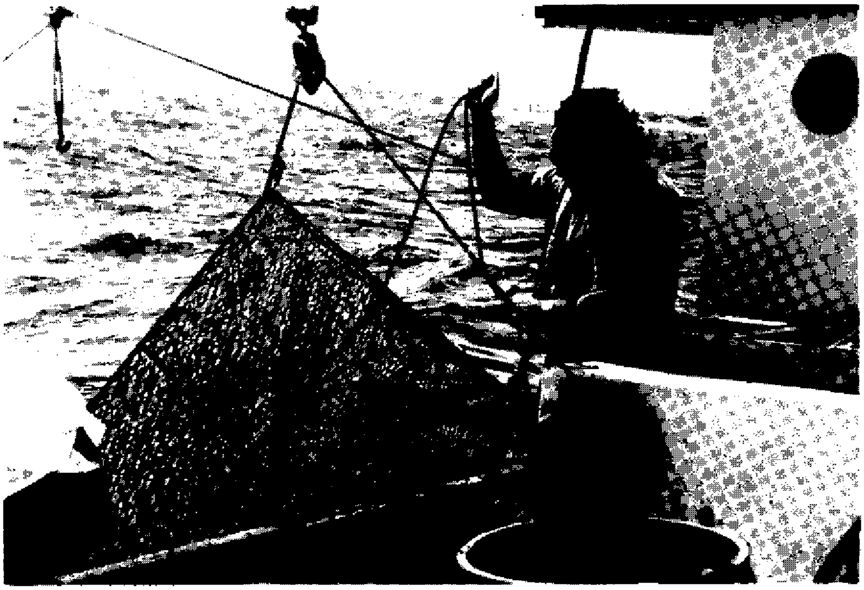

Figure 1. Retrieving a trap by hydraulic pinch puller with pot warp run through a boom-rigged snatch block. Note heavy algal fouling on mesh wire. Rotation of the frame has begun, to bring the trap on board by hand.

Figure 2. Landing a new, clean trap showing details of frame construction.

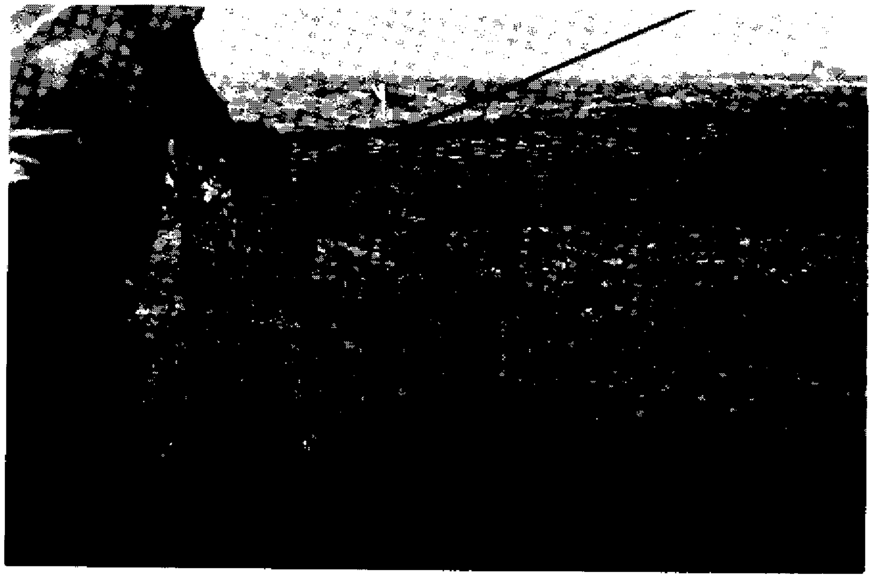

Figure 3. View of a funnel suspended from the top panel of a trap, with entrance facing outboard. The downward slope and the small exit face the camera.

Figure 4. A landed trap with a typical catch ready to be emptied into sorting boxes for weighing.

Figure 5. A typical mixed catch of lane and gray (mangrove) snappers with lesser amounts of blue runner and tomtate. These fishes were in excellent condition, free of any lacerations after a 5 -day soak.

Figure 6. An example of conspecific attraction in a catch consisting entirely of mature lane snapper. These fish have been emptied directly from the trap onto crushed ice and were marketed in the round two hours later in excellent condition.

"hog rings." This method of attachment was found to be faster than soft wire lacing and clearly reduces chances of long rips or separations along seams. Several traps were built with vinyl covered mesh, but no advantages were noted in catch rates to offset the additional cost.

Two funnels of a Munro design (Munro, 1973; Fig. 3), modified by removing the final fold, were installed in diagonally opposite corners of each trap. Buoy lines of 5/16-inch, black, polypropylene pot warp were shackled to the remaining opposite corners. A rubber-hinged door was cut into a bottom corner across from a funnel.

To inhibit electrolysis, two zinc anodes were tightly wired to the frame and mesh near each funnel, so that top, bottom, and side panels were in direct contact with the attachment wires.

RESULTS

Of the 20 traps deployed in February 1975, 19 were still present in April after 257 trapping events had been recorded. The total cumulative catch was 2,380 kg of snappers with an average catch of 9.25 kg/haul. At the end of 6 months, 17 traps, representing 620 events and 101 trap-months of fishing effort, yielded 4,449 kg of snappers, for an average of 7.17 kg/haul. The associated catch of all other species was not weighed in the field, but it was estimated to constitute about one-third of the total snapper weight, or an additional 793 kg and 1,483 kg, respectively, for the two periods indicated above. Total fish production from these traps for the 6-month period was 5,932 kg.

The effectiveness of this fishing method is evident when we consider that some of these traps had been in use since May 1974, producing catches prior to February 1975 in excess of the 9.25 kg/haul figure. The catch-per-unit-effort subsequent to August 1, 1975 declined below 7.17 kg, but remained substantial.

During the trial period some 4.5 hauls would theoretically have been required to pay for each trap, based on a cost of $52 per trap placed in the water and a 50¢/lb round weight price for all snappers.

Table 1 illustrates the results obtained in south Florida compared to Caribbean experiments of similar design.

Abnormal catches associated with seasonality, spawning, and other factors as yet unknown are indicated in Table 2. These figures list some of the extremes in variability encountered during the project.

Ranking of species by frequency has been reported by Munro (Munro, Reeson, and Gaut, 1971) for his Jamaican test site. Table 3 indicates that an entirely different rank-order exists in the present study area.

CATCH DETERMINANTS

With the appearance of Munro's excellent reports, many aspects of trap

Table 1. Comparison of Fish Trap Catches

	Area		
	Boca Raton	Jamaican 1/ Banks	North 2/ Leeward Banks
Average soak (hr)	108.00	18.00	16.40
Snappers (kg)	9.25	7.62	11.65
Other fishes (kg)	3.08		2.94
Number of trap hauls	257.00	226.00	26.00

1/ Wolf and Chislett (1974).
2/ Chislett and Yesaki (1974).

Table 2. Atypical Trapping Events -- Single Haul Totals.

Species	Number	Weight (kg) 1/
Umbrina coroides 2/ (sand drum)	42	22.67
Kyphosus sectatrix 2/ (Bermuda chub)	15	54.43
Caranx crysos (blue runner)	920	158.75
Caranx bartholomaei (yellow jack)	11	90.71
Lutjanus synagris (lane snapper)	-- 3/	40.82
Lutjanus apodus 2/ (schoolmaster)	52	45.35

1/ Estimated.
2/ Only trapping record.
3/ Number unknown.

Table 3. Composition of Fish Trap Catches by Weight for Three Areas.

Family	South Florida (%)[1/]	Saba Bank[2/] (%)	Family	Jamaica[3/] (%)
Lutjanidae (Snappers)	70.0	79.3	Scaridae (Parrotfishes)	16.4
Carangidae (Jacks and pompanos)	12.0	7.3	Acanthuridae (Surgeonfishes)	15.2
Pomadasyidae (Grunts)	8.0	-	Pomadasyidae (Grunts)	11.6
All others	10.0	13.4	Palinuridae (Spiny Lobsters)	8.1
Total	100.0	100.0	Serranidae (Sea basses)	7.9
			Lutjanidae (Snappers)	4.0
			Carangidae (Jacks and pompanos)	3.5
			All others	33.3
			Total	100.0

1/ Estimated.
2/ Wolf and Chislett (1974).
3/ Munro, Reeson, and Gaut (1971).

fishing in the Caribbean have been clarified and statistically demonstrated by means of a mathematical model. However, while all of the factors affecting trap ingress in the Jamaican study seem to be at work in south Florida (moon phase, tidal rhythms, conspecific attraction, and trap design), several other catch determinants evidently have influenced results of the present project.

Regardless of moon phase or trap condition, unfavorable catches were associated with quiet sea conditions in conjunction with clear Florida Current water moving slowly through the fishing grounds. Conversely, favorable catches were associated with rough seas, turbid water, and strong bottom currents, especially when these conditions prevailed for several days. The combination of a neritic water mass with strong, reversing long shore currents resulted in the best yields. During occasional periods of prolonged disturbed weather and rough sea conditions, snappers, especially *L. analis* and *L. griseus*, are known to move inshore to the surf zone, where they feed actively during the day.

When traps are placed on a broad, sandy submarine plain, they become the most prominent bottom feature and can be seen by divers from a considerable distance. Small fishes, particularly the tomtate (*Haemulon aurolineatum*), approach the trap almost immediately. These fish are often the most prevalent component of the catch; their numbers increase through conspecific attraction, as is the case with lane snapper. Under circumstances described in detail by Starck and Davis (1966) and Starck and Schroeder (1971), gray snapper leave their diurnal schooling sites to feed over a wide territory at night. At this time they encounter traps already occupied by small fishes that are the natural prey of the larger gray snapper. Entry of predators, such as groupers, barracuda, jacks, etc., is probably governed by interest in the smaller occupants who have entered before them. Simple curiosity, then, does not seem to be required for ingress, and it is probably inaccurate to refer to these trap designs as "curiosity traps."

Seasonality is an important factor affecting fish trap success. Unfortunately, beyond the study by Moe (1972), virtually nothing is known about such concentrations and movements of non-pelagic fishes in southern Florida. It is evident from Table 2 that various fishes make sudden, unexplained appearances in the study area, but the causes have not been determined. It is not logical to blame slowly declining catch rates entirely on gradually deteriorating trap condition. Instead, it seems likely that seasonal variations in snapper density may account for many of these changes in catch rate. Lane snapper, in particular, are known to form large spawning schools in late spring, after which they become relatively dispersed. However, in the study area, where fishing grounds are highly compressed (the 200-m isobath is found less than 5 km offshore), substantial quantities of snappers can be caught throughout the year. Around sea-floor projections or over broad foraging grounds, snappers may become too dispersed seasonally to permit commercial fishing.

PROBLEMS

Some atypical catches listed in Table 2 constitute a deviation from snappers as the target species; and where they are not locally salable, these catches must be considered an economic problem. Even vermilion snapper (*R. aurorubens*), considered highly desirable in Florida east coast restaurants, curiously have no commercial value at all on the Florida west coast (E. A. Joyce, Jr., pers. comm.).1/ In this same regard, Bohlke and Chaplin (1968) remarked that many fishes (e.g., Caranx bartholomaei, yellow jack), considered troublesome pests during these experiments, are, in fact, valuable commercial species elsewhere. The blue runner (Caranx crysos) is another example of a seasonally abundant component of the catch that cannot readily be sold in south Florida. During October 1975 some traps became so clogged with blue runner that they presented considerable difficulty in landing.

Since our traps are believed to exert a high degree of thigmotropic attraction for a wide variety of fishes, the only means of avoiding unwanted species appears to be through deployment of the traps in zones not frequented by these schooling species but still frequented by foraging snappers. Such trap manipulations are probably beyond the ability of most fishermen who are not aware of these subtle distinctions on entering a new fishery.

Spiny lobster (Panulirus argus) occasionally constitute a problem by occupying and defending one or both funnel entrances, effectively blocking entry of fish. We have a record of one mass entry of 30 adult P. argus in a single trap during August 1975. Contrary to the results reported by Munro (1973, 1974) and Ting (1972), no Spanish lobster (Panulirus guttatus) have entered these traps, since they invariably have been placed on open sand bottoms, far from the caves and deep crevices preferred by this smaller species.

There is considerable evidence to indicate that newly constructed traps have unusually high catch rates, sometimes well above the 11.3-kg mean (Craig, In prep.), but a gradual decrease tends to occur with time. There is an inverse relationship between trap catch rate and the occurrence of assorted marine fouling, particularly by algae, which may represent a deterrent to ingress and thus constitutes a chronic problem. Various methods of hand cleaning the traps were systematically applied, but the effects on catch rates were inconclusive. Toward the end of this project, soft sponges and algal fouling (Fig. 1) were successfully removed from traps by on-board spraying of filtered sea water with a high (1,000 p.s.i.) pressure roof-cleaning machine.

Fortunately, theft is not a serious problem in this fishery, since the traps are too heavy to be lifted by the casual boatman. Also, the contents cannot easily be removed by divers. Nevertheless, trap losses approaching 20% for a 6-month period under circumstances suggesting that not all fell victim to boat traffic. Wolf and Chislett (1974) reported trap losses of 10-20% per trip in their exploratory cruises along shelf edges in the Windward Islands and off northeastern South America.

1/ E. A. Joyce, Jr., Chief, Bureau of Marine Science and Technology, Florida Department of Natural Resources, Tallahassee, FL 32304, pers. comm.

FISH TRAPS AND CONSERVATION

From the irrational variety of restrictive county ordinances attempting to regulate use of fish traps in south Florida, it is evident that much confusion and primitive thinking still surrounds this subject, in spite of the succinct analysis of the problem by Munro (Munro, Reeson, and Gaut, 1971). The prevailing view of most conservationists and some fishermen is that lost traps -- Hipkins (1974) calls them "ghost traps" -- somehow continue to attract cumulative increasing numbers of fishes or lobsters for a long, but unspecified, period of time. To date no field evidence supporting this theory has been presented in the literature pertaining to Florida or the Caribbean Sea. Munro (1974), in fact, has shown that in Jamaica, after comparatively long soaks of 14-20 days (based on lunar periodicity), escapement approached ingress, so that trap catch remained essentially constant.

As previously indicated, conditions in the present study area in south Florida have been found to be quite different from those in Jamaica. For reasons as yet not fully understood, any break of more than a few centimeters in the wire mesh side panels, not only permits escape of the contained catch, but also thoroughly destroys the effective attractiveness of the trap. More than 90% of the water hauls (zero catches) were due to one or more "cannon shot" holes in mesh panels where large predators had charged the trap. Long slashes in the top panel were associated with several lost traps which were recovered by SCUBA divers. In south Florida, the likelihood of predator damage is believed to be geometrically proportional to increasing soak time, if the results of our experiments can be considered representative. In practice, it was found that escapement through trap holes became an increasing problem if the traps were not hauled after 5 or 6 days.

Where natural predators may fail to otherwise damage the traps, self-destructing panels can be easily incorporated into any design fish trap by means of magnesium-alloy hinge wires having a known, constant corrosion rate (J. D. Richard, pers. comm.)2/ A few of these simple wires could be used in connection with the removal door to insure an automatic escape hatch.

SUMMARY

The most important results of this study can be summarized as follows:

(1) Large steel fish traps of improved design constitute an effective and practical fishing method, to produce large quantities of target species with moderate effort.

(2) Catch composition can be controlled to a considerable extent by placing traps in different habitats within the fishing grounds.

2/ J. D. Richard, Associate Professor, Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, FL 33149, pers. comm.

(3) Snappers dominate catches of traps placed on broad, uniform sand bottoms adjacent to their diurnal schooling positions.

(4) Attraction and ingress are influenced by a wide variety of factors, including trap condition, design, placement, orientation to currents, degree of fouling, sea state, lunar phase, predator preemption, and seasonality.

(5) Fish traps left untended do not result in wastage of marine resources in areas where predators are prevalent and damage traps so that fish escape. Elsewhere, traps can be designed to deteriorate within a selected time period.

LITERATURE CITED

Bohlke, J. E. and C. C. G. Chaplin.
1968. Fishes of the Bahamas and adjacent tropical waters. Acad. Nat. Sci. Philadelphia. Livingston Publ. Co., Wynnewood, Pa., 771 p.

Buesa-Mas, R. J.
1962. La nasa Antillana. Centro de Investigaciones Pesqueras, Cuba, Contrib. 15, 26 p.

Chislett, G. R. and M. Yesaki.
1974. Spiny lobster fishing explorations in the Caribbean. Mar. Fish. Rev. 36(5): 43-48.

Courtenay, W. R., Jr., D. J. Herrema, M. J. Thompson, W. P. Azzinaro, and J. van Montfrans.
1974. Ecological monitoring of beach erosion control projects, Broward County, Florida, and adjacent areas. U. S. Army, Corps of Engineers, Coastal Engineering Center, Ft. Belvoir, Va., Technical Memorandum No. 41, 88 p.

Craig, Alan K.
1974. New developments in the spiny lobster fishery of southeastern Florida. Proc. 26th Annu. Sess., Gulf Caribb. Fish. Inst., p. 131-143.

Godcharles, M. F.
1970. Exploratory fishing for southern sea bass Centropristes striatus melanus, in the northeastern Gulf of Mexico. Fla. Dep. Nat. Resour., Mar. Res. Lab., Tech. Ser. No. 63, 26 p.

Hipkins, F. W.
1974. A trapping system for harvesting sablefish, Anoplopoma fimbria. U. S. Dep. Commer., NOAA, NMFS, Fishery Facts 7, 20 p.

Long, G. W.
1942. The fisheries of Florida during 1941. U. S. Dep. Inter., Fish Wildl. Serv., Fishery Market News 4(3): 7-8.

Moe, M. A.. Jr.
1972. Movement and migration of south Florida fishes. Fla. Dep. Nat. Resour., Mar. Res. Lab., Tech. Ser. No. 69, 25 p.

Munro, J. L.
1973. Large volume stackable fish traps for offshore fishing. Proc. 25th Annu. Sess., Gulf Caribb. Fish. Inst., p. 121-128.

_________.
1974. The mode of operation of Antillean fish traps and the relationship between ingress, escapement, catch, and soak. J. du Conseil 35(3): 337-350.

Munro, J. L., P. H. Reeson, and V. C. Gaut.
1971. Dynamic factors affecting the performance of the Antillean fish trap. Proc. 23rd Annu. Sess., Gulf Caribb. Fish. Inst., p. 184-194.

Munro, K.
1885. Shad fishing in Florida. Harper's Weekly 29: 203.

Sirelius, U. T.
1906. Uber die sperrfischerei bei den Finnisch-Ugrischen volkern: Eine vergleichende ethnographische untersuchung. Suomalais-Ugrilainen -- Societe Finno-Ougrienne. Helsingfors, Druckerei der Finnischen Literatur- Gesellschaft, 485 p.

Starck, W. I., II and W. P. Davis.
1966. Night habits of the fishes of Alligator Reef, Florida. Ichthylog. Aquarium J. 38(4): 313-356.

Ting, R. Y.
1972. Investigation on the resource potential of the spiny lobster (Panulirus argus Latreille) in Puerto Rico. Completion Report, Project 2-97-R, Puerto Rico Dep. Agric., 25 p.

Wolf, R. S. and G. R. Chislett.
1974. Trap fishing explorations for snapper and related species in the Caribbean and adjacent waters. Mar. Fish. Rev. 36(9): 49-61.

THE RED SNAPPER RESOURCE OF THE TEXAS CONTINENTAL SHELF

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ABSTRACT

Since the discovery of the Galveston "lumps" or "Western Grounds" in the 1880's and the subsequent development of the Texas red snapper fishery, the fishing grounds, for both commercial and sport fishermen, have expanded to include numerous other topographical features on the Texas Continental Shelf.

Catch statistics for Texas commercial landings of "red" snapper (Lutjanus sp.) from 1887 to 1973 probably reflect socio-economic forces more than ecological influences. Peak landings of approximately 2 million pounds were reported for 1902, 1908, and 1963-65. While the total commercial red snapper catch off the Texas coast remained relatively stable for 1963-72, Texas landings from the area generally have decreased. Recreational catches of red snapper from the Port Aransas area have remained stable over the past two years.

Several information gaps exist with regard to the red snapper resource, foremost of which is knowledge of the ecology of the species or species group which comprises the fishery. Other specific research needs are discussed.

INTRODUCTION

The Texas commercial red snapper fishery developed in the 1880's with the discovery of the Galveston "Lumps" or "Western Grounds" (Camber, 1955). Since then it has grown to include not only these lumps or grounds, but additional snapper banks, small depressions, smooth bottoms, offshore petroleum platforms, artificial reefs, shipwrecks, and other bottom features. In addition to the commercial fishery, many of these areas attract sport fishermen, who are beginning to rival the commercial fishermen in exploitation of the resource.

Snappers are usually found in areas of irregular bottom terrain, in depths from 20 to 150 fathoms, with the preferred depths being from 40 to 80 fathoms (Juhl) 1/. These areas are commonly called topographical highs or depressions. The more distinct areas are commonly called snapper banks. Figure 1 shows the locations of most of these banks. Relief for these banks ranges from 13 feet for Big Dunn Bar to 325 feet for the Flower Garden Banks. These banks are normally fished by sport fishermen in the spring and summer and by commercial fishermen in the fall and winter.

Based on handline catch data from 1970 to 1973, Bradley and Bryan (1975) reported that the banks off Port Aransas produced more and larger red snapper in the winter and that handline fishing for snapper was more productive at night than during the day.

During the spring and summer, commercial fishermen from south Texas ports search extensively for red snapper from latitude 27°30'N, southward to Port Isabel, Tex. While areas of irregular bottom topography generally are more productive, catches sometimes occur along smooth bottoms between 35 and 55 fathoms (Bryan) 2/. Detailed bathymetry sheets, prepared by U.S. Department of Commerce, NOAA, NOS for the Bureau of Land Management, outline many of these areas on the Texas Continental Shelf.

Offshore oil and gas "rigs," which include multi-well platforms and single well installations, are also frequented by snappers. There were only 7 rigs on the Federal Outer Continental Shelf off the Texas coast in 1963, as compared to 57 rigs in 1974 (U. S. Geological Survey) 3/. These rigs are fished by both commercial and sport fishermen, because they serve as a haven and shelter for many types of marine life, including snappers. The marked increase in biomass, due to the "reef effect" of the rigs, contributes significantly to the economically important sport and commercial fisheries (Gulf

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1/ R. Juhl, Pascagoula Laboratory, National Marine Fisheries Service, NOAA, Pascagoula, MS 39567, pers. comm., 1974.

2/ C. E. Bryan, III, Texas Parks and Wildlife Department, Rockport, TX 78382, pers. comm., 1975.

3/ U. S. Geological Survey, Oil and Gas Operations, Metairie, LA 70011, computer printout, 1975.

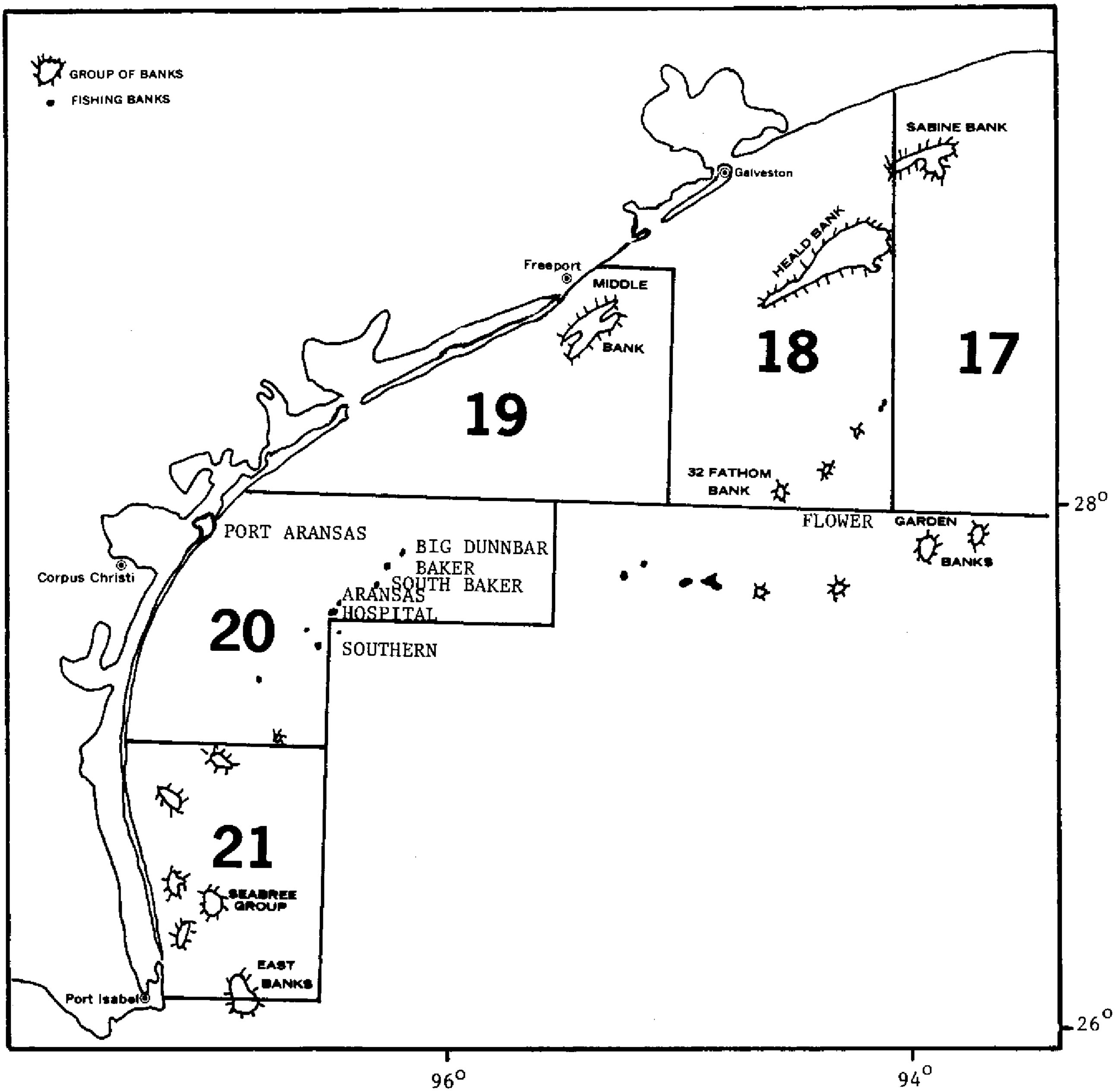

FIGURE 1

Locations of Major Fishing Banks and Statistical Shrimp Grid Zones for the Texas Continental Shelf.

Source : U.S. Department of the Interior (1975).

Universities Research Consortium, 1974). Other good snapper areas off the Texas coast include artificial reefs, shipwrecks, and bottom obstructions.

COMMERCIAL EXPLOITATION

Catch statistics for Texas landings of red snapper (1887-1973) probably reflect socio-economic forces more than ecological influences. Peak annual landings of more than 2 million pounds were reported in 1902, 1908, and 1963-65 (Fig. 2). The recent history shows a decline from 2.25 million pounds in 1964 to a relatively stable low of approximately 1 million pounds per year from 1969 to 1973. The trawl catch of red snapper during this period remained relatively stable; the decline can be attributed to a decreasing handline catch, the bulk of which comes from "reef-type" areas. Some observers have attributed the decline in landings to increased sportfishing pressure and the removal of juvenile stock by shrimp trawling (Bradley and Bryan, 1975). However, the number of handline fishermen licensed in Texas decreased from 796 in 1963 to 385 in 1970 (Fishery Statistics of the United States, 1963-70, 1965-73) and, although these figures are by no means absolute, this trend is certainly a factor in the decline of Texas red snapper landings.

Analysis of the catch location may provide a better understanding of the decline in Texas red snapper landings. The total commercial catch from the Texas Continental Shelf (Fig. 1: statistical zones 17-21)4/ remained relatively stable for the period 1963-72, while the actual Texas landings from the area generally decreased. Specifically, Texas landings comprised 97.4% of the catch from the Texas Shelf waters in 1963, but only 48.5% in 1972 (Fig. 3). Table 1 presents the 10-year mean catch by statistical zone and the breakdown (percentage of total catch) by state. The two most productive zones were 18 and 20, with a combined annual average of almost 1 million pounds per year. Texas landings comprised 35% of the total catch from zone 18 and 96.3% from zone 21. Obviously, competition from other states is another factor to be considered in the decline of Texas landings for this period.

RECREATIONAL EXPLOITATION

Little information exists concerning the recreational catch of red snapper off Texas, but, according to Carpenter (1965), there has been an increase. During 1970-74, approximately 12 Texas-based party boats were involved in snapper fishing: 4 from Galveston, 4 from Port Isabel, 2 from Freeport, and 2 from Port Aransas. In addition, numerous charter boats and private parties fish Texas offshore waters.

In an effort to obtain the dollar value of certain snapper banks, Frishman 5/ compiled information for 1974 and 1975 on the recreational boats operating from the Port Aransas area. In 1974, 117,500 pounds of red snapper

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4/ Zone 17 primarily covers the waters off Louisiana, but a portion of the Texas Shelf is located in this zone.

5/ S. Frishman, editor, South Jetty News, Port Aransas, TX 78373, pers. comm., 1975.

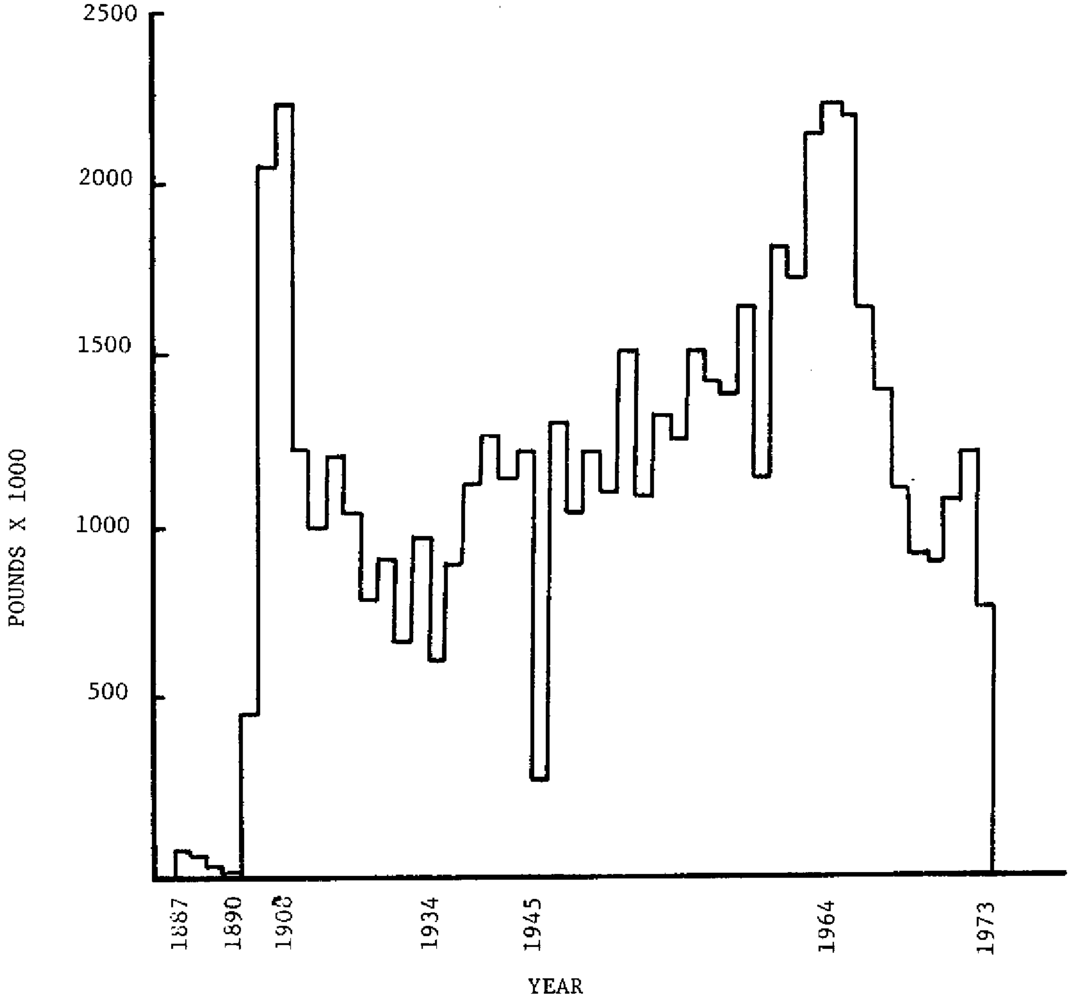

FIGURE 2

Texas Red Snapper Landings for Selected Years from 1887-1973.

Sources: Fishery Statistics of the United States, 1970 (1973) and Texas Landings (1973, 1974a, and 1975).

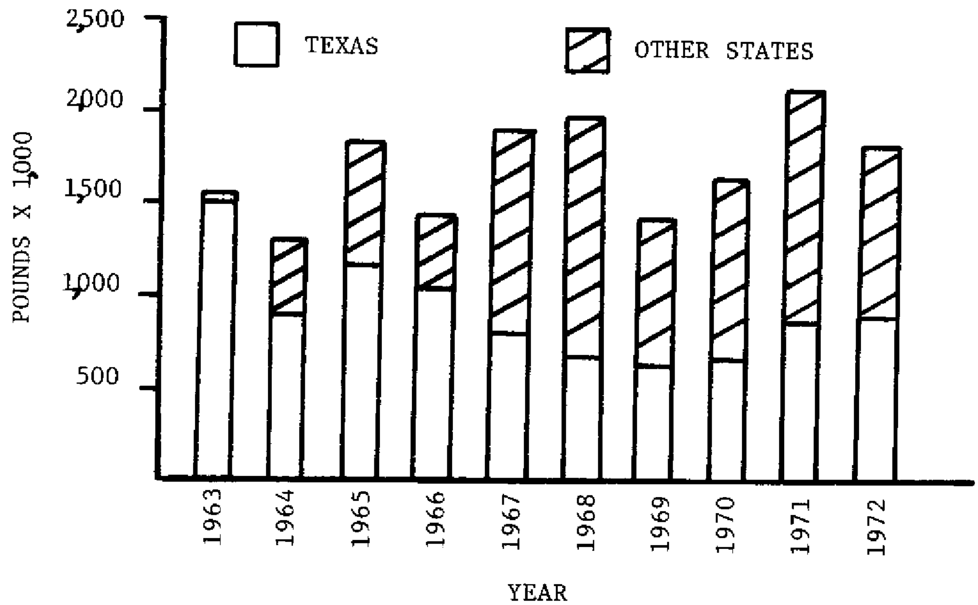

FIGURE 3

Red Snapper Landings from Statistical Zones 17-21. "Other States" includes Louisiana, Mississippi, and Alabama.

Source : U.S. Department of Commerce (1963-72).

Table 1. Red Snapper Catch by Statistical Zones on the Texas Continental Shelf and Percentage Landed by State, 1963-72.

Zone	10-Yr Average (pounds)	Texas (%)	Louisiana (%)	Mississippi (%)	Alabama (%)	Total (%)
17	171,740	35.8	4.4	37.8	22.0	100.0
18	512,200	35.0	0.8 1/	29.6	34.6	100.0
19	179,820	51.7	--	46.3	2.0 2/	100.0
20	442,830	51.6	--	48.4	--	100.0
21	363,510	96.3	--	3.7 3/	--	100.0
Total	1,670,100					

1/ For 1963 only.

2/ For 1967 only.

3/ For 1967-68 only.

Source: U. S. Department of Commerce (1963-72).

were landed for 12,015 man-days fished. In 1975 the recreational fishery accounted for 109,000 pounds of red snapper for 8,550 man-days fished. This fishery is based principally on several banks located on the Texas Continental Shelf, the most popular being Baker, South Baker, Aransas, Hospital, and Southern Banks (Fig. 1).

DISCUSSION

Although our information concerning the Texas red snapper fishery is limited, recent changes in the exploitation of this important resource are evident. The following account of these changes has been developed for consideration by the reader and is by no means absolute. We hope it will serve to stimulate research leading to rational management of the resource.

On the Texas Continental Shelf the total catch has remained relatively stable, while Texas landings have declined. Evidently, the pressure of competition for the snapper resource posed by commercial fishermen from other Gulf Coast States has forced a decline, both in Texas landings and the number of men willing to continue fishing as a livelihood. The southwestern portion of the area has increased in importance to Texas landings. This shift in emphasis can be attributed to a move away from competition. The competition is more severe during the winter months, when fishermen from other states move into the area because of better weather conditions and the proximity of the fishing grounds to shore.

During the summer the commercial emphasis shifts toward the shallower areas of minimal relief, following the larger snapper which move into these areas to spawn. While competition from other states diminishes, shrimp trawling poses another unquantified form of competition. The recreational fishery concentrates on "reef-type" areas and is strictly seasonal, occurring mainly during June, July, and August. Based on the seasonality of the fisheries and information available for the Port Aransas area, recreational fishing does not appear to have a significant direct effect on the commercial fishery. The commercial landings for zone 20 (Fig. 1) in 1974-75 were greater than 150,000 pounds, of which approximately 50% was landed from January through March 1974 and in December 1975 (Texas Landings, 1974b, 1974c, 1974d, and 1975), while the summer recreational fishery landed 117,500 pounds in 1974. Although the winter commercial catch and the summer recreational catch are both based on easily located bottom features which are generally productive, the shift of commercial interest from the banks to other areas during the summer results in a minimal amount of direct conflict. Presently it is unknown whether the recreational catch is large enough to affect the total commercial yield; however, the recreational catch was stable for 1974-75 in the Port Aransas area.

RECOMMENDATIONS

Management based on scientifically generated information is a must if the snapper fishery, along with all other renewable resources, is to remain productive. Several information gaps exist with regard to the Texas red snapper resource, foremost of which is knowledge of the ecology of the species. Studies in this area must be conducted in a coordinated and systematic manner. Future research queries should include the following:

(1) Do bottom features comprise a limiting factor for snapper production? If so, in what manner can man-made installations, including petroleum platforms, be best developed to enhance production, while accomplishing their primary purpose?

(2) Does shrimp trawling significantly deplete juvenile snapper stocks?

(3) What is the actual recreational fishing pressure on the fishery?

As the drive to exploit our natural resources accelerates, great skill and foresight will be required to properly manage this valuable sport and commercial fishery, insuring its best and highest use as a renewable resource.

LITERATURE CITED

Bradley, E. and C. E. Bryan, III.

1975. Life history and fishery of the red snapper (Lutjanus campechanus) in the northwestern Gulf of Mexico: 1970-1974. Proc. 27th Annu. Sess., Gulf Caribb. Fish. Inst., p. 77-106.

Camber, C. T.

1955. A survey of the red snapper fishery of the Gulf of Mexico, with special reference to the Campeche Banks. Fla. Board Conserv., Tech. Ser. No. 12, 64 p.

Carpenter, J. S.

1965. A review of the Gulf of Mexico red snapper fishery. U.S. Dep. Inter., Fish Wildl. Serv., Circ. 208, 35 p.

Fishery Statistics of the United States, 1963-70.

1965-73. Statistical digests Nos. 57-64. U.S. Dep. Commer., NOAA, NMFS (before 1968 by U.S. Dep. Inter., Fish Wildl. Serv.), Wash., D.C.

Gulf Universities Research Consortium.

1974. Report No. 138, 39 p.

Texas Landings.

1973. Annual summary 1972. Curr. Fish. Stat., No. 6124, 7 p. U.S. Dep. Commer., NOAA, NMFS, Wash., D.C.

________________.

1974a. Annual summary 1973. Curr. Fish. Stat., No. 6423, 7 p. U.S. Dep. Commer., NOAA, NMFS, Wash., D.C.

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1974b. January 1974. Curr. Fish. Stat., No. 6440, 2p. U.S. Dep. Commer., NOAA, NMFS, Wash., D.C.

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1974c. February 1974. Curr. Fish. Stat., No. 6460, 2 p. U.S. Dep. Commer., NOAA, NMFS, Wash., D.C.

1974d. March 1974. Curr. Fish. Stat., No. 6481, 2 p. U.S. Dep. Commer., NOAA, NMFS, Wash., D.C.

________.

1975. December 1974. Curr. Fish. Stat., No. 6669, 2 p. U.S. Dep. Commer., NOAA, NMFS, Wash., D.C.

U.S. Department of Commerce.

1963-72. General Canvass 1963-72-- Gulf of Mexico. NOAA, NMFS, Wash., D.C.

U.S. Department of the Interior.

1975. Final Environmental Impact Statement, Vol. 3. OCS Sale No. 41, Bureau of Land Management, Graphic 4, 1 p.

FISHING BANKS OF THE TEXAS CONTINENTAL SHELF

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ABSTRACT

The Texas Outer Continental Shelf is occupied by numerous topographical highs commonly referred to as snapper banks. These banks are frequented by commercial and sport fishermen seeking red snapper, vermilion snapper, groupers, and other varieties of game fish. At least four distinct classes of hard-bank epifaunal communities have been recognized on the Texas Shelf and are herein described, along with accounts of the populations of associated fishes. Bathymetric charts of 16 of the banks are presented.

INTRODUCTION

Although in recent years less than a half-dozen commercial snapper fishing boats have worked out of Texas ports, a considerable number of such vessels from Florida and Alabama frequent the Texas-Louisiana Continental Shelf in pursuit of snappers of the genera *Lutjanus* and *Rhomboplites*, as well as groupers and hinds of the genera *Mycteroperca* and *Epinephelus*. The western Gulf of Mexico commercial hook-and-line fishery and the Texas head boat sport fishery owe their existence to the presence of numerous offshore hard-banks and topographical features, around which a number of important commercial and sport fishes continually congregate. From 1970 to the present, we have had opportunity and funding to study, for reasons not directly related to fisheries, the biology and geology of some of the more important of these banks (Fig. 1). Much of the information we have gathered seems pertinent to the understanding of natural habitats of lutjanids and serranids in the western Gulf of Mexico.

Bright and Pequegnat (1974) described the biota of the West Flower Garden Bank, which, with the East Flower Garden Bank, represents the most complete and complexly developed reef and hard-bank assemblage on the Texas-Louisiana Outer Continental Shelf. The reader is referred to that publication for a bibliography of papers dealing with western Gulf banks.

OBJECTIVES

In an attempt to add to the understanding of preferred natural offshore habitats of commercial and sport fishes in the western Gulf of Mexico, we will summarize here, in diagrams and text, the results of several years of sampling and observation on reefs and hard-banks, and make public detailed bathymetric charts which we hope will be useful to scientists and fishermen.

METHODS

Our studies have been ecologically-oriented, biological and geological surveys. Sampling techniques have, therefore, employed corers; grabs; dredges; hook-and-line fishing; spearfishing, rotenone poisoning, gathering, observation, and photography by SCUBA divers; underwater television; and, most effectively, observation and sampling by research submersibles.

In 1972 we used the General Oceanographics submarine NEKTON GAMMA to investigate that part of the West Flower Garden lying below 45 meters depth. In 1974 and 1975 we examined 11 additional banks with the Texas A&M Oceanography Department submarine DIAPHUS. Most of the biological and geological observations described here are results of dives made in the DIAPHUS. The NEKTON GAMMA and DIAPHUS are both equipped with manipulator arms, external sample containers, portable television recorders and cameras, all of which were used.

Three of the bathymetric charts presented here were taken from previous publications. The others were generated during a U.S. Bureau of Land Management-funded "baseline" study of south Texas Outer Continental Shelf fishing

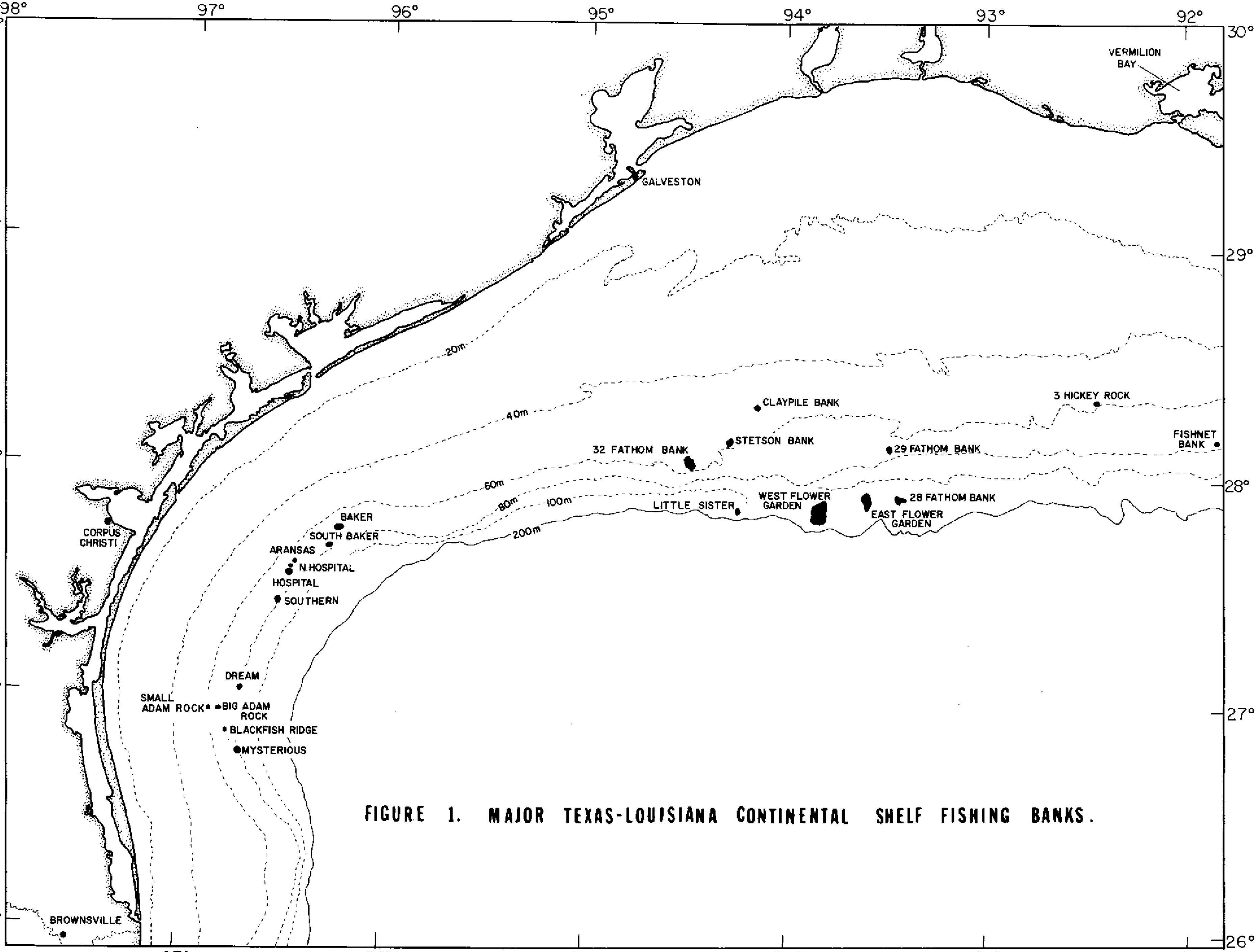


FIGURE 1. MAJOR TEXAS-LOUISIANA CONTINENTAL SHELF FISHING BANKS.

banks, using Decca Hi-Fix and Lorac positioning, Decca and Hydrosurverys side-scan sonar, and Decca and Raytheon precision depth recorders.

BENTHIC BIOTA AND FISHES

Reef and hard-bank biota in the western Gulf are easily distinguishable into at least four assemblages, all of which are faunally linked and composed of organisms known to occur at the diversely populated East and West Flower Garden Banks.

Bright and Pequegnat (1974) listed over 250 species of benthic invertebrates and more than 100 fishes from the West Flower Garden. The distinctive biotic zonation of the West Flower Garden (Fig. 2) is basically the same as that of the East Flower Garden (Fig. 3), though differences are apparent. Above 45-49 meters both banks are covered with thriving submerged coral reefs which, except for their total lack of shallow-water alcyonarians, are good examples of the *Diploria-Montastrea-Porites* community so common on reefs in the Caribbean Sea and southern Gulf of Mexico.

The East Flower Garden harbors, in addition, sizeable knolls occupied almost entirely by populations of the small branching coral *Madracis mirabilis* (*Madracis* Zone). Finger-sized remains of dead *Madracis* are extremely important components of the sediment on and adjacent to the reef. In some cases, the coarse carbonate sand which typically occurs between coral heads in the *Diploria-Montastrea-Porites* Zone is entirely supplanted by *Madracis* rubble.

Other knolls at the East Flower Garden are covered completely by lush growths of leafy algae, including *Caulerpa*, *Chrysymenia*, *Halymenia*, *Gloiophloea*, *Lobophora*, *Microdictyon*, and others. The presence at the East Flower Garden of the Leafy Algae Zone, the *Madracis* Zone, and knolls of intermediate biotic composition which bear various types of sponges, *Madracis* clumps, patches of leafy algae, and extensive encrustations of coralline algae is indicative of a greater degree of lateral biotic variability on the approximately 70-acre crest of this bank than is found at the West Flower Garden, where the *Diploria-Montastrea-Porites* Zone predominates everywhere above 45-49 meters (approximately 100 acres).

Table 1 indicates that the coral reefs at the East and West Flower Gardens (22-49 meters) house more species of epifauna, stony corals, and fishes than do zones deeper on these banks or on other banks. It is interesting, however, that we have rarely encountered snappers on the Flower Garden reefs, though the red snapper, *Lutjanus campechanus*, is abundant on the lower reaches of the banks around rocks and drowned reefs. *Mycteroperca* spp. are present more uniformly at all depths, but appear more conspicuous around topographical irregularities on the banks below the reefs due to the general reduction in fish abundance and numbers of species there. On the other hand, the smaller *Epinephelus* spp., though common on the coral reef, are not often seen at greater depths.

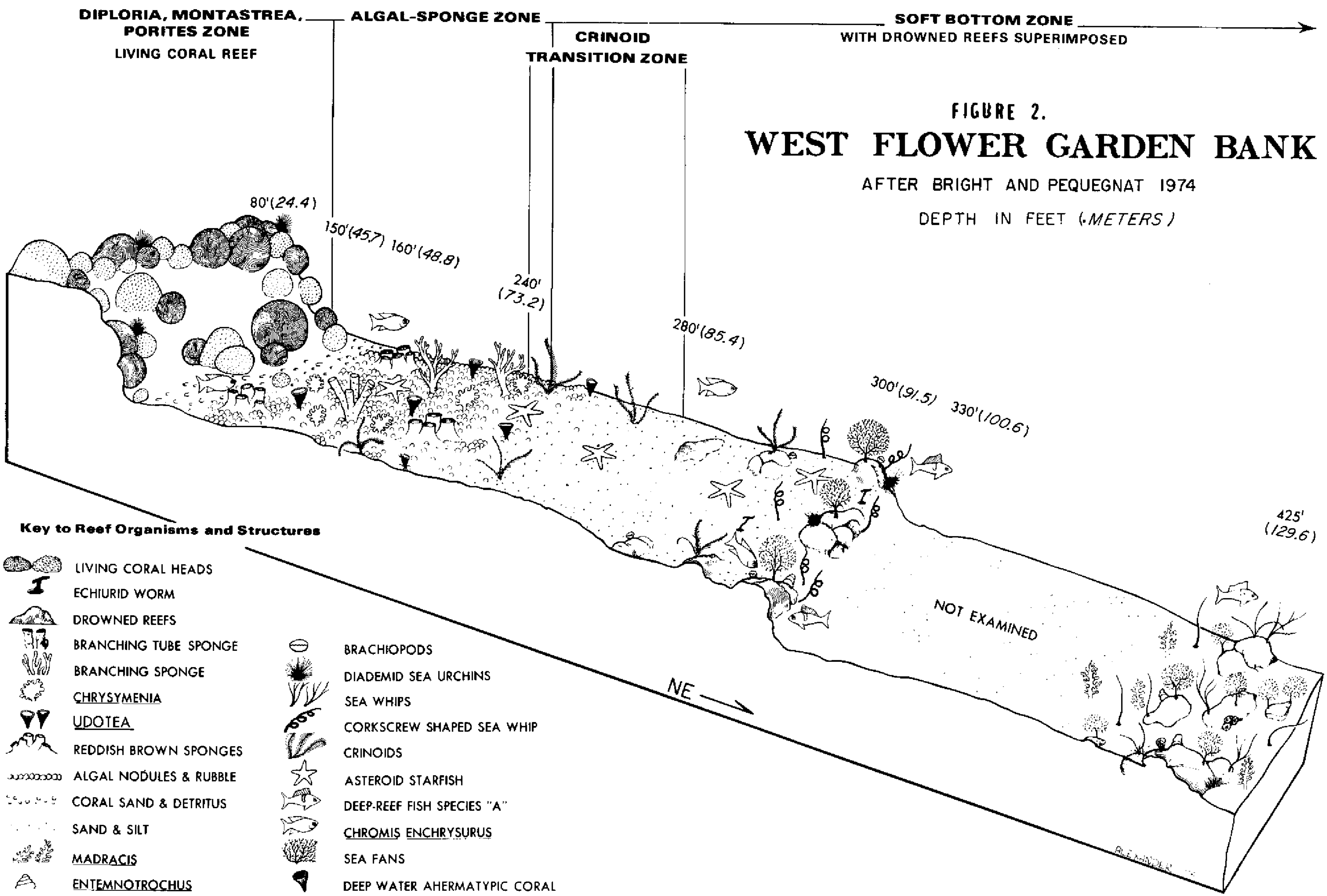


FIGURE 2.
WEST FLOWER GARDEN BANK
AFTER BRIGHT AND PEQUEGNAT 1974
DEPTH IN FEET (METERS)

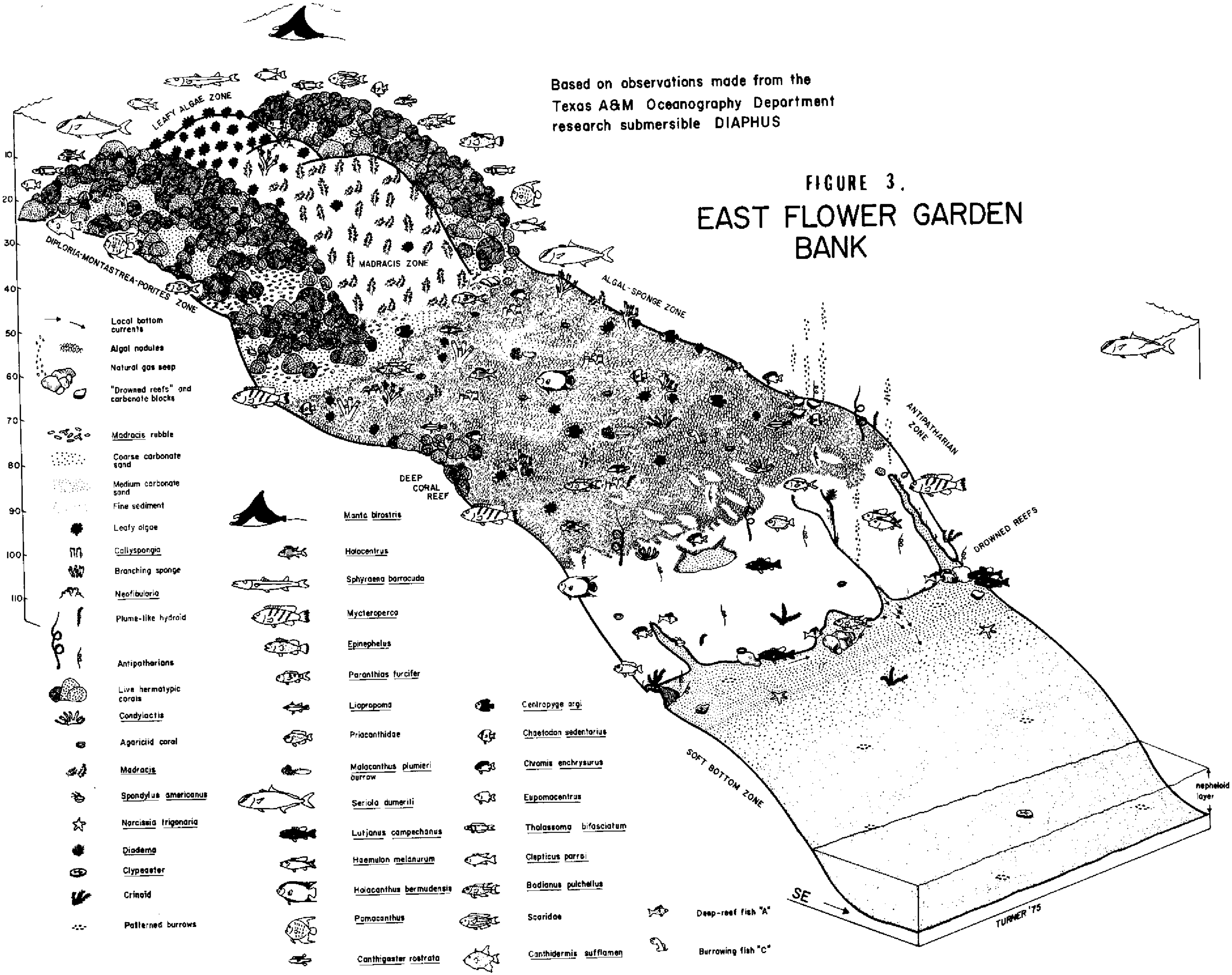


FIGURE 3.
EAST FLOWER GARDEN BANK

Table 1. Organisms encountered by us at various fishing banks, with indications of relative abundances.
**** very abundant, *** abundant, ** moderate population, * known to be present, p - presumed present.

	Claypile	Stetson	East Flower Garden and West Flower Garden				South Texas Fishing Banks	Fishnet
Depths in meters	35-55	28-56	22-49	49-76	76-92	92-107	53-78	61-82
CORALLINE ALGAE								
encrusting		*	****	***	**	*	*	*
nodules				****	*			
<u>Lithothamnium</u> spp.			****	****	**			
<u>Lithophyllum</u> spp.		*	**	**	*		*	*
CALCAREOUS GREEN ALGAE			*	**				*
LEAFY ALGAE	**		****	***	*		*	*
FORAMINIFERS (encrusting)								
<u>Gypsina plana</u>		*	*	***	*			
SPONGES	**	***	**	***	**	*	**	**
<u>Agelas</u> sp.		*	**	*	*	*	*	
<u>Callyspongia</u> spp.	**	*	**	**				
<u>Ircinia campana</u>							**	
<u>Neofibularia nolitangere</u>	*	**	*	***	**		*	
<u>Verongia</u> spp.	*		**	***				
PLUME-LIKE HYDROIDS		*		**	**	**	**	
ALCYONARIAN WHIPS								
<u>Ellisella</u> sp.					*	*		
ALCYONARIAN FANS					**	**	**	
<u>Hypnogorgia</u> sp.	*						*	*
<u>Scleracis</u> sp.				*	*		**	
<u>Thesea</u> sp. "B"					*			
<u>Thesea</u> sp. "A"							*	
ANTIPATHARIANS			*	***	***	**	***	***
ANEMONES								
<u>Condylactis</u> sp.			*	***	**			
HYDROZOAN CORALS								
<u>Millepora alcicornis</u>		***	***	*				
ANTHOZOAN STONY CORALS								
<u>Stephanocoenia intersepta</u>		*	*					
<u>Madracis decactis</u>		*	**					
<u>Madracis mirabilis</u>			****					
<u>Madracis asperula</u>				*				
<u>Madracis brueggemanni</u>				*			*	
<u>Agaricia agaricites agaricites</u>			**					
Saucer-shaped agariciid			*	**	*		*	
<u>Helioceris cucullata</u>			*	*				
<u>Siderastrea sidera</u>	*		*					
<u>Porites astreoides</u>			****					
<u>Diploria strigosa</u>			****					
<u>Diploria</u> spp.			****	**				
<u>Colpophyllia natans</u>			***					
<u>Colpophyllia</u> spp.			***					
<u>Montastrea annularis</u>			****					
<u>Montastrea cavernosa</u>			****	**				
<u>Scolymia</u> sp.			*					
<u>Mussa angulosa</u>			*					
ahermatypic solitary sp. "A"							*	
ahermatypic solitary sp. "B"						*		
ahermatypic solitary		*						

Depths in meters	Claypile 35-55	Stetson 28-56	East Flower Garden and West Flower Garden 22-49	49-76	76-92	92-107	South Texas Fishing Banks 53-78	Fishnet 61-82
GASTROPODS								
Busycon spp.							*	*
Cypraea spp.		*	**				*	
PELECYPODS								
rock borers	***	****						
Jouannetia quillingi		****						
Lithophaga bisulcata		*						
Lima sp.			***					
Spondylus americanus			***	***			***	
BRACHIOPODS								
Argyrotheca barrettiana					***	***	**	
POLYCHAETE WORMS								
Hermodice sp.			**	**			***	****
Spirobranchus giganteus		**	****	**				
CRABS								
Carpilius corallinus			*					
Stenorynchus seticornis		**	**	**	**	*	*	
LOBSTERS								
Panulirus sp.			*					
Scyllarides sp.			*				*	
MANTIS SHRIMPS								
Gonodactylus spp.		*	*	***				
STARFISH								
Narcissia trigonaria				*	*			
BASKET STARS								
Gorgonocephalidae					**		**	**
SEA URCHINS								
Clypeaster sp.		**				**		
Diadema antillarum		****	****		*		*	**
SEA CUCUMBERS								
Isostichopus sp.	*	**	*				**	
CRINOIDS				*	****	****	****	****
PATTERNED BURROWS	****	****		**	****	****	****	****
FISHES								
Ginglymostoma cirratum Nurse shark			*					
Manta birostris Manta ray			**					
Gymnothorax moringa Spotted moray			*	*				
Gymnothorax spp. moray eels		*	*	*				
Aulostomus maculatus Trumpetfish			**					
Holocentrus ascensionis Longjaw squirrelfish			**					
Holocentrus spp. (large species)	*	**	***	**	**		**	
Holocentridae (small species)		**	**	*			**	*
Myripristis jacobus Blackbar soldierfish		*	*					
Sphyraena barracuda Great barracuda		***	***	*			***	

Depths in meters	Claypile 35-55	Stetson 28-56	East Flower Garden and West Flower Garden 22-49	49-76	76-92	92-107	South Texas Fishing Banks 53-78	Fishnet 61-82
Epinephelus adscensionis Rock hind	**	***	***	**				
Epinephelus cruentatus Graysby			**	*				
Epinephelus spp. hinds	**		***	**				*
Dermatolepis inermis Marbled grouper			*	*	*			
Mycteroperca spp. groupers		**	**	**	**		*	**
Paranthias furcifer Creolefish		***	***	**			*	
Serranus annularis Orangeback bass				**				
Liopropoma sp. basslet		**	*	**			**	**
Priacanthidae bigeyes	**		*	**	*		**	**
Priacanthus arenatus Bigeye		*	*					
Apogon spp. cardinalfishes		*	***				**	
Malacanthus plumieri Sand tilefish			*	**	**			
Sand tilefish burrows			*	**				
Amblycirrhitus pinos Redspotted hawkfish			**	*				
Rachycentron canadum Cobia							*	
Caranx spp. jacks		**	**	*			**	
Caranx ruber Barjack			**					
Seriola dumerili Greater amberjack	**	**	**	**	*		**	**
Selene vomer Lookdown							*	
Scomberomorus spp. mackerels		*	*				*	
Lutjanus campechanus Red snapper	p	***	*	***	***	***	***	***
Lutjanus spp. snappers (not Red)		*	*				*	
Rhomboplites aurorubens Vermilion snapper	p	***	*				***	***
Haemulon melanurum Cottonwick		**	*	**	**		**	
Calamus spp. porgys		**	**	**			*	
Equetus spp. drums	*	*	*	*	*	*	*	
Equetus acuminatus High hat		*		*			*	
Equetus lanceolatus Jackknife-fish			*	*	*	*	*	
Mulloidichthys martinicus Yellow goatfish		*	**	*				
Pseudupeneus maculatus Spotted goatfish	**	**	**	*				
Chaetodon aculeatus Longsnout butterflyfish			*	*				
Chaetodon ocellatus Spotfin butterflyfish		**	***					
Chaetodon sedentarius Reef butterflyfish	*	***	***	***	*	*	***	***
Pomacanthus spp. angelfishes		***	***	*			*	
Pomacanthus paru French angelfish	**	***	***	*				
Pomacanthus arcuatus Gray angelfish		*	*					

	Claypile	Stetson	East Flower Garden and West Flower Garden				South Texas Fishing Banks	Fishnet
Depths in meters	35-55	28-56	22-49	49-76	76-92	92-107	53-78	61-82
Holacanthus ciliaris Queen angelfish		**	**	**			*	
Holacanthus bermudensis Blue angelfish	*	**	*	**	*	*	**	**
Holacanthus tricolor Rock beauty			**	**	*	*		*
Centropyge argi Cherubfish			*	***				
Eupomacentrus spp. damselfishes		***	***	*			**	
Eupomacentrus partitus Bicolor damselfish			***	*				
Chromis cyaneus Blue chromis		*	***					
Chromis multilineatus Brown chromis		**	***					
Chromis enchrysurus Yellowtail reeffish	*	****	***	****	***	***	****	****
Bodianus rufus Spanish hogfish		**	***					
Bodianus pulchellus Spotfin hogfish		**	**	***	*	*	***	***
Halichoeres garnoti Yellowhead wrasse			*					
Thalassoma bifasciatum Bluehead		****	****	*				
Clepticus parrai Creole wrasse			****					
Scarus spp. parrotfishes			**	*				
Sparisoma viride Stoplight parrotfish			**	*				
Gobiosoma sp. sharknose goby		***	****	***			*	
Acanthurus spp. surgeonfishes		**	**	*				
Acanthurus coeruleus Blue tang		*	*					
Balistes capriscus Gray triggerfish		*	*					
Balistes vetula Queen triggerfish		**	**	*			*	
Canthidermis sufflamen Ocean triggerfish			***					
Melichthys niger Black durgon			***					
Lactophrys triqueter Smooth trunkfish			**					
Canthigaster rostrata Sharpnose puffer		***	***	***			*	
Ogcocephalus vespetilio Longnose batfish				*				
Deep-reef fish "A"					***	***	***	*
Fish "B"							**	
Burrowing fish "C"	****	**		**			*	

In comparison to the biotic populations of the Flower Gardens above 49 meters, those of the banks occupying similar depth ranges elsewhere on the Shelf (Stetson, 3 Hickey Rock, Claypile) are less diverse and numerically smaller. Stetson Bank (Fig. 4) supports an epifaunal community dominated by the hydrozoan stony coral Millepora alcicornis, sponges, and the rock-boring pelecypod Jouannetia quillingi (Bright, Pequegnat, DuBois, and Gettleson, 1974). The substratum at Stetson is siltstone and claystone in various stages of induration. Most of the outcrops are soft siltstone and easily perforated by the abundant rock borers. A majority of the surface area of the rock is bare, and, where epifauna occurs, it is generally restricted to the upper halves of the outcrops, where up to 100% cover has been observed. We have never visited 3 Hickey Rock, but we have viewed photographs which indicate obvious biotic similarities to Stetson (Millepora and sponges appear to predominate). In general, we feel that Stetson, and probably 3 Hickey Rock, are manifestations of a hard-bank assemblage, composed primarily of a limited number of the species which occur on the coral reefs at the East and West Flower Gardens, with notable deficiencies in the populations of anthozoan corals and fishes. Where the important commercial and sport fishes are concerned, however, Stetson seemingly compares well (Table 2).

Possibly because the crest of Claypile Bank is somewhat deeper (approximately 35 meters), the Millepora-Sponge assemblage occupying Stetson has not developed there. Although the substratum is comparable to that at Stetson, the fact that the outcrops are much lower in relief may be significant. The benthic community which has developed at Claypile is a rather limited one, composed primarily of several species of leafy algae and a sparse population of sponges. The presence of numerous rock borers reflects the similarity of the outcropping rocks to those of Stetson. In places on Claypile, sizeable meadows of leafy algae resembling Sargassum were recorded on videotape, but none was collected and the identification is speculative. The greatest concentrations of fishes were seen in and over these meadows. Our information on Claypile is scanty, but it is obviously occupied by a benthic assemblage which must be categorized separately from those of the other banks studied. Corals are insignificant in number; Siderastrea sidera occurs rarely in small knobs several inches in diameter. The fishes seen there all occur on the Flower Garden Banks, but the most conspicuous species (one which we have not yet identified and therefore call burrowing fish "C") has been seen by us at the Flower Gardens only below the coral reefs.

The 28 Fathom Bank, unlike Stetson, 3 Hickey, and Claypile, is comparable to those parts of the East and West Flower Garden Banks designated Algal-Sponge Zone in Figures 2 and 3. A comparison of Table 3 with the two columns in Table 1 covering the 49- to 92-meter depth range at the Flower Gardens shows that the diverse populations on all three banks are extremely similar within that depth range. The 28 Fathom Bank, however, lacks the extensive coral reef and other communities which cap the Flower Garden Banks. The bottoms in the Algal-Sponge Zones of all three banks are covered primarily with nodules (up to fist size and larger) composed of encrustations of coralline algae, mostly Lithothamnium with some Lithophyllum, and lesser amounts of the encrusting foraminifer Gypsina plana (Abbott, 1975; Hogg, 1975). The coralline algae are important and abundant on the coral reef,

FIGURE 4.

STETSON BANK

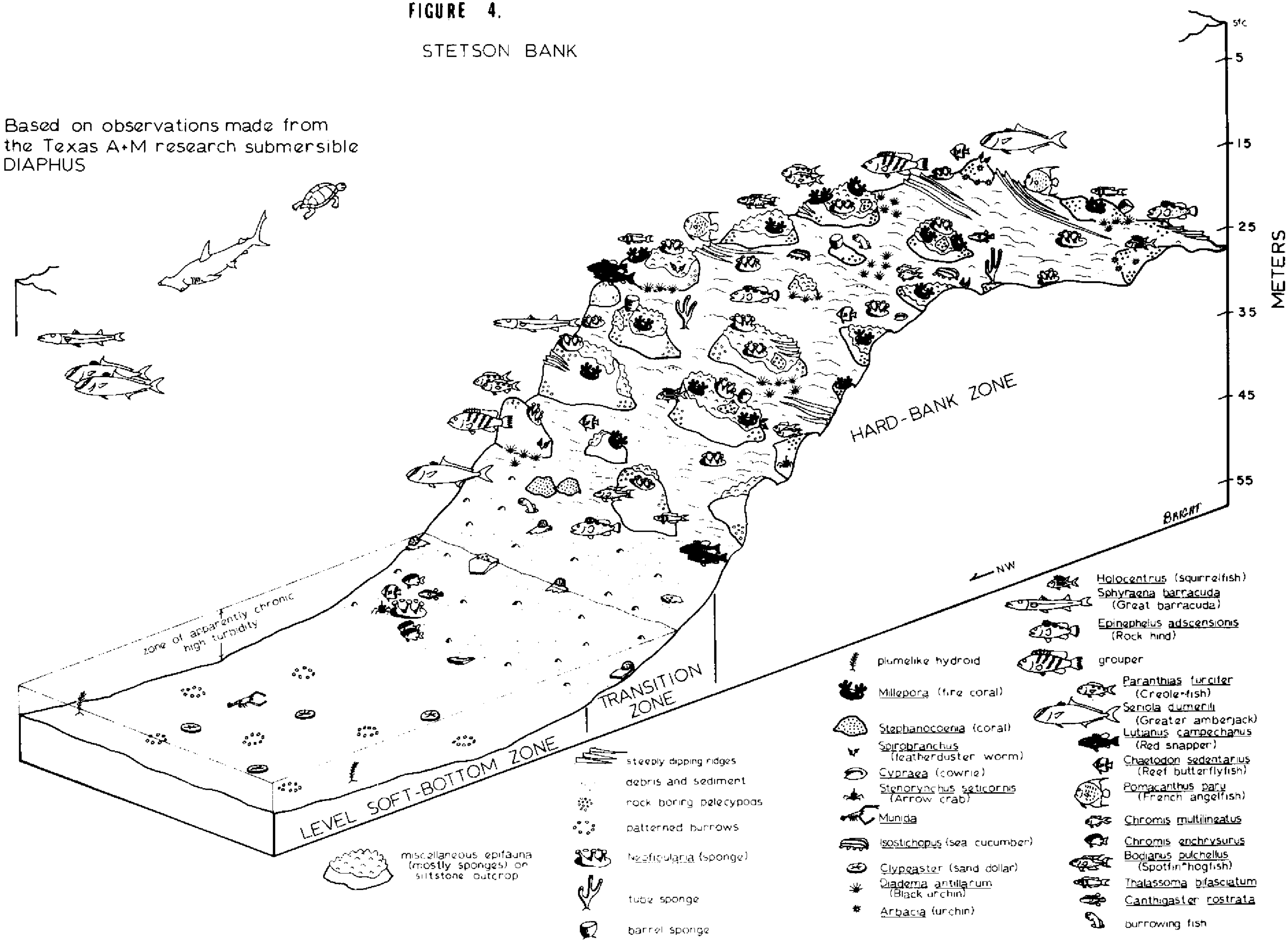


Table 2. Summary of results of hook-and-line fishing from our research vessels, 1972-1975. *** most frequently caught,** often caught, * sometimes caught.

	EFG + WFG	Stetson	South Texas Fishing Banks
Carcharhinid sharks	*		**
Gymnothorax spp. morays	*		*
Enchelycore nigricans Viper moray	*		
Holocentrus spp. squirrelfishes	***	**	**
Sphyraena barracuda Great barracuda	**	**	***
Epinephelus guttatus Red hind	*		
Epinephelus adscensionis Rock hind	**	**	
Epinephelus cruentatus Graysby	***		
Mycteroperca spp. groupers	**	*	*
Dermatolepis inermis Marbled grouper	*		
Paranthias furcifer Creole fish	*	*	*
Priacanthidae bigeyes	**	**	
Malacanthus plumieri Sand tilefish	**		*
Rachycentron canadum Cobia			**
Seriola dumerili Greater amberjack	***	***	***
Caranx spp. jacks	**	**	*
Selene vomer Lookdown			*
Coryphaena hippurus Dolphin	*		* juveniles
Scomberomorus spp. mackerels	*	*	*
Lutjanus campechanus Red snapper	***	***	***
Lutjanus spp. snappers	*	*	*
Rhomboplites aurorubens Vermilion snapper	***	***	***
Haemulon melanurum Cottonwick	***	***	***
Calamus spp. porgies	**	*	*
Pomacanthus spp. angelfishes	*	*	
Acanthurus spp. surgeonfishes	*	*	
Balistes vetula Queen triggerfish	**	*	
Balistes capriscus Gray triggerfish		*	
Canthidermis sufflamen Ocean triggerfish	*		
Melichthys niger Black durgon	*		

Table 3. Conspicuous benthic organisms and groundfishes seen at 28 Fathom Bank. Depths given indicate our observations only and do not preclude presence of the species at other depths.

	Depths of observation (meters)	Comments
Algae		
Coralline algae	52-91	Probably *Lithothamnium* and *Lithophyllum*. Forming nodules. Encrusting outcrops and rubble.
Soft algae	52-67	Probably extend somewhat deeper.
Sponges		
Neofibularia	52-61	
Agelas	61	
Anemones		
Condylactis	61	
Antipatharians	52-85	
Echinoderms		
Sea cucumber	55	Probably *Isostichopus*.
Comatulid crinoids	67-88	
Fishes		
Holocentrus spp.	67	
Mycteroperca spp.	52-67	
Paranthias furcifer	67	Dense schools.
Epinephelus spp.	52-67	
Malacanthus plumieri	52-61	
Seriola dumerili	55-67	
Lutjanus campechanus	61	
Equetus spp.	52	
Chaetodon sedentarius	67	
Holacanthus sp.	67	Either *H. bermudensis* or *H. ciliaris*.
Pomacanthus paru	52-67	
Centropyge argi	61	
Chromis enchrysurus	52-88	Very abundant.
Bodianus pulchellus	67-88	
Balistes capriscus	67	
Balistes vetula	52-67	
Xanthichthys ringens	67	Sargassum triggerfish.

as well as in the Algal-Sponge Zone, and they extend significantly onto the drowned reefs to depths exceeding 90 meters. In the lower reaches of the Algal-Sponge Zone, the nodules give way to coralline algal crusts adhering to the hard carbonate substratum. The coralline algae decrease in percentage of cover but are still quite abundant in depths of 80 meters or more. Among and attached to the nodules, is a sizeable population of leafy algae, generally the same organisms which occur in the Leafy Algae Zone at the East Flower Garden. Sponges are very conspicuous, particularly the encrusting Neofibularia nolitangere oxeata, the tube sponge Callyspongia vaginalis, and the branching Verongia sp. Other particularly conspicuous invertebrates of this zone are small saucer-shaped growths of agariciid stony corals and a large anemone, Condylactis sp. The expected fishes are seemingly as abundant at 28 Fathom Bank as in similar depths at the Flower Gardens, and the commercial species are well represented.

Natural gas seeps issue abundantly from 28 Fathom Bank and the East Flower Garden below the coral reef. These seeps are intermittent and characteristically emit repeated short bursts of several to hundreds of bubbles, each usually less than one inch in diameter. There is no evidence that such seeps have had any effect on the benthic populations. We have observed very small amounts of white mucus-like material at the points where gas escapes from the rock. No such "deposits" have been detected where gas escapes through sand, although the bottom of a large surge channel at 70-80 meters at the East Flower Garden was totally covered with a similar-appearing substance. Speculation that fishes are attracted to gas seeps has not been confirmed by our observations. The fish are nearly always inclined to position themselves over or beside rocks, outcrops, or bottom irregularities. Where gas seeps occur, they happen also to be associated with these features. However, fishes that congregate nearby seem to be oblivious of the gas, showing no behavior which would indicate an affinity for it. In addition to the East Flower Garden and 28 Fathom Banks, gas seeps have been seen by us at Fishnet, Claypile, and Baker.

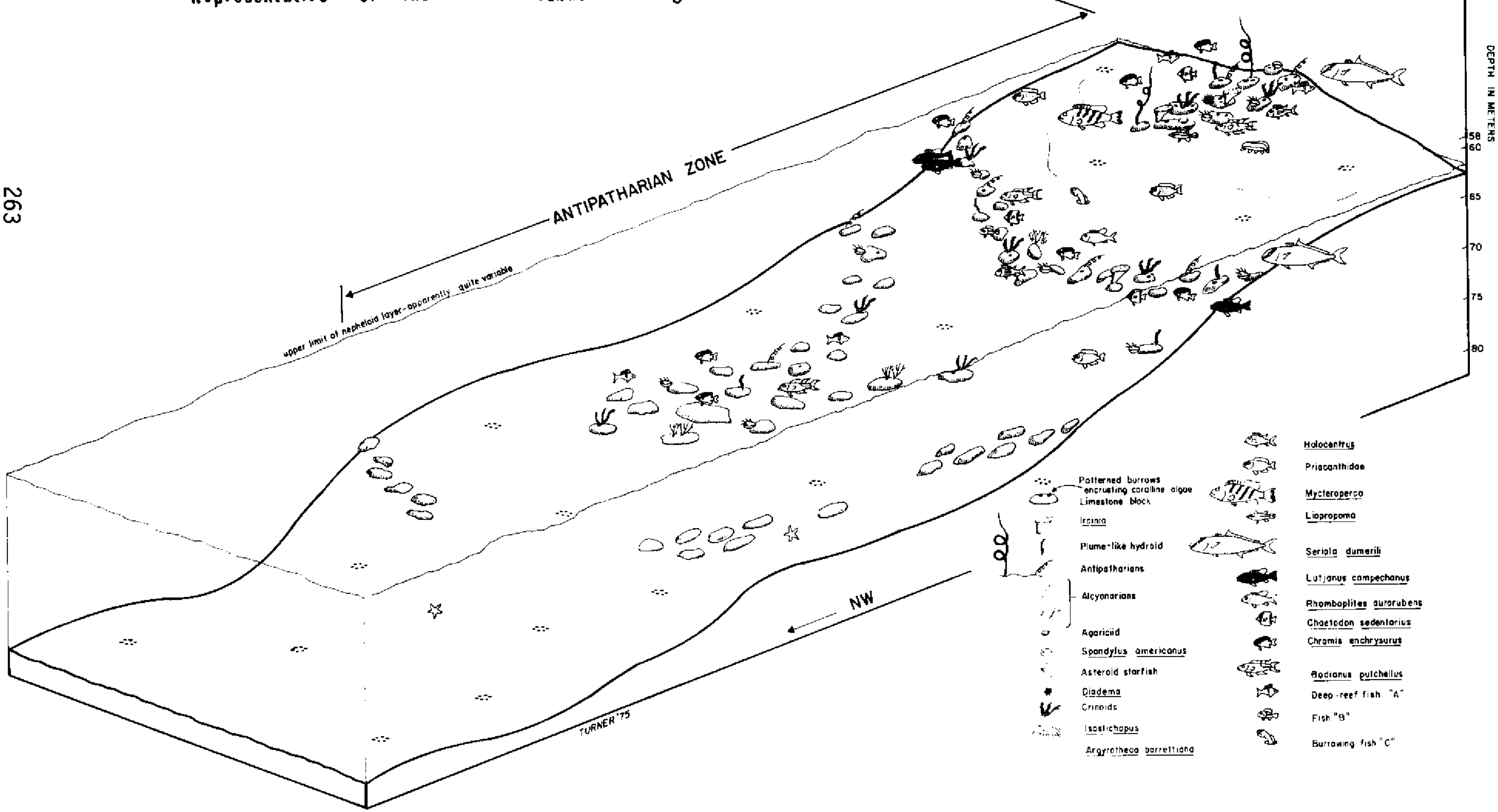
The deepest hard-bank assemblage examined by us (Antipatharian Zone, Fig. 5) occupies all of the south Texas fishing banks visited (Baker, South Baker, North Hospital, Hospital, Southern, Dream, and Big Adam Rock). We presume the hard-bank assemblage also occurs at Aransas Bank, but we have no observations there. Fishnet Bank bears the Antipatharian Zone biota, as do the drowned reefs and portions of the Flower Garden Banks adjacent to them.

The Antipatharian Zone represents a transition downward from the shallow-water benthic biota to a truly deep-water assemblage (Table 1). Interestingly, whereas the assemblage is developed at the crests of the south Texas banks (53 meters or so), truly comparable deep-water populations at the Flower Gardens usually start at depths greater than 70 meters. The generally clearer water at the Flower Gardens may be a factor here, particularly in influencing the lower limit of lush coralline algal and soft algal growth. Missing from the zone-proper are stony corals, except sparse populations of the saucer-shaped agariciid, a small species of Madracis, and solitary ahermatypic varieties. Lithophyllum is present in reduced quantities, and leafy algae are sparse. Present are abundant populations of

Based on observations made from the Texas A&M Oceanography Department research submersible DIAPHUS

FIGURE 5.
SOUTHERN BANK

Representative of the South Texas Fishing Banks



comatulid crinoids, deep-water alcyonarian fans, deep-reef fish "A" and fish "B," all of which are either absent from or rare above 76 meters. The most conspicuous organisms in this zone are the bedspring-shaped white antipatharian "sea whips." Whereas their depth range extends almost to the coral reef, they are rarely seen shallower than 55 meters at the Flower Gardens (Figs. 2 and 3). On the south Texas fishing banks and Fishnet Bank they are abundant from the crests down, thinning out with depth. The south Texas banks apparently differ from the others in their possession of conspicuous populations of the large, vase-like, white sponge Ircinia campana.

The deep-reef fish "A" is a particularly reliable indicator of the Antipatharian Zone assemblage. It has not been seen shallower than 80 meters at the Flower Gardens, but it occurs from the crests downward at Fishnet and the south Texas banks. The yellowtail reeffish, Chromis enchrysurus, is undoubtedly the most abundant species of its size (5-10 centimeters) on the Texas-Louisiana banks below 50 meters and within the Antipatharian Zone particularly. It frequents all of the banks in schools of up to several hundred, though it occurs in smaller groups and singly. At least in the spring, Chromis enchrysurus occupies territories and engages in agonistic behavior toward other fishes, changing temporarily from its typically dark-above/light-below coloration to a dusky gray. Although we have no evidence to indicate it, the yellowtail reeffish would seem to be an ideal forage fish for snappers and groupers.

The south Texas banks are particularly subject to nearly total inundation by the thick nepheloid layers (turbid water layers) which overlie the predominantly soft bottom of the Texas-Louisiana Outer Continental Shelf (Fig. 5). Off south Texas the difference between relief of the hard-banks and thickness of the nepheloid layers is so small, it is probable that most of the time only the top 10 or so meters of the banks are in relatively clear water. We strongly suspect that during storms or prolonged heavy weather, the south Texas banks are entirely covered by turbid water. Even the rocks at the tops of these carbonate banks are covered with a thin veneer of fine sediment wherever the sparse epifauna and coralline algae do not occur. It is our impression that the epifauna and coralline algal encrustations are best developed at the crests of these banks and tend to decrease in abundance downward into the nepheloid layer. The nepheloid layer we observed at Stetson Bank was well down toward its base (Fig. 4), those at the Flower Gardens were well off the hard-banks altogether (Fig. 3), and that at Fishnet started at 80 meters (Fishnet crests at about 61 meters). The Flower Gardens are, therefore, because of their position at the edge of the Continental Shelf, bathed perpetually by clear oceanic water. Stetson is probably subject to occasional heavy doses of turbid neritic water, while the south Texas banks must frequently be covered by the nepheloid layer. We speculate, therefore, that the assemblages of the south Texas banks are rather adapted to turbid water conditions, whereas those of Stetson and the Flower Gardens are possibly less tolerant.

Even so, there seem to be indications that biota of the Antipatharian Zone thrive better in clear water. Certainly the biota are more numerous on the drowned reefs at the Flower Gardens than on the south Texas banks and appear to be better developed at the tops of the south Texas banks than on their flanks. Big Adam Rock, which has relatively little relief above the surrounding soft bottom, was entirely covered by the nepheloid layer when we examined it. We found that it has a much sparser benthic population than that of its neighbors a few miles north. Fishnet Bank, with a nepheloid layer somewhat farther down on its sides, appeared to us to harbor a more diverse and abundant Antipatharian Zone population than any of the south Texas banks. However, speculations concerning the significance of the nepheloid layer as a controlling environmental factor are unconfirmed.

Lutjanus campechanus and Rhomboplites aurorubens were about as abundant on the south Texas fishing banks as on the northern banks. We were surprised at the few sightings and hook-and-line captures of Mycteroperca and the total lack of sightings or captures of species of Epinephelus on the south Texas banks. Fishnet Bank, on the other hand, harbored at least a moderate population of Mycteroperca (as did the lower reaches of the Flower Gardens), and Epinephelus was present. If indeed the groupers and hinds are less abundant on the south Texas banks, the reasons are not apparent and there is a possibility that there should be some concern over the status of the serranid populations off south Texas.

On the banks from Stetson north, we have observed large schools of good-sized creole-fish, Paranthias furcifer. This species is sometimes caught on hook-and-line, and perhaps it, as well as the cottonwick (Haemulon melanurum), which is abundant and easily caught on all the banks, deserves consideration for potential commercial fisheries.

GEOLOGY OF THE BANKS

The banks of the Texas Outer Continental Shelf may be divided into two main groups. Those banks north of lat. 27^{o} 46'N. are associated with salt domes in the subsurface, and their distribution is generally the same as that of shallow salt domes. The banks south of lat. 27^{o} 46'N. are not associated with any shallow, subsurface structures, and their distribution is probably controlled by a Late Pleistocene shoreline approximately 60 meters below the present sea level.

The relief on the banks is quite variable, with those banks in the northern area generally having greater relief. The 28 Fathom Bank has the greatest amount of relief, with a maximum of 118 meters in a distance of 2,200 feet. The least amount of relief is on 32 Fathom Bank, with a total of 6 meters in a distance of 10,500 feet.

Banks such as those described here occur on the Outer Continental Shelf eastward to the head of the Mississippi Canyon. The crests of these banks increase in depth toward the east; the deepest one is in the Mississippi Canyon at a depth of 98 fathoms. This increase in depth of crests is due to downwarping of the Shelf, caused by the weight of the Mississippi Delta.

All of the banks are covered by a heavy growth of coral and coralline algae, except for Stetson and Claypile Banks. These two banks are the only ones known to have outcrops of Tertiary bedrock exposed at the surface of the bank. Some of the banks, such as the West and East Flower Gardens, are living coral reefs. Most of the banks are covered by dead reefs (drowned reefs) that were living from 6,000 to 18,000 years ago at times when sea level was considerably lower than it is at present.

NORTHERN BANKS

Direct geological observations using submersibles have been made at West Flower Garden, East Flower Garden, 28 Fathom, Stetson, and Claypile Banks. Typical of the larger banks on the northern Shelf is the occurrence of gently sloping terraces, covered with sediment and bounded by steep rocky cliffs. These terraces and associated cliffs are especially obvious on the West Flower Garden and 28 Fathom Banks. The rocky cliffs represent drowned reefs that are now dead but were flourishing during a lower stand of sea level. Scattered over the terraces are isolated patch reefs that developed as sea level rose. These features are well illustrated on the chart of the West Flower Garden Bank. The rocky cliffs, patch reefs, and irregular parts of the hard substrate of the Algal-Sponge Zone are places where large schools of snappers, groupers, creole-fish, barracuda, and jacks congregate. There are three drowned reef levels at the West Flower Garden Bank, occurring at -56, -91, and -128 meters. At the East Flower Garden Bank there is one large drowned reef at a depth of about -63 to -85 meters. At 28 Fathom Bank drowned reefs occur at -52, -56, -80, and -90 meters on the north side, and a single reef occurs from -100 to -170 meters on the south side.

The sediments that surround the actively growing reefs are coarse sands and gravels, grading into finer sediments with increasing depth of water. The distribution of sediment types on the West Flower Garden is typical of the actively growing reefs. At the crest of the reef, between the large coral heads, a coarse coral-molluscan sand covers the bottom. This sand is moved by severe storms into chutes that carry it to the base of the reef, where it is spread by currents into a narrow band immediately adjacent to the base of the reef at depths of from -45 meters to -49 meters. Close to the base of the reef are large blocks of reefrock that have been torn loose by storms and have tumbled down the steep slopes. Beginning at a depth of about -49 meters and extending to a depth of about -73 meters, the bottom is covered by a coarse gravel composed of nodules of coralline algae. This sediment is the substrate of the Algal-Sponge Zone illustrated in Figure 2. From -85 meters to a depth of -106 meters, the sediment consists of a foraminifera-coral-coralline algae sand. Below -106 meters the sand gives way to the sandy, silty clays that are the normal deposits of the Outer Continental Shelf.

The 32 Fathom Bank has a very low relief, but the record on the precision depth recorder indicates a hard bottom. Neither direct observations nor sampling have been conducted at 32 Fathom Bank. However, our experience with other banks at comparable depths indicates that the bottom should be covered with the hard, coralline algae nodules, typical of the Algae-Sponge Zone.

SOUTHERN BANKS

Direct geological observations have been made on Baker Bank, South Baker Bank, North Hospital Bank, Hospital Rock, Southern Bank, Dream Bank, and Big Adam Rock. The greatest relief on the southern group of banks is found on Southern, with a maximum relief of 22 meters. The average relief on the other banks is about 10-12 meters. As mentioned earlier, these banks differ from the northern banks in that they are not associated with salt domes. The banks are all drowned reefs that were thriving coral-algae reefs during lower stands of sea level.

Southern Bank is typical of this group, and the diagram in Figure 5 illustrates the nature of the bottom topography. Three levels of reef development are shown at -72, -68, and -63 meters. These levels are identical to the massive rocky, drowned reefs of the northern banks, but have very little relief. The substrate between these reef levels is a pavement of dead coralline algae, covered by a thin film of fine clay- and silt-size sediment deposited from the nepheloid layer which more or less continuously covers these banks.

As these reefs are no longer actively growing, the coarse, gravelly and sandy sediments that are found surrounding actively growing reefs to the north, are not present at the surface. Sediment cores taken adjacent to the drowned reefs show the sandy and gravelly sediment to be covered by about a foot of sandy and silty clay.

SUMMARY

Biotic assemblages on reefs and hard-banks of the Texas-Louisiana Outer Continental Shelf can be distinctly grouped, according to their natures, into four general categories: (1) the sparse Claypile Bank biota (35-55 meters) of predominantly low-growing filamentous and leafy algae and sponges, with occasional "meadows" of high-standing leafy algae occupied by numerous fish; (2) the more diverse Stetson and 3 Hickey Rock biota (28-56 meters) dominated by the hydrozoan fire coral (*Millepora alcicornis*) and sponges; (3) the highly diverse and abundant Flower Gardens/28 Fathom Bank biota, with coral reefs (22-49 meters), algal nodule and sand-covered platforms (45-76 meters), and drowned reefs (76-100+ meters), bearing an assemblage of organisms directly comparable to the deep-water biota of category 4; and (4) the deep-water biota of the south Texas fishing banks (53-78 meters) and Fishnet Bank (61-82 meters), characterized by the presence of antipatharian whips, deep-water alcyonarian fans, comatulid crinoids, certain species of deep-dwelling fishes, and sparse populations of encrusting coralline algae.

Commercial snappers and groupers frequent all of the banks, though there is a possiblity that serranid populations may be smaller on the south Texas banks than on the others. The most abundant and conspicuous fish on the banks, excluding the coral reefs at the Flower Gardens, is the small yellow-tail reeffish, *Chromis enchrysurus*.

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LITERATURE CITED

Abbott, R. E.

1975. The faunal composition of the Algal-Sponge Zone of the Flower Garden Banks, northwest Gulf of Mexico. Master's Thesis, Tex. A&M Univ., Oceanogr. Dep., 205 p.

Bright, T., W. Pequegnat, R. DuBois, and D. Gettleson.

1974. Baseline survey, Stetson Bank, Gulf of Mexico. Signal Oil and Gas Co., Environmental Conservation, Houston, 59 p.

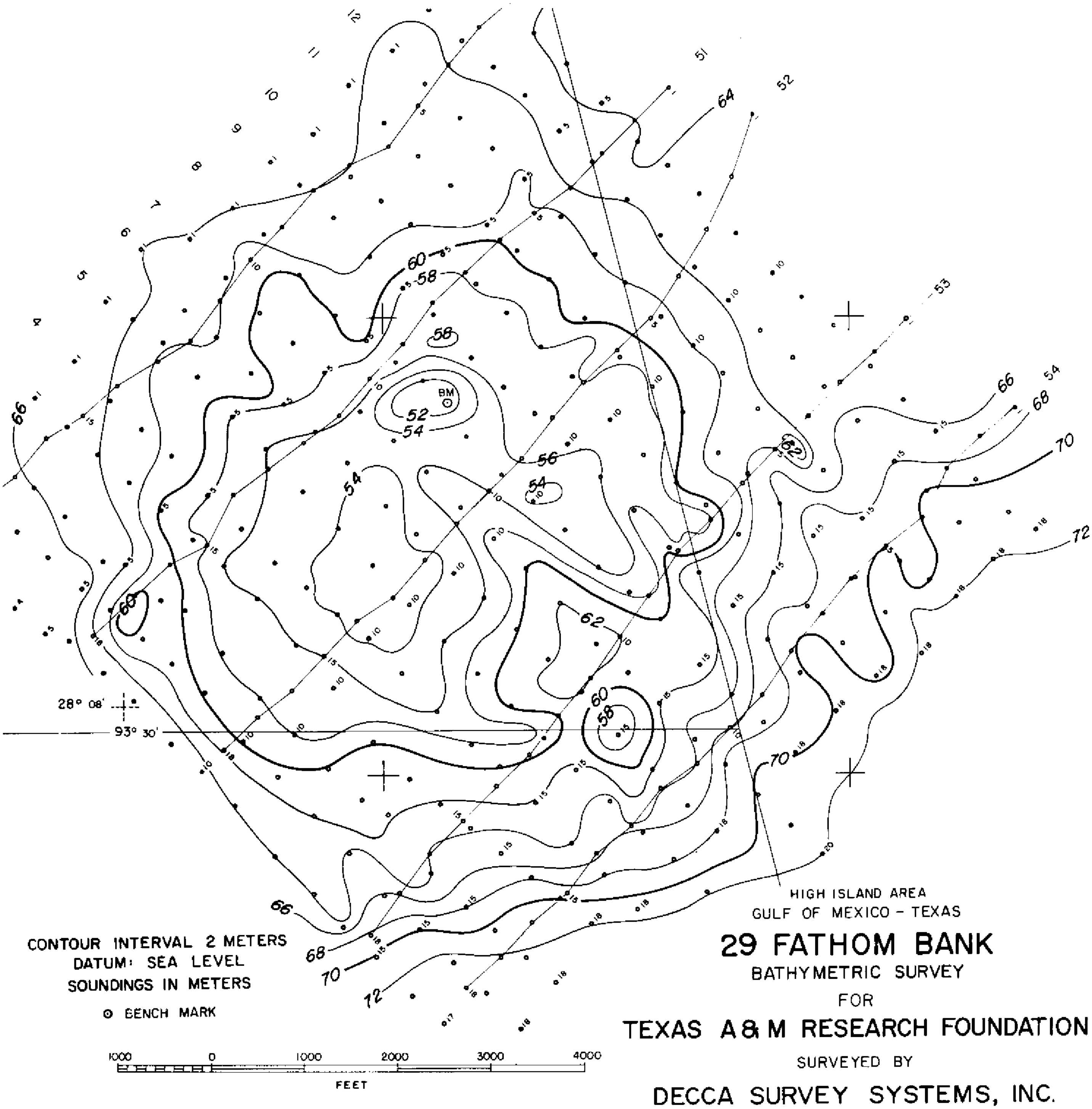
Bright, T. J., and L. H. Pequegnat (editors).

1974. Biota of the West Flower Garden Bank. Gulf Publishing Co., Houston, 435 p.

Hogg, D. M.

1975. Formation, growth, structure, and distribution of calcareous algal nodules on the Flower Garden Banks. Master's Thesis, Tex. A&M Univ., Oceanogr. Dep., 57 p.

MAPS


HIGH ISLAND AREA
GULF OF MEXICO - TEXAS
29 FATHOM BANK
BATHYMETRIC SURVEY
FOR
TEXAS A&M RESEARCH FOUNDATION
SURVEYED BY
DECCA SURVEY SYSTEMS, INC.
CONTOUR INTERVAL 2 METERS
DATUM: SEA LEVEL
SOUNDINGS IN METERS
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93° 30'
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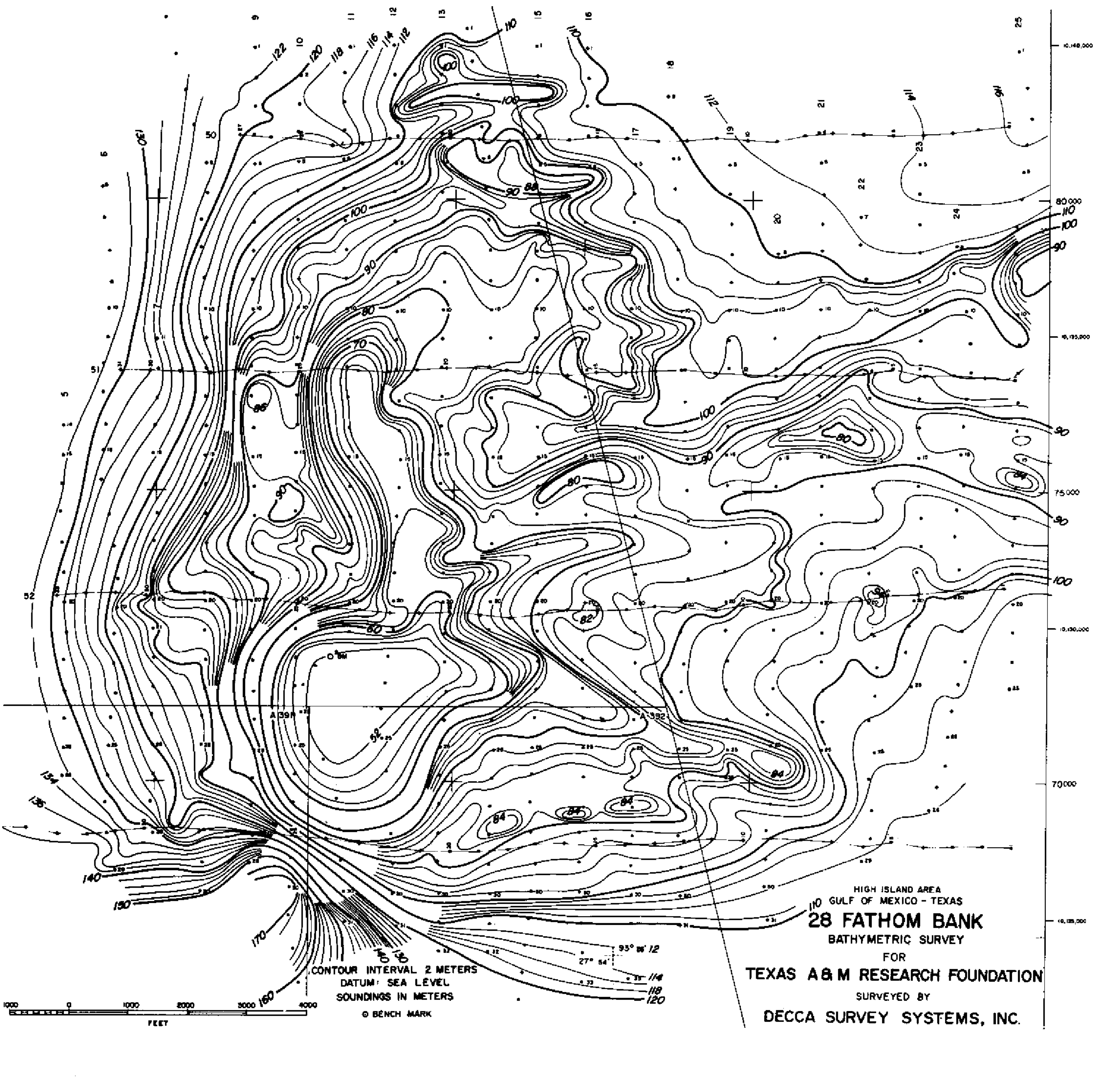
FEET



HIGH ISLAND AREA
GULF OF MEXICO - TEXAS
28 FATHOM BANK
BATHYMETRIC SURVEY
FOR
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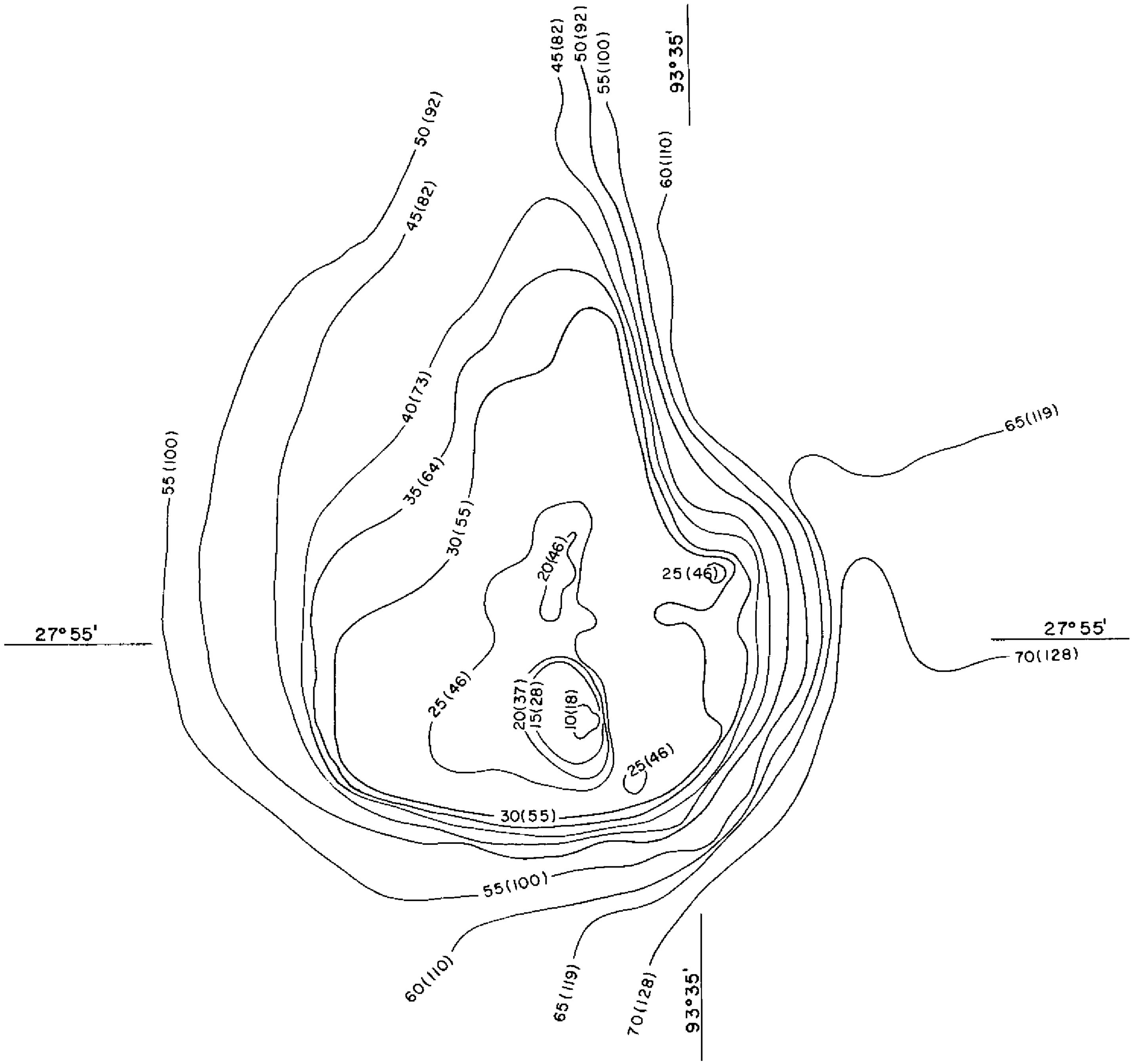
FEET



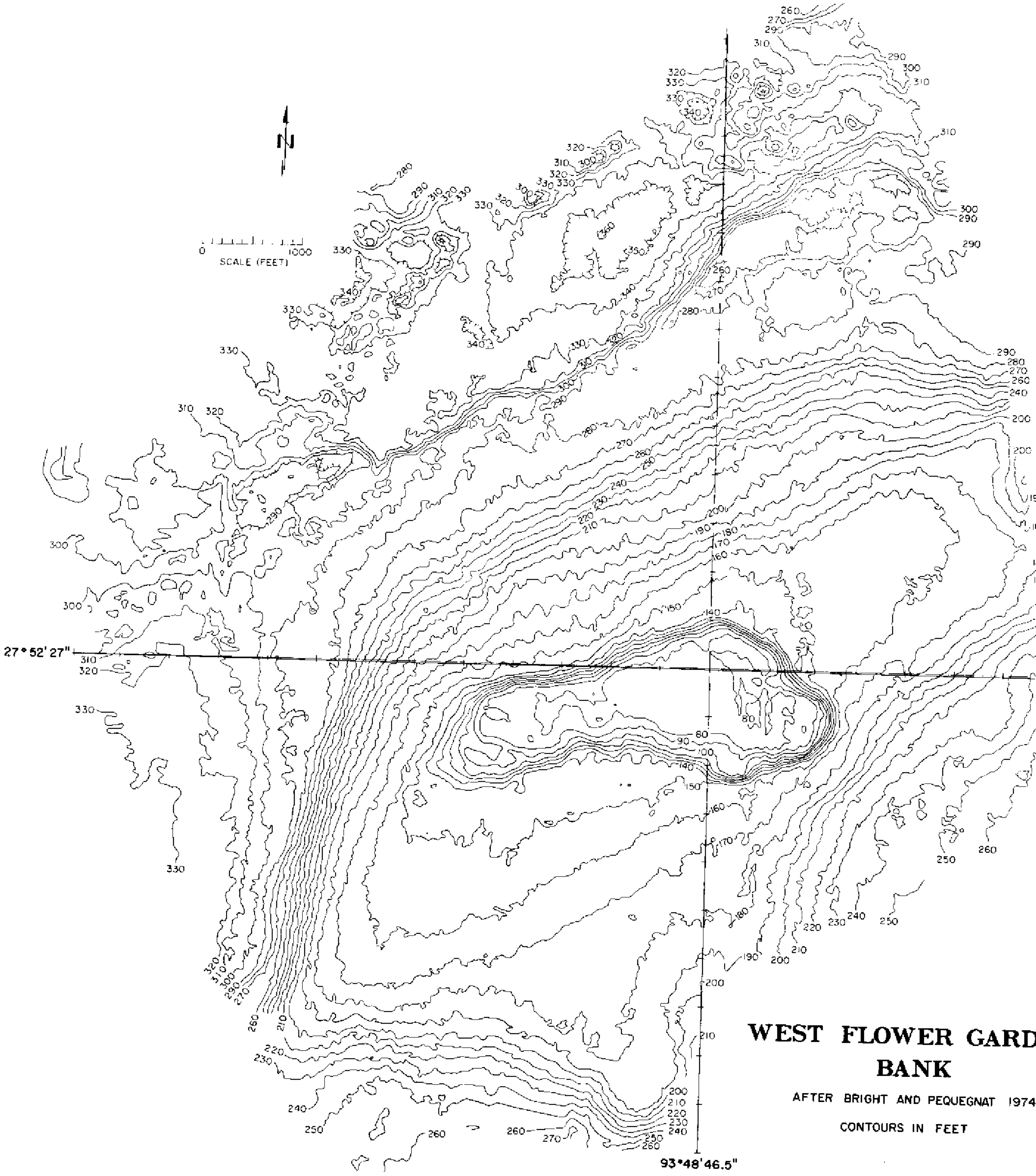
EAST FLOWER GARDEN BANK

AFTER PARKER AND CURRAY 1956

CONTOURS IN FATHOMS (METERS)

0 1 2

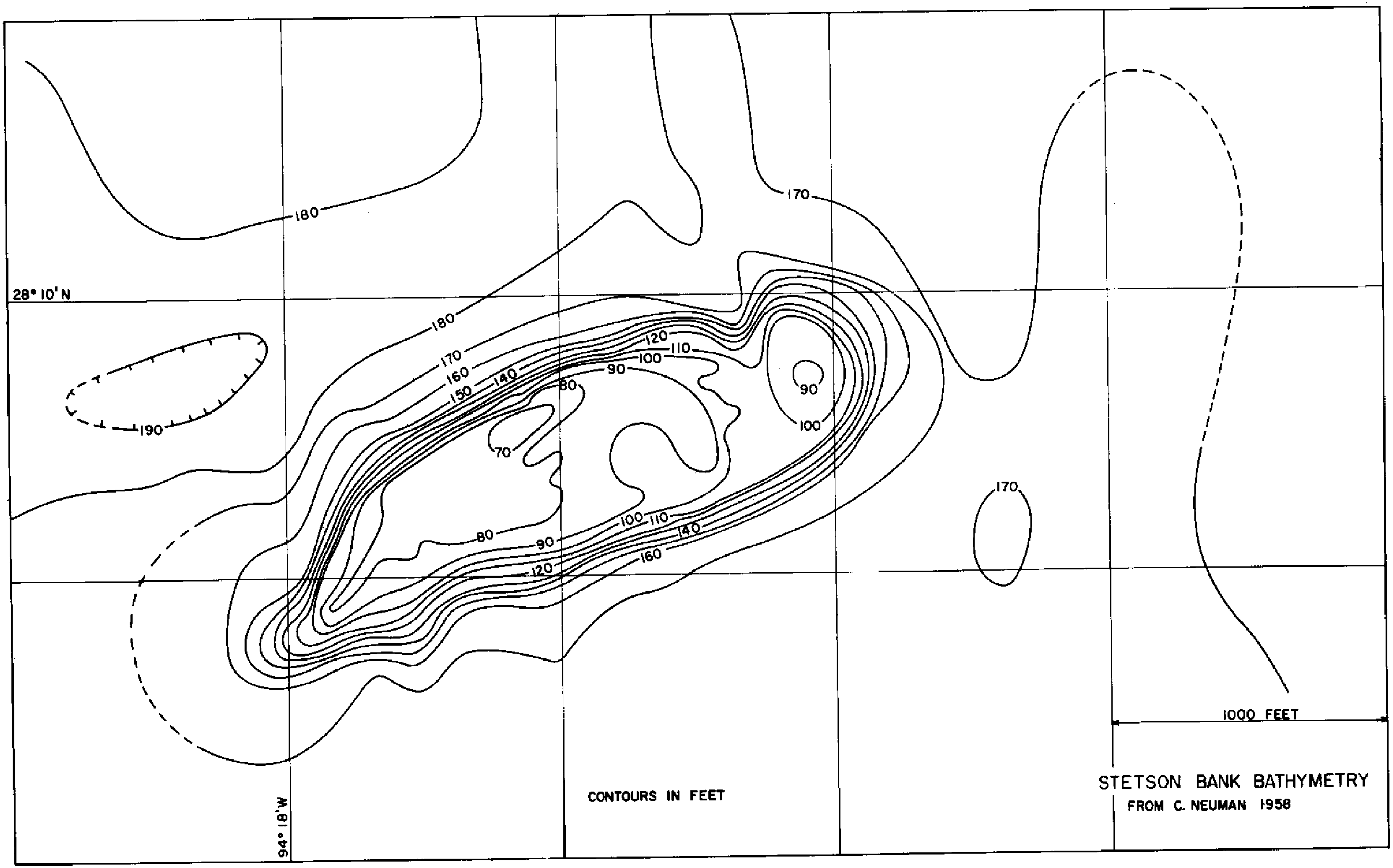
STATUTE MILES

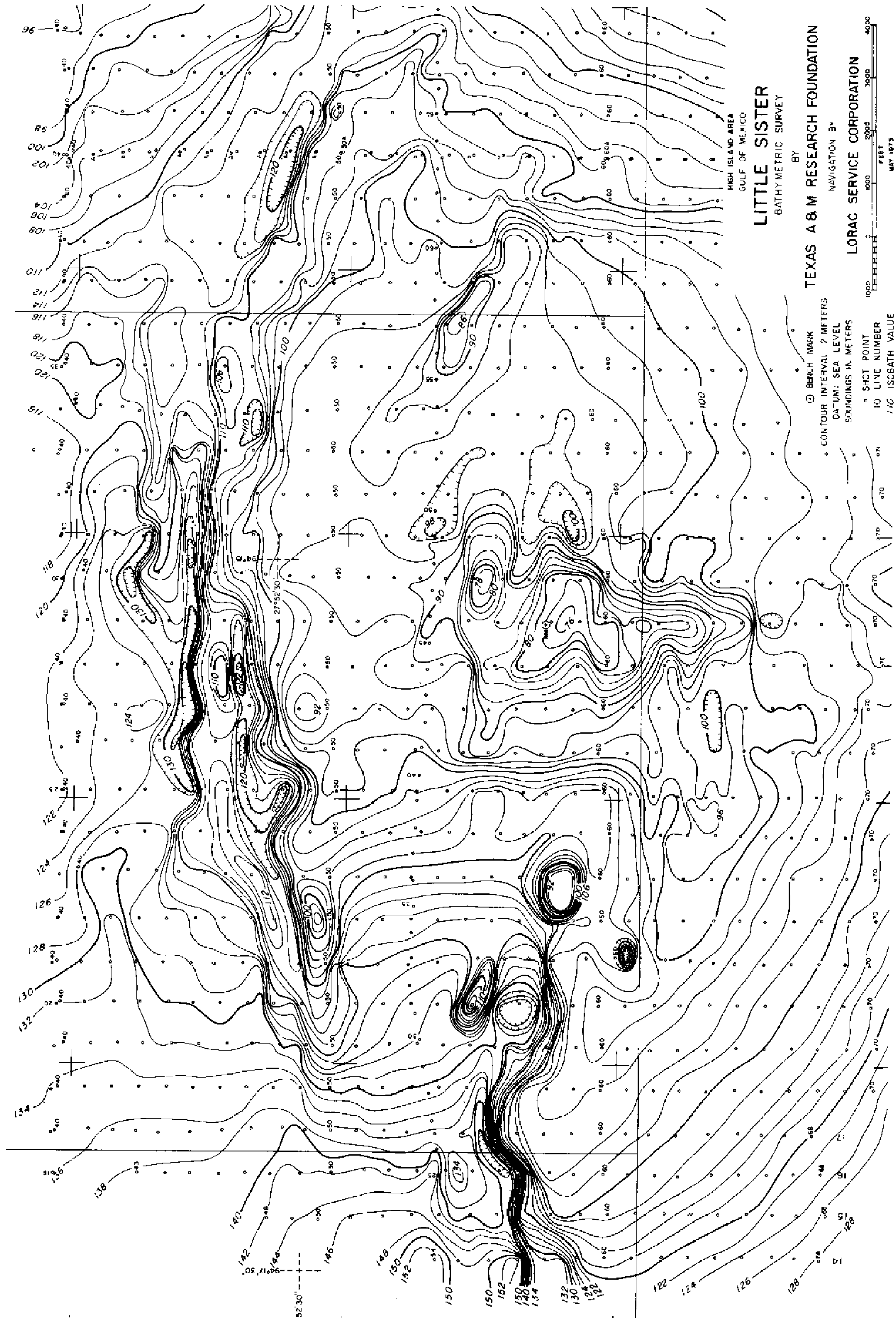


WEST FLOWER GARDEN BANK

AFTER BRIGHT AND PEQUEGNAT 1974

CONTOURS IN FEET


STETSON BANK BATHYMETRY
FROM C. NEUMAN 1958
CONTOURS IN FEET
1000 FEET
28° 10' N
94° 18' W
70
80
90
100
110
120
140
150
160
170
180
190


HIGH ISLAND AREA
GULF OF MEXICO
LITTLE SISTER
BATHYMETRIC SURVEY
BY
TEXAS A & M RESEARCH FOUNDATION
NAVIGATION BY
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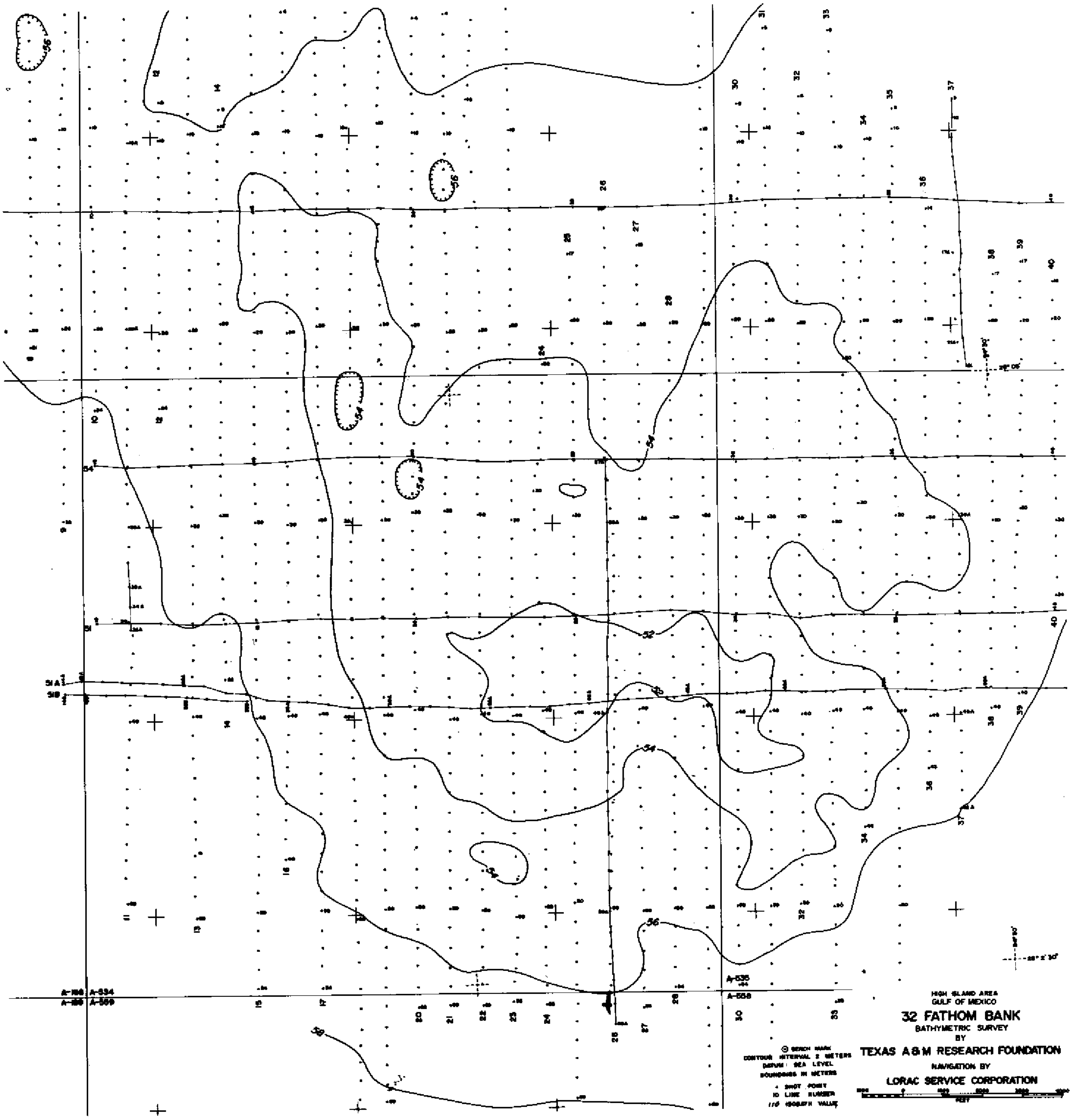
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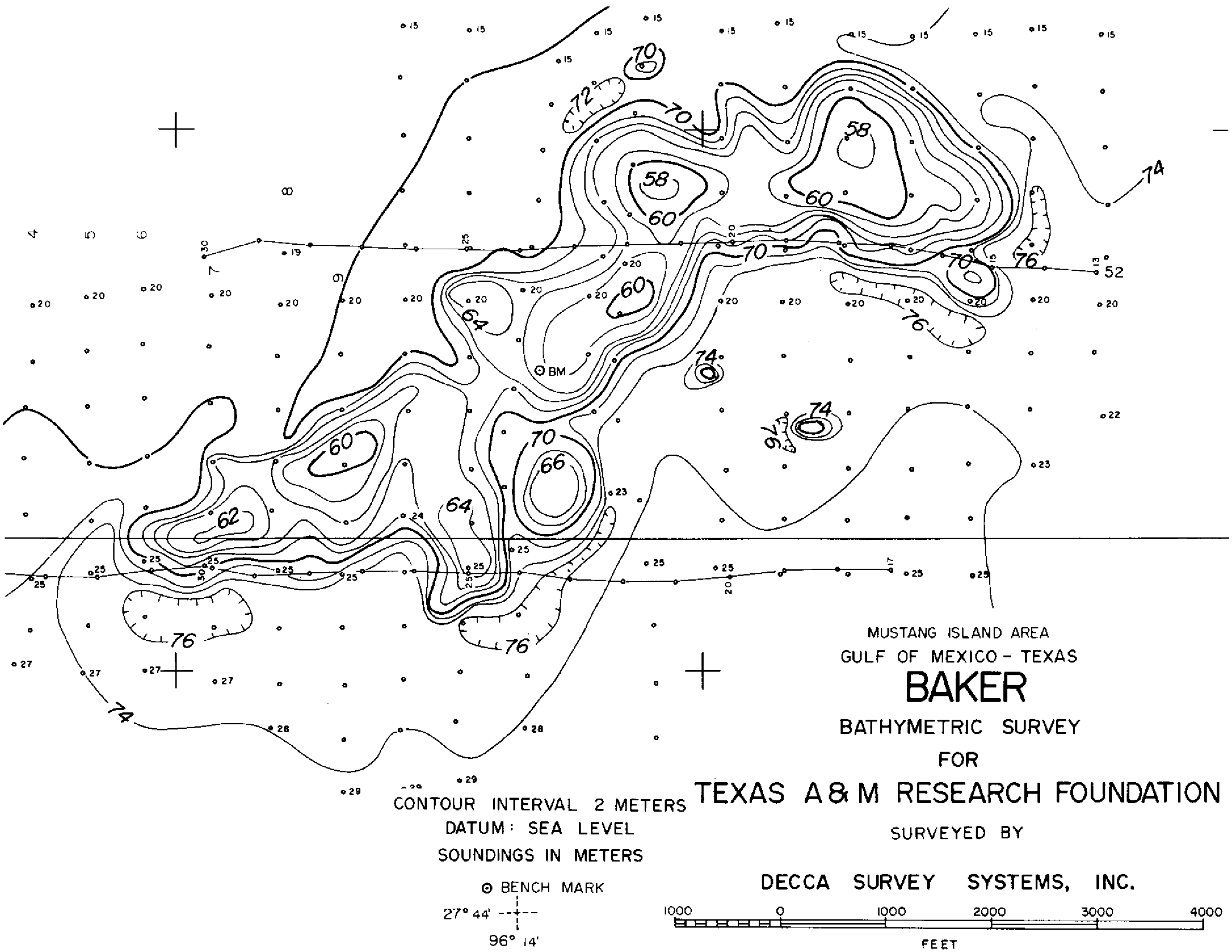
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FOR
TEXAS A&M RESEARCH FOUNDATION
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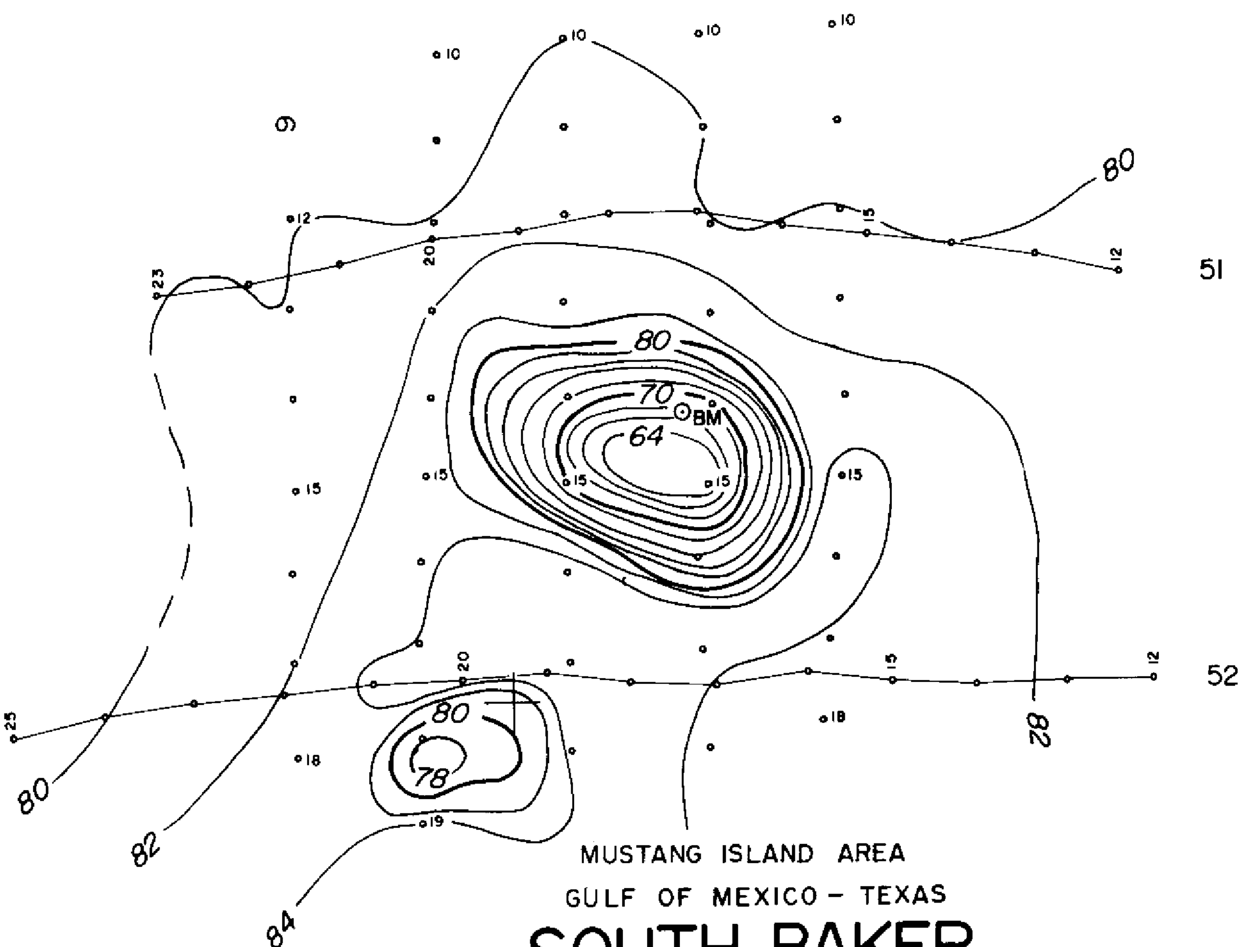

MUSTANG ISLAND AREA

GULF OF MEXICO – TEXAS

SOUTH BAKER

BATHYMETRIC SURVEY

27° 40′

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FOR

TEXAS A&M RESEARCH FOUNDATION

SURVEYED BY

DECCA SURVEY SYSTEMS, INC.

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SOUNDINGS IN METERS

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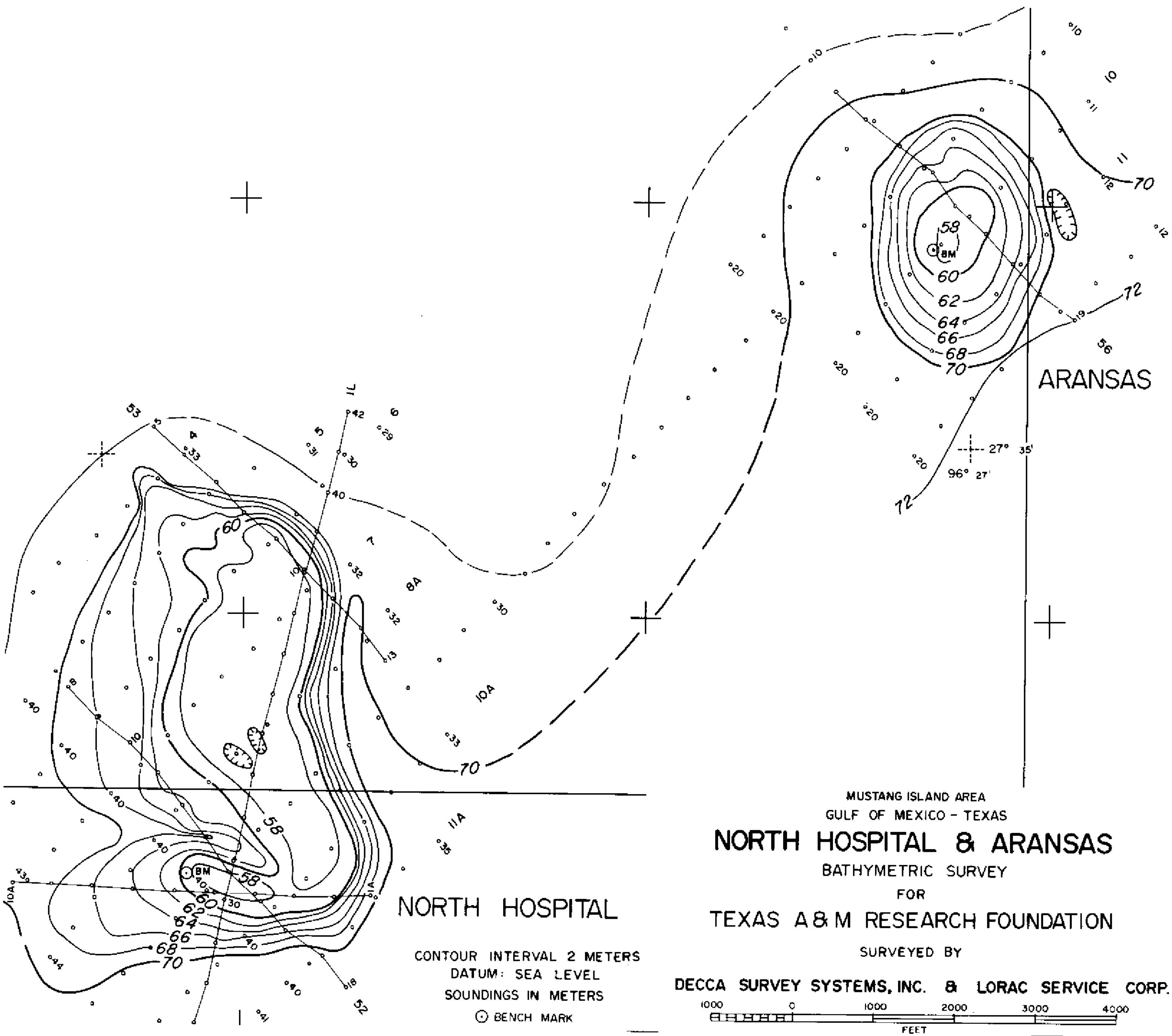
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GULF OF MEXICO - TEXAS
NORTH HOSPITAL & ARANSAS
BATHYMETRIC SURVEY
FOR
TEXAS A&M RESEARCH FOUNDATION
SURVEYED BY
DECCA SURVEY SYSTEMS, INC. & LORAC SERVICE CORP.
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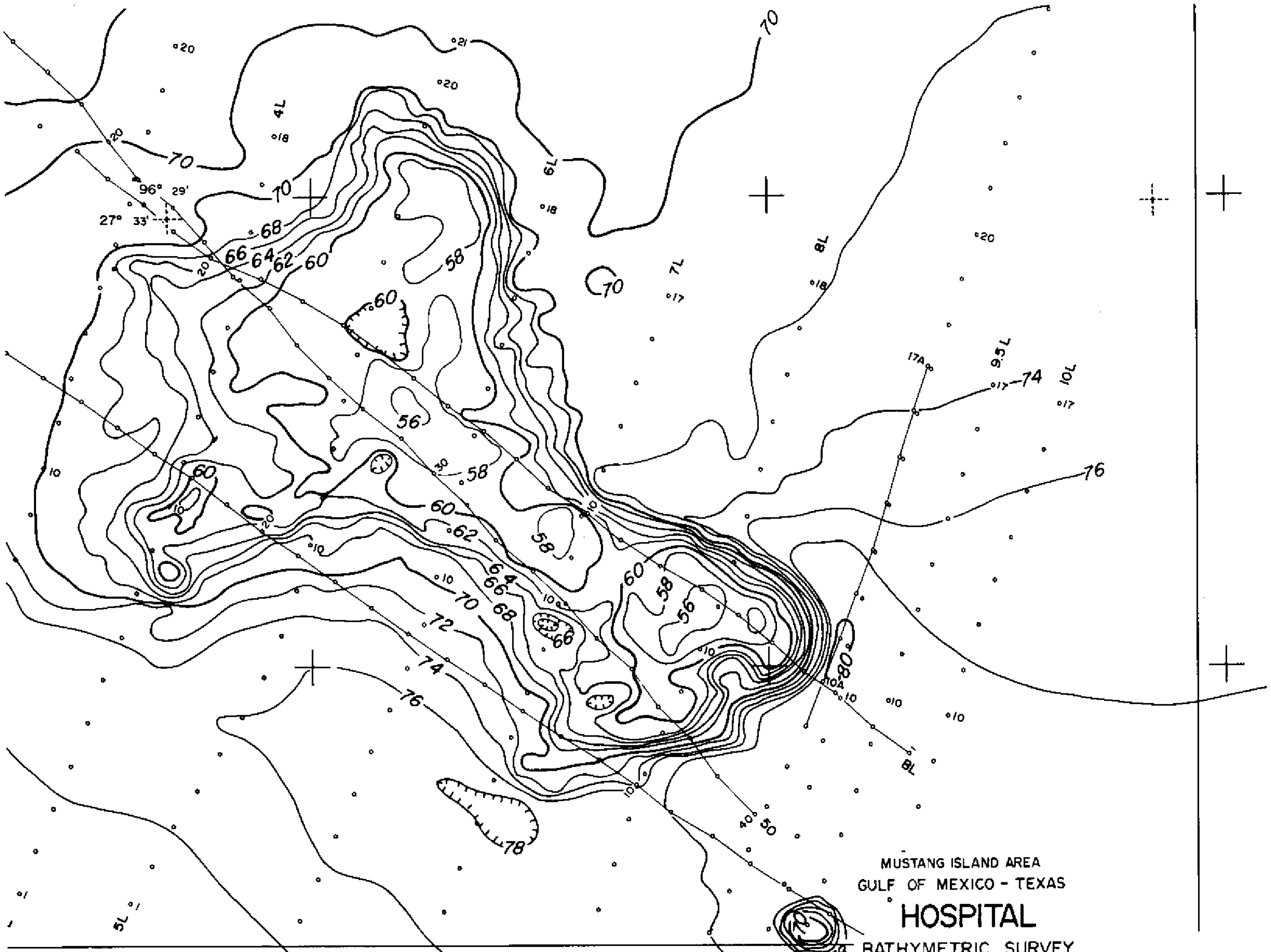

FOR

TEXAS A&M RESEARCH FOUNDATION

SURVEYED BY

DECCA SURVEY SYSTEMS, INC. & LORAC SERVICE CORP.

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DETAILED BATHYMETRY OF HOSPITAL FROM BATHYMETRY OF HOSPITAL ROCK PREPARED BY SOUTHWEST RESEARCH INSTITUTE (1969).

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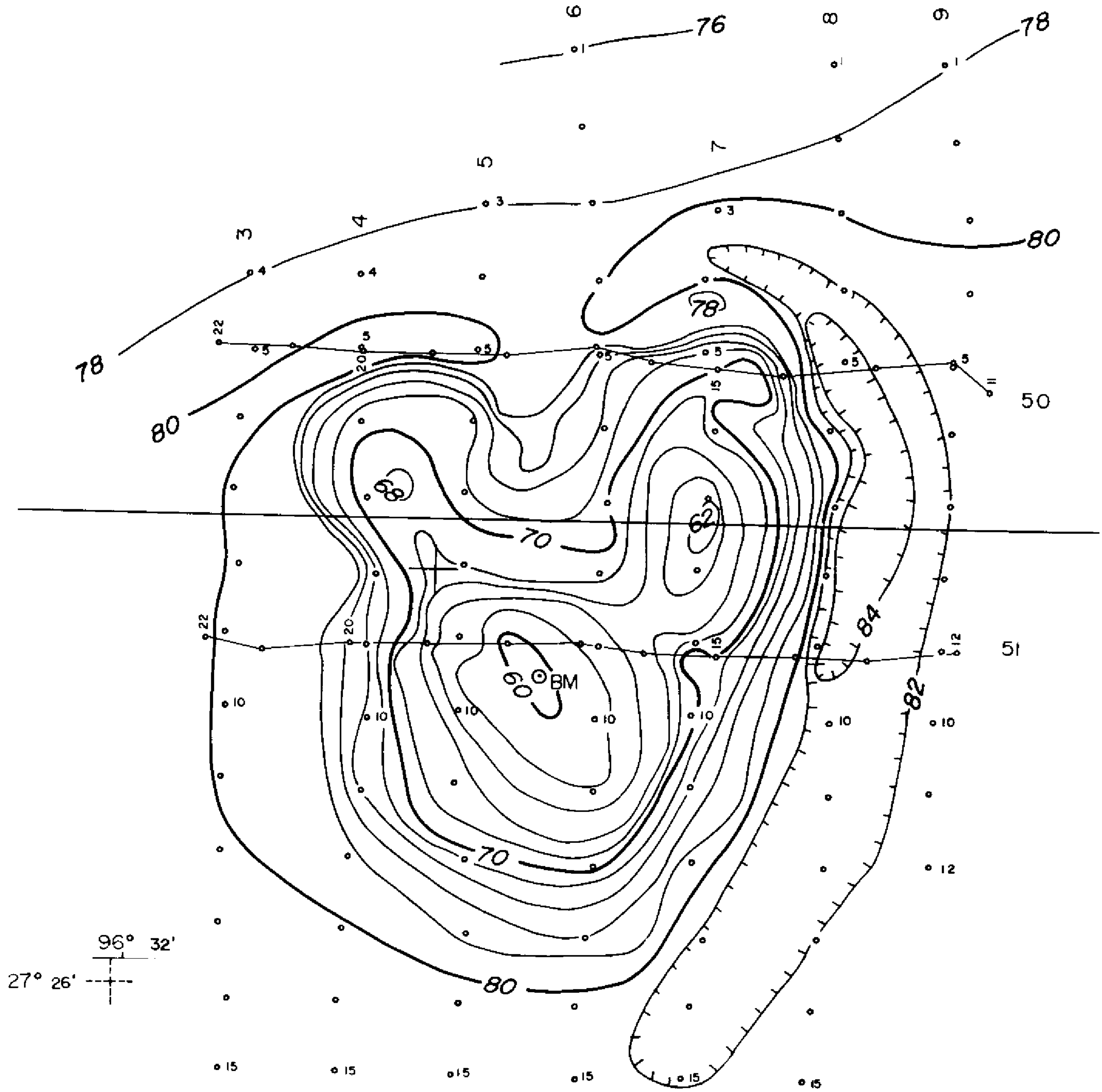

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SOUNDINGS IN METERS
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MUSTANG ISLAND AREA
GULF OF MEXICO – TEXAS

SOUTHERN

BATHYMETRIC SURVEY
FOR

TEXAS A&M RESEARCH FOUNDATION

SURVEYED BY

DECCA SURVEY SYSTEMS, INC.

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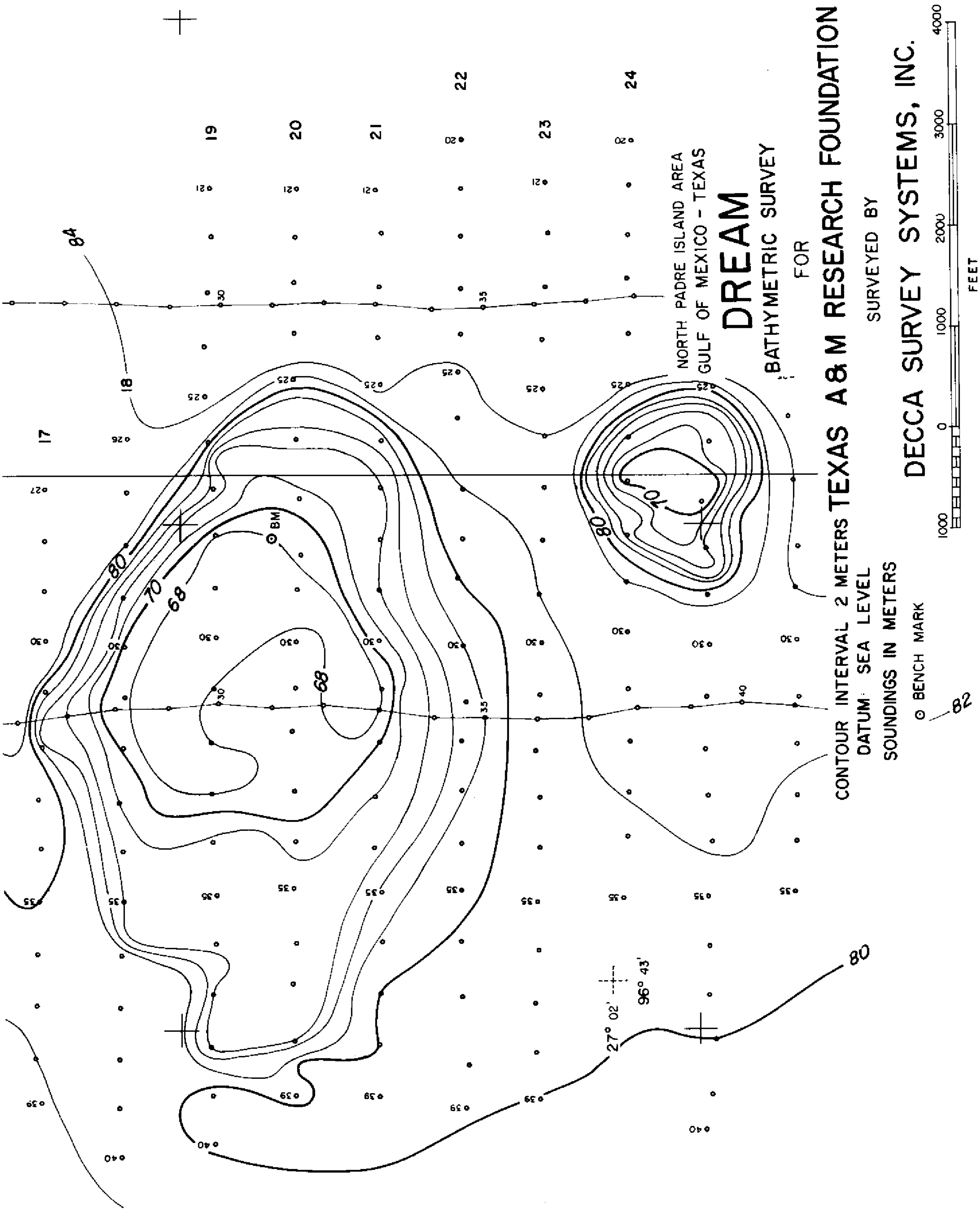

NORTH PADRE ISLAND AREA
GULF OF MEXICO - TEXAS
DREAM
BATHYMETRIC SURVEY
FOR
TEXAS A&M RESEARCH FOUNDATION
SURVEYED BY
DECCA SURVEY SYSTEMS, INC.
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SOUNDINGS IN METERS
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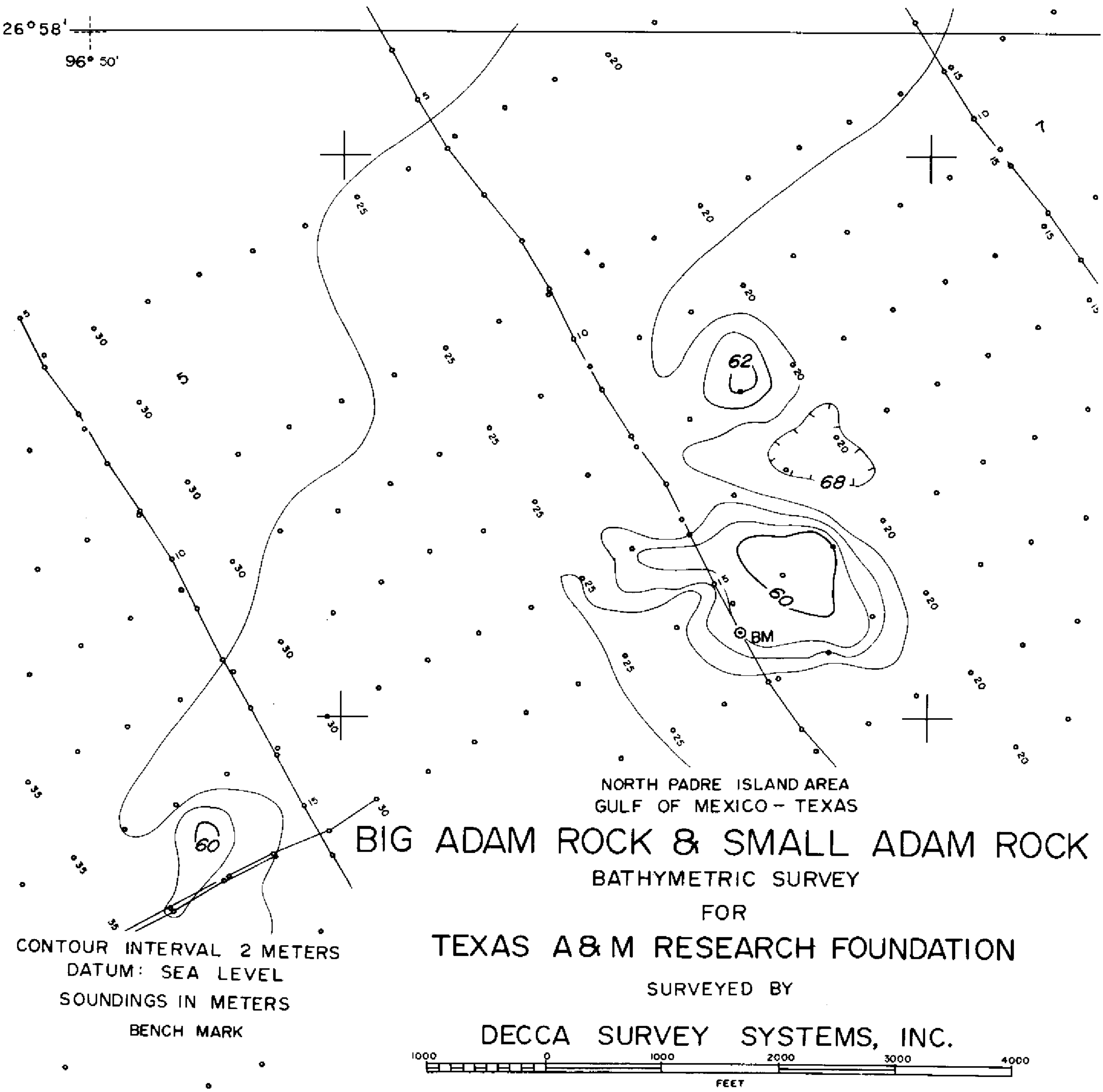
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NORTH PADRE ISLAND AREA
GULF OF MEXICO – TEXAS
BIG ADAM ROCK & SMALL ADAM ROCK
BATHYMETRIC SURVEY
FOR
TEXAS A&M RESEARCH FOUNDATION
SURVEYED BY
DECCA SURVEY SYSTEMS, INC.
CONTOUR INTERVAL 2 METERS
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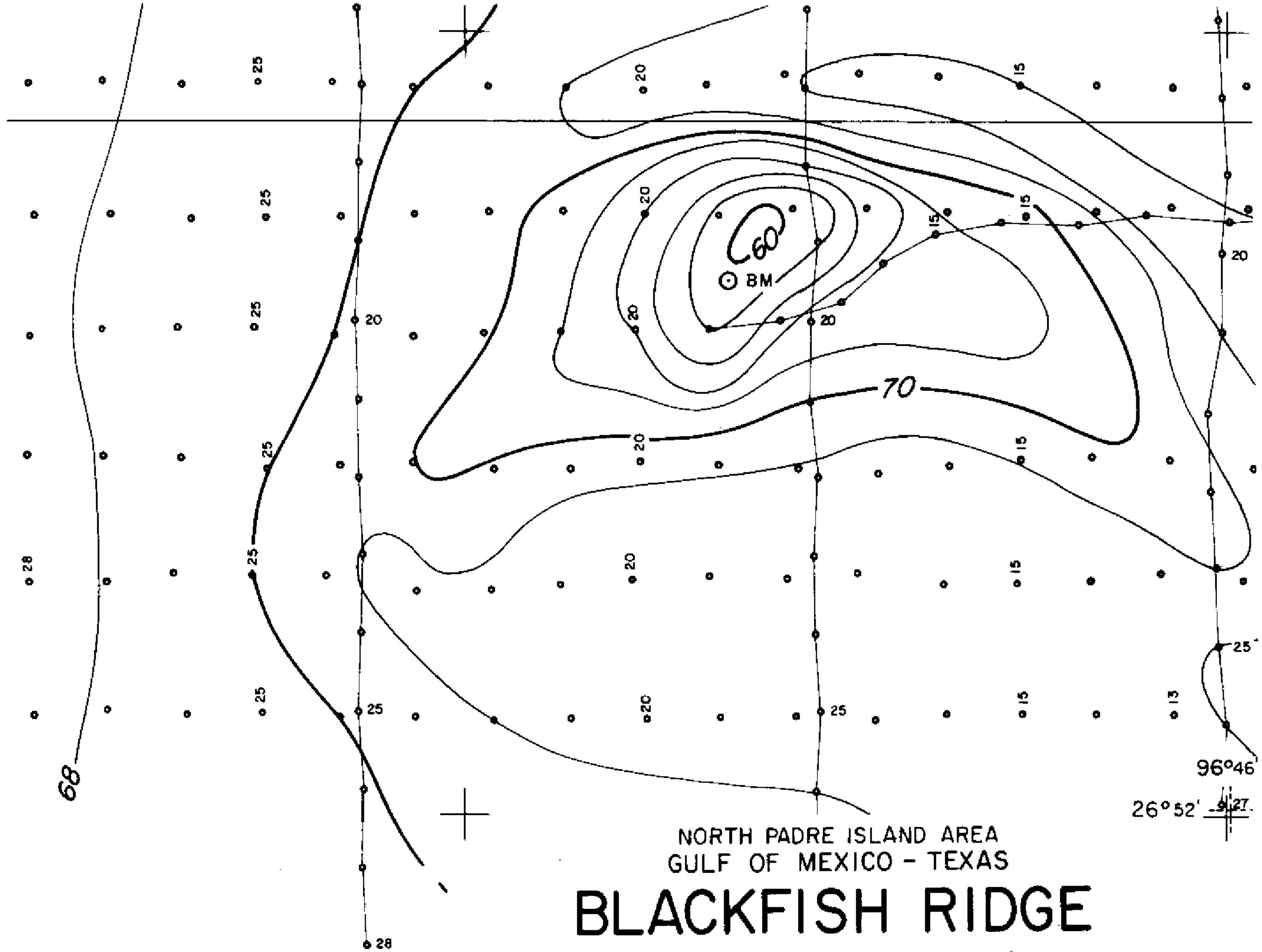

NORTH PADRE ISLAND AREA
GULF OF MEXICO - TEXAS

BLACKFISH RIDGE

BATHYMETRIC SURVEY

FOR

TEXAS A&M RESEARCH FOUNDATION

SURVEYED BY

DECCA SURVEY SYSTEMS, INC.

CONTOUR INTERVAL 2 METERS
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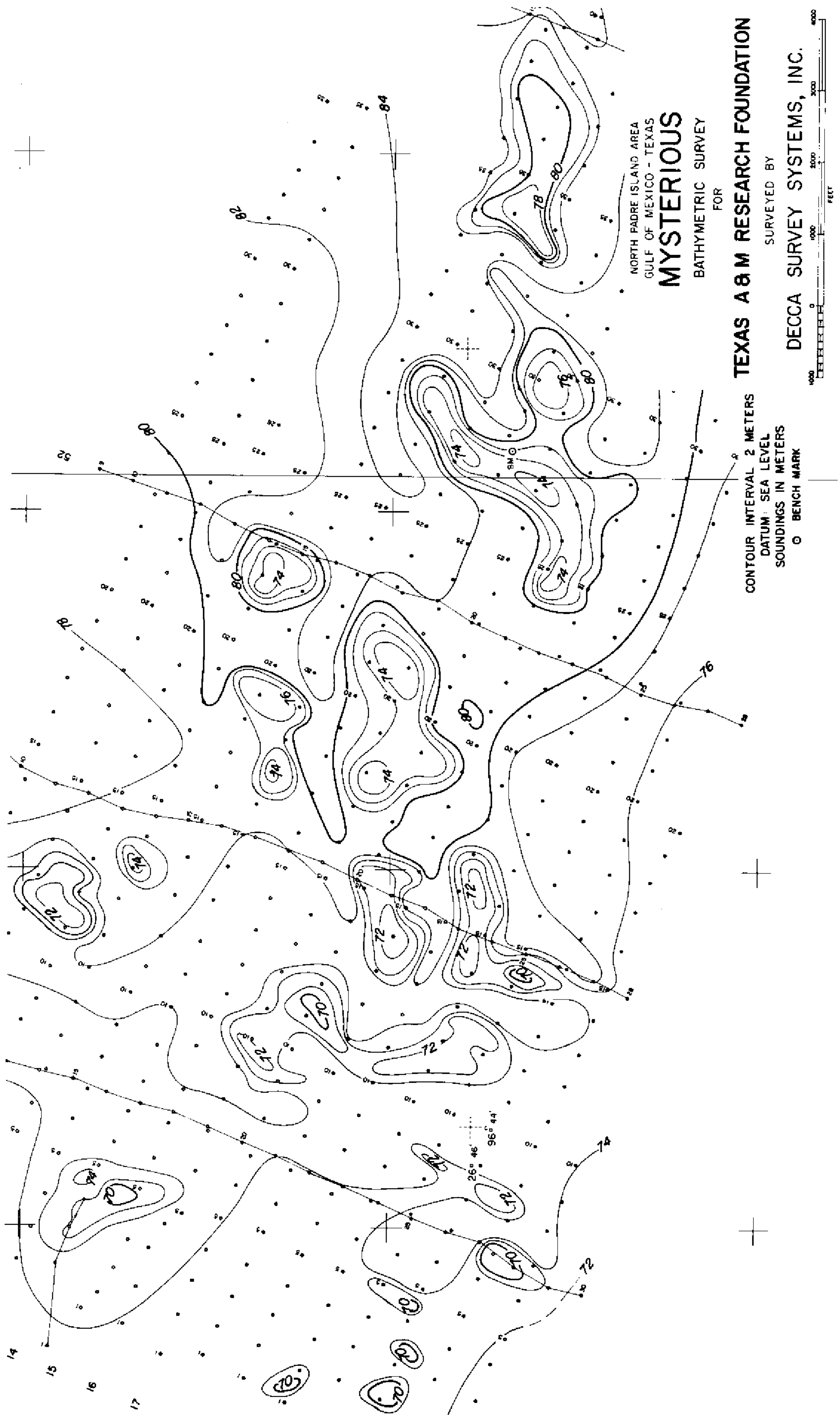
NORTH PADRE ISLAND AREA
GULF OF MEXICO - TEXAS
MYSTERIOUS
BATHYMETRIC SURVEY
FOR
TEXAS A&M RESEARCH FOUNDATION
SURVEYED BY
DECCA SURVEY SYSTEMS, INC.
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PANEL 1

DISCUSSION

A. JONES:

The papers we have heard on the snapper-grouper resources have described both a complex resource base and complex fisheries. Some authors have described the historical trends of the fisheries, and others have expressed optimism concerning increased yields that may be available. There are, of course, problems of matching the available resources to the increasing fisheries. What are your questions?

BULLIS:

I think one point in Dr. Klima's presentation that needs clarification is the implication that by reducing the harvest of small red grouper, you would get a significantly increased yield. This is done by changing fishing tactics and changing the nature of the fisheries. You are going to have to give up the small fish to get this increased poundage.

KLIMA:

Yes. If you increase effort at this age of entry (3 years), you are not going to really increase your production. You can increase effort significantly without making any real changes in production. If you change the age at entry by fishing different areas, different types of gear, perhaps then you can significantly increase production.

A. JONES:

I interpreted your yield isopleth a little differently. It looked to me that increasing fishing mortality, even at age 3, could increase the yield by a factor of four or five.

KLIMA:

It's a very gradual increase. For example, if you increase fishing mortality 100%, you would increase your yield perhaps 20%; but if you increased age of entry to 5 years and then increased fishing mortality 100%, you would increase your yield 100%.

BORTONE:

I'm afraid that that isopleth you've shown isn't quite accurate in some instances because you have to incorporate the biology of the organism, which, in this case, obviously shows sex reversal. I think you may have to wind up showing perhaps two completely different types of yield where the males come into the population amongst the females. When you take that into consideration, you maybe can sustainably show a much lower yield. Again, perhaps more data is needed.

KLIMA:

Right.

A. JONES:

Let me ask Gene Nakamura one question about one of his figures. This was the landings of groupers in 1960, which were 74.8 million pounds, and this dropped to what -- 15 and 16 million pounds in the two subsequent 5-year intervals? Do you think those figures are in the right ball park, or is there information for that?

NAKAMURA:

These data here, these points here, were obtained from fewer than 2,000 interviews; and then, the people who were interviewed were asked to recall information for the past year. And golly! Try to set confidence levels to that! I wouldn't even try. But, these are the only data that are available now. I can't even cite any other data.

A. JONES:

Thank you. I think this points out very well that we are dealing with an information problem here. For the commercial parts of the fishery, and especially for the recreational parts of the fishery, we are lacking very basic information -- the most basic information that you would need to make judgments on the condition of the stocks.

DE SYLVA:

I just have a comment, and I would like to know if perhaps somebody else is doing the same thing. We have a proposal we are preparing with Sea Grant which may help obviate problems of identification. We want to prepare an illustrated field guide and key to the snappers and groupers. Does anybody else know of anyone doing this?

KLIMA:

Yes, FAO is doing an illustrated key of all the fishes of the western central Atlantic. Walter Fischer in Rome is doing this, and I'm sure you must be aware of that. Of course, one of the groups would be the snappers and groupers.

DE SYLVA:

I don't know if they are going to cover all 52 species.

KLIMA:

They will cover a large majority because these are of commercial and recreational importance. Some of these fishes, like the rat-tails, naturally will not be covered in great detail, but I can find out more information if anyone wants to know.

A. JONES:

I think the long life of most of these species is quite interesting from a fishery management point of view. It's somewhat different from the situation that we have for many of our Gulf and Caribbean fishery resources; and the implication of the slow growth rate and the probably slow natural mortality rate, which would be correlated with the long life, would pose somewhat different management problems than we have with some of the faster growing stocks of animals.

BULLIS:

I'd like to ask Charlie Futch to clarify one point here. /_Futch presented the verbal summary of the paper by Beaumariage and Bullock._/ It seems to me that you were enforcing Ed Klima's inference that red grouper can potentially provide a much higher yield if we can find some selective way of reducing mortality at the younger age groups. This is something that seems to be coming out of these papers and discussions, and I'd like to know whether that's a correct inference from your statement.

FUTCH:

I think perhaps it is. We know so little about them. It's easy to say something about it because we don't know anything about them.

BULLIS:

Yes, but I wondered whether you were trying to make this point -- that perhaps the capture of unusually large numbers of small red grouper may have some serious impact on the viability of the red grouper stocks.

FUTCH:

I think it might, inasmuch as they do mature in 5 years or so; and some of these fishes that I've seen brought in to, for example, Tarpon Springs, Florida are much smaller than 5-year-old fish.

BULLIS:

I see this as a horrible management problem because red grouper is taken as part of a mixed grouper catch. How do we manage just the red grouper? I think this opens up a whole raft of fantastically difficult questions. I'm just trying to see whether the discussions are arriving at maybe a consensus on a point that has to be looked at. I'm not trying to put words into your mouth.

FUTCH:

I think it bears further discussion.

HUNTSMAN:

A question to Jim Cato -- I'm just curious about the source of your data on the annual catch-per-year by head boats in west Florida.

CATO:

From a questionnaire taken personally by myself from the owners of the boats and captains.

HUNTSMAN:

In other words, it was recall information of theirs. I'm just curious about sampling procedure.

CATO:

Also, we talked to the owners of the boats, the captains of the boats, and some fishermen to find out estimates of catch. Fishermen go out each day and know about how many pounds of fish they're catching. From records, we know how many fishermen went out, and we could get catch-per-fisherman that way.

HUNTSMAN:

I found it extremely interesting. It sounds like an extraordinarily productive fishery, in the sense that vessels on the west coast of Florida are catching twice that of vessels on the southeast Atlantic coast, where I estimate they're harvesting about 66,000 pounds per vessel per year, running probably at the same percentage capacity of anglers, compared to 134,000 pounds per vessel. I find this interesting because a lot of our head boat captains have participated in either commercial fisheries or head boat fisheries on the west coast of Florida. They prefer fishing on the southeast Atlantic coast because it hasn't been exploited as intensively and it's a better fishery. It's interesting that some statistics, at least, seem to refute this by an order of two, and that's why I'm curious. You begin to wonder if you shouldn't begin looking more carefully at the recall information -- these fellows tend to be very generous.

We often deal with the problems of sport and commercial conflict, but I saw, as a synthesis of something from Charlie Futch's comments and Ed Klima's comments, a situation in this fishery where there appears to be no conflict -- in fact, agreement, in the sense that restricting the intensity of harvest of groupers and snappers is going to further both kinds of fisheries, at least in North Carolina, South Carolina, and Georgia. The driving force in the head boat fishery is the potential for anglers to catch big fish. They can fill the boats with spots and croakers without getting out of sight of land; but, if there's such a thing as a trophy group fisherman, it's the fellow who rides our offshore head boats 30-40 miles offshore and forks over $30 a head, which is a fair sum these days. He wants to catch big ones; and so, if you take the big ones away, you'll take away the attractiveness of this head boat fishery in our part of the world. Simultaneously, it behooves the commercial fishery to enter in a harvest of bigger fishes because overall yield will be increased. So, it's very encouraging to see a point in which both interests can be furthered by a less intensive harvesting system.

A. JONES:

Thank you for those comments. We have a number of people in the audience who are experienced, first hand, with production of party boats in the Gulf area. Do we have anybody who wants to comment on these figures of roughly 130,000 pounds for party boats?

SEBASTIAN:

I do not run a party boat, per se. I run a charter boat, and there is a difference. We're booked in advance, primarily by a telephone, and we work 6 to12, up to 15 people; and, we do not run what is called a head boat operation. So there's a considerable difference in the type of operation. And, I am very suspicious of some of the production figures off some of these head boats. I don't believe they've got that kind of fish along the Florida coast. If there are that kind of snapper here, why can I count 18 commercial snapper boats based in Florida working right under my front door off the Louisiana coast? I'm casting doubt; I'm suspicious of some of these production figures because if the fish were here, the commercial people would be here on it, too. This is my point.

One more thing while I'm on the floor, please. Dr. Klima, if all this potential snapper is there and needs to be worked, would you comment on the restrictions and the reasons why they are not being worked, whether it's fuel-wise, distance-wise, or fear of Caesar's ghost, or whatever?

KLIMA:

I think there are several things. One of the prime reasons, of course, is the problem of ciguatera in the Windward Islands and some of the other areas. Another problem is the investment in some of these areas. It's very difficult because when you invest, you've got to have a very short turn-around. The restrictions will be put on you by the local government and will phase you out very quickly. The FAO/Barbados project has come into confrontation with this type of thing and not solved it. Now at the Western Central Atlantic Fisheries Commission meeting, which is going to be in Trinidad next week, this is one of the topics that will have to be discussed in detail. If the Caribbean area is going to be developed and snappers and groupers are one of the larger resources, how effective can an international organization or government or consortium be to develop the resources? There are some very difficult questions. I don't think anyone has all of the answers.

A. JONES:

Do we have any other comments on production by party boats from the west coast of Florida?

JOHNSTON:

The data I have is off the Texas coast, based at the Port Aransas area followed by Steve Frishman, and I would like to throw these figures out. In 1974, based on two party boats, 117,500 pounds of red snapper were landed for 12,000 man-days fished. In 1975, 109,000 pounds of red snapper were landed, based on one party boat and numerous charter and private boats for 8,550 man-days of fishing. This is principally on several banks, notably Baker, South Baker, Aransas, Hospital, and Southern, off Port Aransas. It conflicts with the other data that's presented.

CATO:

It comes pretty close in terms of the 134,000 pounds I was talking about. But, that's for all fish, of which we estimated 37% was red snapper (which is 50,000 pounds of red snapper), which is pretty close to your red snapper figures, if I interpret what you said correctly.

JOHNSTON:

Right. The other fish, the other species -- 3% of the catch or 4% of the catch -- were very low.

JUHL:

Just to comment on Don Allen's paper. The statistics don't include production from Puerto Rico and the Virgin Islands because they're not recorded in the national statistics. The production between the two areas, Virgin Islands and Puerto Rico, is a total of 6 million pounds by commercial fishing; and of that, more than half is snapper and grouper. It's estimated that the recreational fishery is about the same size. In the recreational fishery, the percentage of snapper-grouper is even higher -- maybe about 75% snapper and grouper, so that means that maybe you can add another 7-8 million pounds to your total landings.

ST. AMANT:

Are there any data to indicate what portion of the catch from the recreational segment is going into the market that may be inadvertently classed as commercial catch in your figures?

HORN:

Ninety percent.

A. JONES:

OK. Mr. Ralph Horn offers a figure of 90% of the recreational catch, so-called recreational catch, entering commercial channels, if I interpret your remark correctly.

HORN:

Right.

ST. AMANT:

Are we counting these poundages twice as a landing, as a commercial landing and also as a recreational statistic?

RICHBOURG:

The only statistics that are collected in Florida, as far as fish production, are by National Marine Fisheries Service, and they come from only the wholesale dealers. Now, if there are figures on recreational production, they come from estimated catches of boat captains; and there's no way that those figures can be accurate. Whenever an individual sells us some party fish, we put it down as "party fish," where it can be picked up that way by the National Marine Fisheries Service. Or, if there is a boat that is a recreational boat, we put it down "party boat," where it can be picked up that way. But there's probably one out of a hundred that does that. Now, as far as what Mr. Horn said about 90%, he might have meant that 90% of the recreational fish is sold commercial. He didn't mean that 90% of the fish showed up in the commercial part of the production.

HORN:

Right.

CATO:

Mr. Richbourg and Mr. Horn, too. In terms of what you're calling the recreational catch, were you talking about the catch by an individual who goes fishing and sells his fish or that by the party boat owner who will line up a crew and go commercial fishing and sell his catch? There are two different measures.

RICHBOURG:

If he makes a trip as a commercial boat, then he is listed as a commercial fisherman; but, if each individual sells his fish, these are "party fish." At one time, many people met these boats and bought the fish directly from the people. This has sort of played out over the years because fish have gotten so scarce that you can hardly get the people to go on the boats and catch them. They used to make money catching fish like this, but they can't do it any more, so they don't have quite as many people fishing as they used to on the head boats.

BULLIS:

As a point of clarification, these are merely top-of-the-head figures. Four years ago, we started noting that a great number of small, individual boat owner/operators were bringing their catches in and making direct deals with seafood restaurants and retail outlets. As of four years ago, we had a couple of our staff look at the State of Florida in an attempt to see how many operations may be going on where you had individual operators going out and catching fish, either as pure commercial fishermen or party boat operators selling their catches to retail outlets, which would include restaurants and retail stores. At that time we found, and this is where the figure is very difficult to verify, about 300 such operations going on in Florida alone. That means that there are 300 vessels that are landing unknown thousands of pounds that never enter into the statistics, and I think this is a point that both Mr. Richbourg and Mr. Horn are making.

HUNTSMAN:

I think Don Allen made reference to a very critical point concerning the need for catch statistics. We could use the present statistical system, at least a little better, if we could insure that a location of catch was included in the information, as opposed to the location of landing. I'm sure that on the southeast Atlantic coast, north of Florida, the production is vastly underestimated because the vessels prefer to land or ship to the west coast of Florida, where, as it was pointed out, the prices are traditionally higher. We have numerous vessels come up from Bradenton, Florida and that area. They'll come ashore; a truck will meet them; and fish are shipped immediately south, without ever entering the landings records of the southeast Atlantic coast. We have really a very sketchy idea of what commercial production is from that segment of the commercial snapper fishery.

Finally, maybe a little synthesis to the whole collection of comments here this morning. Since about 1910 or somewhere in that vicinity, the United States has been engaged in a furor of activity concerning Pacific halibut stocks--of international agreements and that sort of thing. Over the last few years, grouper and snapper landings (recreational and commercial combined) exceeded halibut landings (recreational and commercial combined) by a factor of perhaps two. So, we have a very important fishery that receives almost no notice, and one that's also important but received far greater attention than its true worth required.

A. JONES:

Yes, I think that's a very good point, Gene, if you look at the biological studies on snappers and groupers which have been supported. Charlie Futch summarized these, and I think it was very clear that these were quite limited in number. And then on the other hand, you compare this with the very extensive studies of Pacific halibut which have been funded at, I guess, between a half a million and a million dollars a year since the early 1920's, you see the greatly disproportionate level of effort involved in work on these two resources.

BRIGHT:

Talking about statistics, I'm curious to know how, possibly, certain statistics might stack up or compare with some direct observations we have made on the Texas fishing banks using a research submarine. We've actually been able to count some of these fish and get some impression or idea of at least relative abundance. One of the feelings we have is that the large grouper, Mycteroperca, population on the southern banks off south Texas is smaller than the population for the same grouper species on the north Texas coast. The other impression we have concerning the snapper, Lutjanus campechanus, is that population sizes are about the same for the two groups. Now, I'm wondering if this is in any way reflected in statistics, in your fisheries statistics -- catch statistics, commercial and sports landings?

A. JONES:

I think this is a very interesting question. I don't know whether any of our panel members have an immediate answer to this.

BRIGHT:

We may be wrong. I'm just looking for some kind of indication that we may be right or wrong.

A. JONES:

This is certainly a useful supplementary source of information; and where many of these commercial statistics are not recorded by areas, this may be the only kind of information we have on relative densities between different areas.

BRIGHT:

We've been able to get a pretty good gut impression of relative abundances and also the distribution of these fish on the individual banks.

KLIMA:

I'd like to reiterate the point I tried to make before -- that the information that was available to me concerning the Gulf of Mexico and northwestern Gulf was not adequate to do any analysis on the status of the resources. I think this is a very important point because the fisheries of this area are very, very valuable; yet, there is not enough information concerning the statistics or the research for this area to make a thorough and adequate analysis of what the population trends are and what the potential yields are. The State of Florida is doing quite a bit of work off the Florida west coast, but that's not the total area.

BRIGHT:

This is all covered in one of these Contributed Papers on the fishing banks. Another thing we saw was the apparent really low population of the Epinephelus groupers and hinds on the southern banks off Texas; and I was wondering if maybe the high, relatively high, fishing pressure on the southern banks, because of the proximity to Aransas, might have something to do with this. The northern fishing banks off Texas are not very accessible to head boats.

A. JONES:

Dick Roe authored one of the Contributed Papers which might relate to this. He looked at the distribution of the various species from the exploratory fishing data.

ROE:

In that paper, I listed what data we had over the 25 years that Harvey Bullis was talking about, and I'd have to refer to it because I can't recall the figures. But, you might want to look in there. It will be in the Colloquium publication. I listed by depth and by the cited information we had. One of the problems that I've had in this, and I reiterate what Ed Klima said, was that in spite of many, many years of exploration -- and they were truly that, they really weren't stock assessment; and so, we still don't have an awful lot of data.

PANEL 2

PROBLEM IDENTIFICATION BY COMMERCIAL AND RECREATIONAL FISHERY REPRESENTATIVES

Moderator
Harvey R. Bullis, Jr.
Center Director
Southeast Fisheries Center
National Marine Fisheries Service, NOAA
Miami, Florida

We have assembled a distinguised group for Panel 2. We suggested that each panel member give a brief statement of his business and/or occupation, area of interest regarding snapper-grouper resources, and point out the main problems presently facing him as a participant in the user community. Each panel member may discuss availability of the resource, abundance or lack of abundance, fish size, distance to fishing grounds, competition between the different units, how sport fishermen see commercial fishermen and vice versa, and any other relevant matters. Even though we had a formal paper on economics, inject any economic questions that are appropriate to problems of the commercial fishery and other user groups. I would like to ask each panelist to summarize, in approximately 5 - 10 minutes, the salient points he thinks should be raised before the Commission and that need to be taken into consideration regarding where we go with snapper-grouper research and management.

PANEL 2

STATEMENTS

Statement 1

Clyde Richbourg
American Seafood Co.
Pensacola, Florida

I wish to take this opportunity to welcome all of you to Pensacola. It's my home town; and, of course,I have practically grown up in the snapper fishing industry and been in the business for a little over 40 years. It's been really interesting today -- some of the papers that have been presented here. I know some of these people worked real hard. I think they've done an excellent job with the data that were available to them. During my years in the fishing industry, the problems of the snapper industry have received the least research and study. There are less statistics for this industry than for any other. For the past 12 or 15 years, I've been trying to promote a system whereby we could gather the needed statistics for all types of fishing, but we don't have this system available to us. At the present time, the only statistics that are being collected are those that the National Marine Fisheries Service personnel pick up from licensed wholesale fish dealers' records. This probably is about 50% of the fish that are caught and produced throughout Florida, and this again is just an estimation. There's no way of getting a record of it.

So, where do we go from here with snapper? What do we need? I think some of our problems are because we have had a depletion of the snapper resource that is almost unbelievable. We've had a lot of causes. We've had estuarine pollution. Well, how does this affect the snapper-grouper industry in the Gulf of Mexico? It destroys the food chain. When you destroy the food chain, the fish don't have anything to feed on; the fish have to move to other areas or something else. Maybe they eat each other. Then, we've had one industry versus another industry -- in the shrimp industry, which is the most important or the most valuable fishing industry that we have, according to the financial part of it, where we have lost a tremendous amount of snapper that have been caught in the areas where the shrimp boats work. These are primarily small snapper that are in their infancy. Then we've had another problem which resulted from head boat operations. Most of the head boat operators used to be commercial fishermen. They're real good boat captains; they're real good people. They had just gotten to a point where they could no longer make enough money to keep going commercially; so they started operating head boats, where they got paid for taking people out. This they have done to a real good success as far as financial arrangements. But, it has resulted in a lot of fish being destroyed because of the fact that whenever these boats operate and they get a bite of fish in a place, they stay there. They can't afford to move from one place to the other as much as commercial boats do. They stay there, and they've got 40 or 50 lines overboard pulling fish, and they catch everything. They catch the snapper, the porgy, the grouper, the grunts, the rubylips, the squirrelfish, the triggerfish. There's nothing left at sea. And year in and year out at this, fishing in the same areas, depletes the area of fish. These, I think, are our major problems as far as the depletion of the resources.

The thing that I think we need to do, in trying to do something for the snapper-grouper fishing industry, is to do something to rehabilitate the depleted resources. We need better statistics than we have. I think there are ways that this can be done, if the money is made available. I don't know if it can be made available through government systems or not. I know one thing -- if they would spend just half of the money in programs in our oceans and seas and problems down here, of what they spent in the space program, then just think what they could do. They could really have a fishery rehabilitation operation going on. I think they can develop fish hatcheries to where they could get a better study of the snapper and grouper, even if it has to be done in pressurized tanks, if it has to be done at sea. Some of the oil structures that they are moving every once in a while might be made available to hold pressurized systems to keep these fish in and study and see what they do. We certainly need to do something, because the snapper-grouper industry certainly isn't what it has been painted to be here today through some of the research papers. We don't have that type of fish available any more. We used to have over 100 boats operating out of Pensacola. I don't believe that today there are 20, and this has come about because the people just could not produce enough to keep operating. We had two of the largest fish companies in the South -- Warren Fish Company and E. E. Saunders and Company, that have been in the business since the 1880's and that had to go out of business because they couldn't produce enough. One of the gentlemen here on this panel today, Mr. Ralph Horn, when he first got in the snapper fishing industry, was the largest single producer on the Gulf coast. I don't know if his production is still holding up that way, but I know he doesn't produce like he used to. There's not any production like it used to be. The price of snapper has gone from 8¢ to the boat to 95¢ to the boat. The price of snapper has gone anywhere, on the wholesale level, from 11¢ to as much as $1.40. It was stated in some of the statistics here that there's as much as a 72¢ gross profit income. I don't know how they've arrived at that, because I've been handling them now for 40 years and haven't been able to make that much gross on any of them. But I think when you listen to the rest of these fellows here, they probably have a whole lot to offer in the way of what can be done and what might be done; and I think that with needed statistics, we would have some means of rehabilitating the depleted resource.

Statement 2

Jean Beem
Snapper boat owner
Tarpon Springs, Florida

I've been in this business about 8 or 10 years, off and on; however, I have had a commercial hook-and-line snapper boat in the last 2 years only. I built it new -- got into it as a retirement program. We do have problems. One of the main problems we see is, of course, low landing tonnage. We need research on the promotion of fish to bite. We don't know why fish bite or why they don't bite. We need more artificial reefs. The government offered some boats a while back, and the states and cities and municipalities sat on their duffs and let a lot of them go by the board -- Florida got very few of them. We need data on fish baits, and migration of fish, fish habits, and locations of where to fish. This statistical information is available in a lot of commercial fishermen's heads, and this could add to the input of data presented here today. We have very definite patterns among the commercial people in areas they fish on cycling of snapper. It looks like maybe a 5-to 7-year cycle.

Competition from other sources -- Cuban vessels are very competitive in our area. Frequently they're within the 10-to 15-mile limit -- mostly long-line with dory-type boats. They're aggressive many, many times, and they're just a pain in the neck to try to operate around or even go through. They'll haze you; they'll run you out of the Gulf. At times you can't get through them. And, they also do it in areas that they don't have their lines down. Their longlines run about a mile; they run four or five of them to the boat, and they don't want you even in the area. You try that down around Cuba 15 miles out, and you get a real chili-bean education in a hurry. Imports selling at lower prices, or processed, is a concern. We have boats landing snapper fillets in Pinellas County -- it's the same company I sell my fish to. They sell snapper and grouper fillets processed in Mexico. We have some input on the Mexican fisheries here; it's a shame to see how they handle their boats. Well, you ought to see how they handle their fish. There is a question whether the processed products on the market are actually red snapper. I know personally that in Tampa, two or three restaurants are selling scamp as snapper; and if they can't do that, it's red grouper or black grouper. I don't know what the extent of this is. Grouper species are frequently, I think, used in this area as snapper. In the central Gulf coast of Florida, the recreational fishery is a minor problem in competition with commercial fishermen. I don't think it's a problem as much as it is up here (Pensacola) because of the distance that we have to go to fish for snapper on the west coast compared to the distances up here, which are close in. We do have some fast head boats that can get out to the edge of the Middle Grounds one day and get back, but, by and large, I don't think the competition, landing-wise, is a great threat in our area. However, Mr. Burcham and I certainly agree that much could be done to limit the size of grouper, particularly small red grouper -- they're frequently very, very much abused. You've got a tremendous potential there, and if you keep a ½-pound or 1-pound or 2-pound grouper, I think it's a shame.

Economic costs of production versus returns is way out, as all of you know. Labor, ice, groceries, fuel, and bait -- you've got about $600-$800 on a 20-day trip set up, before you ever take off. Eighteen months ago this was about $300. Fuel, as you know, 2 years ago was 14¢; it's 38¢ now. Grouper were selling for 40¢ then; it's selling for 42¢ now. Red snapper was 85¢ then; it's gone up to 90¢ now. Ice was $2.25 - $2.50 a block; it's gone up to $3.00. Cost of money was 7-8%, compared to 10% now. Insurance is almost prohibitive, except on a new hull; an old boat can hardly get insured. Many of the boats down there fishing -- you can see why they're not insured. The 200-mile zone, I think, will seriously hamper the fishing industry of the west coast of Florida. We sit here and we talk about FAO putting money into the island of Barbados and what-have-you down that way, and yet we can't go down there and enjoy it. I think we need to take a look at our national policies on what's happening. If we go to the 200-mile limit here, it would seriously hamper the shrimp people, and certainly the snapper-grouper fishing boats out of the west coast of Florida. Six or eight boats fish with my boat over there consistently in the offshore area, within 75-100 miles of shore, inside the 100-fathom line. I think a bilateral agreement should be looked into, but for the Gulf area as a separate agreement to keep the thing out of the lobster business. I'm sure they've got their own problems; let them settle them. But we need to talk to Mexico and the islands and have some kind of agreement, including Cuba, if they will, to set our own agreements. We have some Mexican vessels over here occasionally --very few; but we get along fine with those people over there, and we do have some processors. We can land over there at a lesser rate, and I think to put a 200-mile limit would be prohibitive.

Trends over the next 5 years -- I think we're going to see less and less commercial fishing, the way things are going now. Cost up, production down, catches low -- there's no way but out of it, and in our area, following the same trends that happened up on this end of the state. Continued foreign competition worsens our situation, due to our national policy. We spend money and then we can't go down there and enjoy the results of it. Possibly, larger, multi-vessel organizations servicing the fresh fish industry and the larger processing boats (80-to 85-foot) may have some additional future, compared to what's going on now with the small ones.

Positive action to be considered -- I think the FCC, the Federal Communications people, ought to get on with us commercial boats, and go out there, and try to use that damned little radio they're making us use over 25 miles. I hope that someday I pick one of them up in a life raft that's tried to use these damned radios. The FM radio is fine. The AM, we can hardly get on the frequency with it because the Mexicans and the Puerto Ricans and the other islanders have all been getting them. They're going out of this country as fast as they can take them away from us and selling them to them. They've got something that will work; we got something that don't work. They make you go to a side band radio -- you're talking about $300 versus $800-$850 or $900 for the cheapest side band you can get. And then,they're messing around with loran. They have loran that'll work on A, and now they're going to go to C and it's not convertible. Reduced imports would be possibly helpful. Subsidize fishermen; let's treat them like you do the farmers, in some kind of incentive program. Tax structure write-off, eliminate state sales tax. We're a wholesale operation; yet we're paying state sales tax on ice, fuel, and bait. It's not right. Commercial fishing is a wholesale operation. I think it should be treated right within the state. This is not a national problem; this is a state problem. I think the Internal Revenue Service needs to be talked to. We're dealing with a low-educational group of people who can't figure out their structure. A simple system of taxation, Social Security, unemployment, and so forth, should be worked out to where these people have an understanding and can work. There's no way you can figure out, from one day to the next, who's going to be on your boat as a fisherman and yet try to take out Social Security and tax from that man's employment, of which he's starving to death already. I think the U. S. Government, in cooperation with the states, should go ahead and go back into the artificial reef production and put some of these out in 30 or 40 fathoms of water for the commercial fishermen and take advantage of that, for those people as well as the recreational people.

Statement 3

George Burcham
Johns Pass Chapter
Organized Fishermen of Florida
St. Petersburg, Florida

Jean Beem covered a whole lot of what I had to say, so I'll make this very brief. I've been a producer of Gulf fishes commercially for 11 years; and we find, as time goes on, we have to go farther and stay longer in order to produce a profitable trip out of it due to the economics, the extra expenses, fewer and smaller fish. We find that fishing in 20 - 30 fathoms, we're catching much, much smaller fish than in the past. To get large fish, we have to go out to around the 65- to 70-fathom line. We catch lots fewer head of fish out there, but the fish we do catch are much, much larger than we catch in the shallower water. Mr. Beem mentioned the small red grouper. Now, you people that have been in the business know -- if you pull him up out of 40-50 fathoms, there's no point in throwing him back because you've killed him when you pull him out of the water. But, in the 30- and 40-foot areas, those little 1/2-pound groupers can be thrown back and they'll live fine and grow up to something worthwhile.

On the 200-mile limit -- there's a lot of pros and cons on that. The bill that passed last Friday has so many bad loopholes in it, I would hate to see it go on through; because, when the people in Washington start controlling all the fishing, it can get in an awful mess. If you don't think so, look at your Postal Department. So, I think it would be much better left in the hands of the state and the district -- for instance, the Gulf States Marine Fisheries Commission. Now, I am a member of the Organized Fishermen of Florida. A lot of people get the idea that we're an organization of unionized fishermen. We aren't that at all. We are a lobbying group. We pool together our money, our small dues which we pay, and hire a lobbyist to go to Tallahassee during these sessions to try to get favorable laws passed, try to kill some that are unfavorable to our organization. We also have a man in Washington, Bill Mustard. He is from the National Fisheries Association, of which we are a member. We have him there to try to get favorable laws passed. And that's basically what the Organized Fishermen of Florida is. I come in contact with a lot of people that think we're like a union in that we're going to be dickering for prices -- better prices and all that. We aren't that at all. We are not a price-fixing outfit. We don't try to do that. We're strictly a lobbying group, trying to better things for all fishermen. In our particular area, we have no fights with sport fishermen and party boat fishermen, because the only thing I see them do that I wish they wouldn't do is take those little bitty grouper, take them out of that shallow water, and many of them are not aged. They're brought in, hung up on a stringer, and they eventually wind up in the trash can and go to the garbage dump.

Statement 4

B. J. Putnam
Panama City Charterboat Association
Panama City, Florida

I'm a little bit different in the opinion here. I get my money before I leave the dock, so I'm a lot luckier than the commercial industry. But, I have good news and bad news for you, from Panama City. We've probably got more fish in Panama City, right now, than we've had in 20 years. Boats making 2-day commercial trips are bringing back catches of 7-8,000 pounds. Commercial boats making 4- and 5-day trips (short-legger trips, they call them) are catching 15-18-20,000 pounds. If you want fish like this, all you got to do is have a hurricane. Cost you about $150 million for you property owners. But, we've got plenty of fish. I don't know how long they'll last, and we'll play hell catching them next year, too; but they're going good right now.

The problems with the recreational fishing versus commercial, where we can help out more than anything else, is by building reefs -- artificial reefs and wrecks and so forth. Mentioned were the Liberty ships that were made available to the state through the Federal Government. We went into this extensively in our program, the Panama City Charterboat Association. The attorney's fees on this alone, gentlemen, were $2,500. That was the cheapest attorney we found. Now, legal eagles in our way must come pretty high. We couldn't even trade fishing trips for them. But then we had to tow the vessel into our area. It had to be brought into our area on our own. We had made a tentative agreement with Cole Contractors, who do the stripping of the Liberty ships in our area, but they would take the super-structure off the vessel and trade for the work that they were doing. As you all know, in fishing this is important. The super-structure is what brings your amberjack and other fish around that help your reefs and keep them alive. In sport fishing, these amberjack are important to us. We probably made more money off amberjack than we have snapper and grouper over the past 2 years because it does fill the box. It keeps the line tight, and it keeps your people smiling. It brings them back. So it's important to us from that phase of it. In order to get a Liberty ship there, we have to make application through the Corps of Engineers. The waiting list on the Corps of Engineers to get your approval now is approximately a year to 18 months. Damned Liberty ship might rot in that length of time -- the condition they were in. So we have a problem there. So what we need is some way to expedite these matters of building reefs. It's a big effort. A small reef in 90 foot of water will produce a fish within 3 months in our area because of the fact that the sunlight gets to it and grows crustaceans; and over 20 fathoms, we'll say, it takes a much longer time -- maybe as much as a year or 18 months to produce satisfactorily. And, these reefs should be put on bottoms that are not productive; that way it takes the pressure off the places that are productive and gives you a more wide area to fish. That's the problem we're faced with -- commercial and charter fishing and party boat fishermen are fishing the same areas day in and day out; and maybe, Charles Sebastian would fish a place and I would fish a place day in and day out. You can't do it. What he doesn't get, I will; and what I don't get, the commercial boats get. So, we're having a problem with that. The best possible answer to it, for the recreational fishing as I see it, is the building of artificial reefs. In order to do that, we've got to have some alleviations from the Corps of Engineers and get the permit where we can get these down there where we do have them available. Possibly another way we could pay for this is (and I'll probably raise some eyebrows whenever I say this) licensing in salt-water fishing. We've had a couple of bills in Florida and we've successfully killed them because of the way they were written, something like H.R. Bill 200. They've got too many bad points to cover the good points. But we're letting private boats come into Florida from Alabama, Georgia, Tennessee, Indiana, Louisiana, wherever, that are fishing for free -- relatively free. We're paying taxes on our boats, commercial licenses on our boats. We have small boats come, and this fee can be taken and 50% of it go back into enforcement and 50% of it go back to building artificial reefs. And I see that that's one of the points we need to do -- is use this facility. And, to kind of answer Charles Sebastian a little, he expressed the opinion about the 15 or 18 Florida boats that were over in Louisiana catching his snapper and grouper. They were just trying to get back all those shrimp those Louisiana boats came to Florida and got. That's what they were trying to do. But, I think that the 200-mile limit, in our recreational end of it, really won't do it -- doesn't affect my part of it or the recreational field of it. Unless it is because of the fact that these fish in hurricanes do come out of deeper waters -- come to our reefs. But the cost of production in our line is just passed along, from us along to the consumer. So the cost of production is not really an important factor in the recreational end of it.

Statement 5

Charles A. Sebastian
Charter boat owner
Grand Isle, Louisiana

We had old Jean Beem really wound up over there. Now, I'm going to try to be relaxed and take it easy. But to respond to Mr. Richbourg on his head boat criticism (I'm not a head boat operator) where he stated that a head boat gets on a spot and fishes 40 people and stays there and catches everything that's there, well, this is true. It's also true of the commercial snapper boat. Now where a head boat is fishing 40 people and we favor two-hook rigs, perhaps some occasionally three, you pull up alongside a commercial boat and he may have 10 people on there working cranked rigs with 25 hooks. Now 10 x 25 is 250 pieces of bait he's got in the water, where a head boat that had 40 people would have 80 pieces of bait in the water -- do you follow? So, the snapper boat with his tremendous amount of bait can pull up to our artificial reefs, and we've got 5,000 of them in the Gulf of Mexico called drilling platforms or production reefs. A commercial boat can pull up to one of these reefs, these oil platforms; he doesn't even bother to tie. He doesn't put a line on the platform, which we do. We tie to the platform. He'll hold her steady there with his steadying sail and his engine, and they drop 250 pieces of bait under that platform. It doesn't take him very doggone long to get every fish that's under there out, and he's gone to the next one, and he hits rig after rig after rig after rig. And we're feeling the pressure, gentlemen; we are really feeling the pressure.

Now we have a number of things that are hurting us. One of our problems is shrimp trawlers. They're catching great numbers of small snapper (and some big ones, too) in shrimping. The shrimp trawling industry is very important in Louisiana; and, to answer B. J. Putnam, if he could have been in Barataria Pass on opening day of the past shrimp season -- I counted 59 trawlers in the Pass about half a mile wide and maybe 2 miles long and they were from Alabama, Georgia, Florida, Texas, you name it -- we had boats there, so this is a two-way street. We catch some of your shrimp and you catch some of ours. This is the same way with the fish, except I don't fish Florida. I fish strictly Louisiana waters; and I have fished the same port, the same business, for 31 years. I'm probably the oldest living charter boat captain, that is experience-wise. But I've done nothing else for 31 years but fish charter boats.

Now, I would like to make the point that getting back to this thing of leaving some fish, and I have a very definite policy. My fish box holds around 1,100 pounds. If I have 10 people on there, when the box is full, my people are told we're going home, because I do not believe in wasting fish. I have a wreck that I fish on that used to be my sugar hole. I fished it for 11 years for red snapper. It was a sunken barge that no one knew about but one other charter captain, and I made 17 trips trying to sneak up on him in every way in the world to find this spot, because he had it and he was catching fish and I couldn't find it. I didn't have loran; I couldn't get a distance. I could get a bearing, but I fished 17 days (not consecutively) to find this place before I <u>did</u> find it. I found it by getting the bearing from the nearest platform, which was 9 miles away, and another platform, about 12 miles away; and I got some sort of an intersect on this position. So I conned my people, "We're going to troll and see if we can't get some king mackerel." And I was fishing wire line to get deep with spoons for bait, heavy sinkers. And every time I'd catch a fish, I'd say, "Be red, you SOB, be red!" Whatever it was, it wasn't red. And finally, I got a red one -- a sow about 15-20 pounds; so I threw the buoy and started my search with the fathometer, and I found it. Now, I fished this one spot for 11 years, and it was very productive for me, and I made a lot of money off it because people will travel farther, pay more money, put up with more discomfort to catch red snapper than any fish that we fish for. It's <u>the</u> fish. We're having to reeducate the people to accept other kinds because we don't have that kind of snapper any more. But I could go to this spot, catch my 1,100 pounds of fish, quit fishing about 11 a.m., 40 miles off shore, be back home by 1-1:30 p.m., and everybody was tickled pink because it had been explained to them beforehand that when the box was full, we were going to leave. And they'd say, "Oh Captain, look! We're catching fish like crazy." And I'd say, "Yes, but I've got to do this again another time this week or day after tomorrow." And I would never hit the spot more than once a week; I'd let it rest. Now this competitor of mine got caught on this spot--he was neatly trapped by two of the TIKI boats. They had one coming from the west and one coming from inshore, and they were smart enough to get the platform between one vessel and this other charter captain, where he couldn't see the vessel until it was nearly on him. So they were coming from two directions; and by the time he saw them and got his anchor up, it was too late. Two things did him in: one was he had allowed his people to throw beer cans and soft drink cans in the Gulf; the other one -- he had an automatic bilge pump which came on about this time and kicked a slick. So that's all a smart captain's got to have --is a general idea of the area. And they started their search pattern, and it wasn't 15 minutes until they had it. They stayed on it for 2 days and 2 nights. I went on it about 3 days later, and I didn't catch the first fish. <u>Not fish one</u> -- I mean not the first snapper. I could fish up shallow and catch triggerfish and spades; fish on the bottom off to one side and could catch some croakers; I could drift fish and catch a king or two, but not one snapper. I used to fish this thing at least once a week for 11 years. I don't even bother to go there any more. There's no use because these TIKI people have it in the log, and every time they pass down the coast, they hit it. So that means every week or so, somebody's on it. So I don't even fish it any more. But I sure had some good fishing for a long time.

Now, one of our other problems is the small boats. There is a proliferation of small boats. It seems to me that the Gulf of Mexico is full of fools and small boats that are trying to drown themselves. I literally mean this. Some of these gentlemen here have said we could place artificial reefs 40 miles offshore. Well, if you place an artificial reef 40 miles offshore, you're going to buoy it. You're going to have to buoy it. If you buoy it, then no matter how early you get up in the morning, by the time you get there, there's going to be 10 or 15 little boats anchored on it. Because there's that many of them. They're just everywhere you look. Forty miles offshore doesn't mean a thing to a man in a small boat. He has gone to a boat supplier or boat dealer for a boat to fish in the Gulf of Mexico. The man will show him an 18-to 20-foot boat with an outboard motor on the back and say, "Cap, you can go any place in that boat." And they do. <u>Any</u> place in that boat. Now, you see these men, these people, 40 miles offshore, 50 miles offshore, 60 miles offshore in these small boats -- no radio, no life preservers, no compass, no brains. But this is one of our problems -- the proliferation of small boats. We have one spot where we fish in the winter months; we have a good run of kings there sometimes. One Sunday I counted 46 small boats tied onto a platform complex. There were five rigs there tied together with a bridge. Forty some-odd boats tied there. Man, it's like Canal Street -- you know, like Broadway. And where I used to go when I first started fishing -- I might go all day and not see a boat. Now every place you look-- zip, zip, zip, zip -- there's a small boat. You take off from the dock, one or two will pick you up; and they'll stay right with you till he figures out what platform you think fish are on. And just before you get there, he pours the coal to it -- zap -- right around you, and he ties up. So we've learned to zig a little. You head for this one where you don't intend to fish; and when he passes you up and throws his line, you go where you intended to go.

We know that a lot of these small boats are selling their fish, and they're getting $1.15 a pound from restaurants, fancy seafood restaurants. But, the number isn't all that great. It used to be when they had plenty of fish, that they'd keep enough fish for their families and sell 50-60-100 pounds of snapper. But you don't see that any more, because they're not catching that kind of snapper. Now, if it wasn't for the croakers, we'd be in a bad way. We're re-educating our people to accept croaker in lieu of red snapper, simply because we can't find enough snapper to produce what is necessary. And a man has to have a tight line -- he has to catch fish.

Statement 6

Ralph Horn
Clark Seafood Co., Inc.
Pascagoula, Mississippi

We have 18 boats right at the present time. We fish all of the Gulf of Mexico. It seems like we infringe on everybody's benefits but our own. We are located in Mississippi, but we don't catch any fish in Mississippi -- only beach fish. We fish Texas, Louisiana, and a little of Florida. We fish the Caribbean. One of the reasons we don't fish much any more in the Caribbean is the size of fish. We had a boat in this week that fished the Caribbean and got 38,000 pounds of fish. We stopped fishing there for about 7 or 8 months. We have about 10 boats that fish in the Caribbean. We have been caught, I think, six times by Colombia, Honduras, but we never had a whole lot of problem in getting out. We can't go that far. It takes us 110 hours to go and 110 hours to come back. And that's the reason we don't fish the Caribbean as much as we used to. We used to have about 10 or 15 boats that fished regularly in the Caribbean.

Another question was raised on this price deal. Seems like the reason we make so much money (I think we do) is that we pay a whole lot less, but that's a good question, too. Another thing, Clyde Richbourg's giving me a lot of problems in New York. They tell me he's got pearls and we've got fish that's dead. Now our fish are about 15 days old and his are 2 days old. And that's one of the reasons that we don't have the price that they have in Florida -- because there's a lot of difference between day-old fish and fish 15 days old. Of course, Charles Anderson has the same thing with the TIKI boats. Another thing with both of us -- Charles Sebastian hasn't counted our hooks lately; we use 40.

But, our number one problem today is manpower. It's not the amount of money they make. The other day a captain told me he was just going to make one more trip between now and Christmas. He shared $5,960 and he was out 21 days. He said he's worked 7 months this year, and I think right now he's made over $30,000 and he's just not going back. But our number one problem, it seems, is altogether different from anybody else's -- it is captains. We're not having as much trouble with our crews as we are with captains.

Now, on the production of fish -- we had a lot better year this year than we have had in any other year. I think that on the Government statistics -- they are right as far as ours are concerned. They are actually right because we have a man that picks them up every day and also they list -- Caribbean, westward, and so forth. Now the westward would mean from Louisiana and Texas; it wouldn't give it by state -- that's another thing. Now, I think we're going to have a lot of fish, due to the decreased use of explosive charges by seismograph boats. I think that that was the biggest problem in the snapper business in the last 10 years, and I think it's been stopped about 3 years. Every fisherman has always told me we have a 7-year cycle on fish, so we should be getting into the cycle now. But our production this year has been a lot -- way up; I guess it's been up 30 or 40%. I was talking to Charles Anderson, TIKI boats, and his is the same thing. But we make half the trips today that we used to make. A guy used to average 20 to 30 trips; today, he just doesn't do it. He just doesn't stay that long. We're lucky if we get anywhere from 15 to 18 trips, and that's the reason that our production per boat is down.

Now on this tax deal, one of you brought up the question of sales tax; we don't pay any tax. We had a bill passed not too long ago in Mississippi that you have to buy an out-of-state license. That puts you in the tug boat class; and that exempts you from tax on ice, fuel, and groceries, which saves us about $50-$75 a trip. Now, our expense on our boats -- we're going to change. We've already sold one large boat, and we're going to sell three or four more that are anywhere from 75 to 90 foot; and we're going to get down into 55- to 65-foot boats, which I think are a lot more economical than the larger boats. The large boats cost too much to operate, and we can go the same distance in the small boats.

But our number one problem is insurance and work. We just don't have anybody to work. And I think that's one thing that's been left out so much today -- we just don't have the people to work any more like they used to. And I can understand it -- they don't have to. Our production is as good as it was. We used to have 10 boats that produced the same amount as today with from 18 to 20 boats. We used to have the same production, but they went twice as much. And our pay -- there's not any difference than what it was. For the times they're going, it's a whole lot higher. And I think our captains, they just have a certain amount they want to make and they don't particularly care about going.

I think it looks mighty good. Of course, Florida's taught us something this year. Of course, Gene Raffield's not happy with that. We had a pompano season this year and never had heard of that before, but we had a good season. Florida fishermen came over and fished for us. I think that our future is real bright, if we can get anybody to work.

PANEL 2

DISCUSSION

BRIGHT:

I'm pretty impressed by these gentlemen's presentations, and I'd like to make some comments before some of the questions are brought up. Concerning some of the questions brought up by Mr. Beem -- a lot of the things that he talked about are what I would consider questions that can be addressed by biologists, scientists, using the state-of-the-art methods that are with us now. If only we had enough money to support them and some of the things like promotion of biting, and bait, and responses of these fish to certain baits, and so on. There are means now where we can actually go down and look at these fish in their natural habitat. We can possibly try baiting and hooking techniques and so on. One thing that comes to mind that fits in with some of the other comments we've had this morning is that we could (even possibly through direct observation in the natural habitat) look at the difference in responses to baits and different size hooks and so on and different fishing techniques of the different sizes of fish within the same genus of the same species -- like the groupers we were talking about. There are ways now, I think, that we can observe more specifically the daily habits, the daily migrations of these fish. There are electronic tagging techniques that can be used and arrays that can be set out that can attract these fish over a period of 24 hours or longer. We can tag fish and actually watch the fish that are tagged over a period of time. And I'm speaking, of course, about the submarine business and going down there and watching the fish right where they live. We've done a lot of this. In the western Gulf, we've got about 100 hours on these banks in the submarine, and we've seen an awful lot of snappers and an awful lot of groupers, and one thing I'd like to ask you gentlemen that's of interest to me is about the size of snapper schools. All the snappers that we've seen from this submarine have been in schools of not more than 25 or 30 fish, or less. Now, my impression in the past is that there were immense schools of these snappers, where the fishermen would simply take fish; but we've never seen these immense schools,in the daytime anyway.

Abundance cycles and so on, or abundances -- this is a very hard thing to get at through the indirect statistics, landings, and so on. It's something that you're using statistics that are published statistics. They're filtered several times, and they're not direct abundance observations. Possibly, direct observations, as to abundance and so on, will give you some ground truth to see if these statistics really are valid -- see if they really do reflect the actual situation in the natural habitat and so on.

Where to fish, where to fish locally on the banks -- now, you fishermen probably know this already; but through direct observation, we can also shed some light on this. That paper that we have has something in it about that; but we have a whole lot more information, concerning distribution of fishes on these various banks in the western Gulf, that are direct observations-- and they're really concrete observations.

BEEM:

You've got loran readings on those available?

BRIGHT:

Yes, sir. In fact, for all the banks that we've investigated, we have charts in the back of that publication with latitude and longitude. You can get loran readings from them because the latitude and longitude is right down to a gnat's eyebrow. And anyone that wants this kind of information can get it either from the Texas A&M Research Foundation, from us directly, or you can get it from the Bureau of Land Management in New Orleans, Outer Continental Shelf Office. These charts of all these banks were on a 2-meter interval, so they might be of some use to the fishermen. Well, I don't want to take up too much time, but what I'm trying to say is that we do have some techniques now -- tagging techniques, electronic tagging techniques for direct observation. If the money were available, it could be applied towards answering some of these direct questions you guys have brought up. The Bureau of Land Management is financing an awful lot of baseline study and so on off the coast of the United States, and I think that it would be a real fine idea to try to integrate some of the fisheries research that really ought to be done with some of the studies that are going on right now that are funded at a fairly high level. And, I also think it would be a real good idea to involve directly with the fishermen. Fishermen, as was pointed out, have an awful lot of store of knowledge about the habits of these fish and so on, and I think this ought to be brought out and circulated among the biologists and also ought to be published, so it would be avaiable. A lot of this stuff -- a lot of the things the fishermen know, biologists are somewhat naive about; and I think that if there can be a better communication between the fishermen and the biologists who are trying to address some of these questions, it might work better all around.

HARDY:

I wondered what, if anything, could be done about trawlers. I wondered exactly how many pounds of small snapper that are in the breeding grounds are shoveled overboard every day by shrimp boats. You don't see any snapper boats shoveling shrimp overboard. Would that have any effect on the snapper industry? And which is worth more -- pound for pound, day for day, cost and everything, man for man -- shrimp or snapper? Who produces more fish?

HORN:

In Bayou La Batre, Alabama, they have about 75 shrimp boats. Now, a few years ago they averaged anywhere from 2 to 5,000 pounds of fish per trip. They don't throw any fish away like they used to; all the fish are sold. But the only problem with it is there's not too much price on it. We pay anywhere from about 25¢ to 30¢ a pound today. But, it's all small. Very few large fish are ever caught in a shrimp net. But this year I don't imagine 50 - 60,000 pounds of snapper were caught in Bayou La Batre. They fish mostly around the mouth of the Mississippi River. We've bought a world of those snapper, and we've hauled a world of them. But this year there just hasn't been any; I think they caught them up -- and it's mostly around the mouth of the Mississippi River.

CHAPMAN:

Mr. Beem, you spoke out against the 200-mile limit, and you made a comment about the difficulties you had with the Cuban fishermen, particularly the longline fishery. Won't a 200-mile limit reduce some competition in that regard?

BEEM:

Per se, yes; but right now, in effect, we've got a 200-mile limit with Cuba, and they fish at our back door, and you can't go down there. I don't think the 200-mile limit would help the Gulf Coast situation at all. I think we've got a family of our own, and we should establish our own agreements between countries -- bilaterally. If Mexico wants 50 miles, we can give them 50 or whatever. We've got a lot of money going to these Gulf Coast States, and I think that we could probably put a handle on it and come up with something that the whole industry could use. But to just arbitrarily grab 200 miles is wrong. Now to answer your question -- if you think the 200-mile limit would reduce competition in the Gulf -- "yes" and "no." It depends on which country you're talking about. Cuba is the worst offender, really. If we had an agreement with Cuba, we could eliminate that.

RICHBOURG:

I'd like to make a comment on the 200-mile limit. I see Bob Jones is asking for recommendations, and I know he wants to make a comment on it, too. The 200-mile limit probably is a good thing for the New England States and for the Pacific Coast; but it's going to be the worst thing that ever happened to the Gulf States. Two hundred miles can not do us any good whatsoever. We are going to have more trouble. We've already lost our lobster industry in Florida, mainly because of the way the 200-mile limit deal was worked. We have approximately 200 shrimp boats that are working in South American countries; and if there is not some deal worked out in those countries where they can continue working there, then we'll have an influx of approximately another 200 boats in the Gulf waters that we don't have now. This is going to create serious problems. Let Bob Jones take it from here.

R. JONES:

It's our opinion --the opinion of the Southeastern Fisheries Association -- and many others, that the 200-mile limit is not going to reduce significantly the foreign competition in the Gulf. And we sort of hope that it doesn't in a way, because, under all the legislation that's being proposed, they speak about traditional fishing, they speak about giving to the foreign nation that portion of the allowable catch which the American fisherman cannot catch. So, if you're not producing the maximum sustainable yield on snapper and grouper, then that portion that you're not catching is going to be available to any nation in the world. That's the way I understand it.

If you don't allow some foreign fishing somewhere off our coast, then no foreign government is going to allow foreign fishing off their coast-- as we can see what's happened to us in the Bahamas just recently. If you force all snapper boats, shrimp boats, or whatever back to the coastal waters of the United States to do their fishing, you're going to have more pressure on your snapper and your grouper and your shrimp and your lobster and everything else than you have now. So, in our opinion, it would behoove us to stick to bilateral and multilateral management schemes, because 200 miles doesn't mean that everything out to 200 miles belongs just to Americans. Gentlemen, that isn't the way it is.

PANEL 3

RESPONSE BY STATE AND FEDERAL AGENCY REPRESENTATIVES

Moderator
William H. Stevenson
Regional Director
Southeast Region
National Marine Fisheries Service, NOAA
St. Petersburg, Florida

Just in a way of trying to get some perspective into this particular panel, I appreciate the fact tnat I'm being put into the situation that, I think we've all agreed, is the only situation for a Fed in the Gulf of Mexico -- and this is as a moderator. I think that we can address these particular problems from the information that has been presented in the last two panels; and, as I see it, the general problems fall into the classical pattern that we have some serious problems from a biological standpoint, from the standpoint of the resource itself, and the information that we know about that resource. There have been some problems raised in the technical area -- both of an administrative type and also the specific technical type. Throughout the entire discussions that took place in Panel 1 and Panel 2, it was very obvious that there are some serious information gaps. These probably fall in two areas: one is the information that is available, and the second is the communication of this information. A third general area is the area of assistance to the users of the resources and also assistance to the scientific community that has to support those user groups. A fourth is support, both to the user groups and to the technical group that is involved; and support is generally translated, in the bureaucracy, into dollars and people. A final area is management; and we must raise the question, therefore, of regulation, since it was a question that was raised, either specifically or implied, in the two panels. It appears to me that the management of regulation is not only a national situation, but it becomes quite apparent from the discussions that went on that there are international management problems that are both implied and explicit in this particular situation. That is about the way it looks to me. There are the problems. As I understand it, Panel 3 is supposed to suggest ways of approaching these problems and discuss, in an exploratory form, possible solutions and how those solutions can be approached.

PANEL 3

STATEMENTS

Statement 1

J. Y. Christmas
Assistant Director for Fisheries Research and Management
Gulf Coast Research Laboratory
Ocean Springs, Mississippi

My comments can necessarily be brief because I think that Bill Stevenson just about covered the ground. Now, in trying to look at problems from the State of Mississippi's point of view, I'm very glad to hear my own opinions substantiated by Mr. Horn's report this morning. I didn't think we really had any resource problem, so far as landings in our state were concerned. Obviously though, there are serious problems, and there are some serious gaps. Some far-reaching decisions must be made. There is the age-old conflict between recreational and commercial fisheries, although it seems to be minimal in this particular fishery. I don't have answers.

I would pose a few decisions that I think management must make. First, what are we going to manage for? What is the basis of management? Are we going to consider that this is a food resource which must be managed to provide, in the long run, the most food for the people who need it at the most economical cost to the economy of the states and the country? Or, are we going to direct management in some other direction? Of course, as we have stressed so many times in these meetings and everywhere else, there is a great need for conclusive statistical information which we must have. There are still big gaps in our knowledge of the biology of these very important species. These gaps must be filled.

There is only one way they can be filled, and that is to provide the necessary funding. Adequate funding can and should be directed to the Gulf of Mexico. A more equitable regional distribution of Federal funding, with appropriate increases, could provide the necessary additional needs for research.

Statement 2

Robert E. Stevens
Chief of Coastal Fisheries
Texas Parks and Wildlife Department
Austin, Texas

I'd like to make a few comments -- perhaps on some subjects that have occurred to me that haven't already been covered. As pertains to management and regulation, I think that's down the road. Nobody knows whether that's going to happen or not; or, if it does, whether it would be sufficiently funded to indeed place limited entry regulations or other regulations to perhaps protect the stocks. And, I'd like to pass on from that, because it is kind of a nebulous situation at this point.

I've got different messages here. The scientists and at least some of the fishermen have indicated that some of the stocks are not overfished. Some of those stocks are in distant waters. I've heard, contrary-wise, that some are overfished. The ones that are overfished -- what can be done about them, in the absence of regulation? Well, the obvious mitigation, I think from what I've heard here, is artificial reefs. I think that providing an infinite number of additional reefs, beyond the 5,000 already out there, would indeed cause enough recruitment or stock there to replenish or establish stocks on a new habitat which is produced by artificial reefs. That's a good idea. I know in Texas, the Texas Marine Council realized over $400,000 of salvage fees. They're going to use that money to construct additional reefs, and I would advise anyone that's going after the old vessels to try to get a better price for the salvage than apparently's been done in Florida and other places. But, I think one other point that needs to be resolved is whether there is sufficient recruitment in terms of the reproductive ability of these fish. Is there enough reproduction to produce all the juvenile red snapper that we need? And the second point is -- is the shrimp industry actually overcropping this recruitment, if indeed reproduction is sufficient. I think this point needs to be resolved; and I think probably we have the state-of-the-art now to resolve it, if the study could be funded sufficiently. We need to lay this to rest. If there isn't enough recruitment, then we could possibly take some steps in this direction. If there is enough recruitment, let's go on to different problems. So, I think probably the two points which are significant to me are the suggestion that we provide more habitats in terms of artificial reefs and that we learn more about the recruitment. Of course, as everybody said, we need more and better statistical information.

Statement 3

Hugh A. Swingle
Chief Marine Biologist
Division of Marine Resources
Alabama Department of Conservation and Resources
Dauphin Island, Alabama

Of course, the biological information can be collected; it's a matter of money. It's a matter of directing the efforts towards a project which hadn't been done in the past. This can be done by just channeling the direction. But, what it really comes down to is what you do with that information. It comes down to what a state can do on a fishery that is almost entirely outside of its state's jurisdiction.

Now, what you can do, talking about artificial reefs -- we've already sunk three of our Liberty ships and will sink another one next week. We've sunk barges; we've sunk tugs. All of these are outside the state jurisdiction of Alabama. You have problems, when you sink something; you've got people complaining because they're out too far or they're not far enough out. This is what you have to do --is try to help everybody. This can be done if you have enough money to do it. We can get permits; we have about 8 or 10 permits right now. We can get barges. We can get old ships out of Bayou La Batre and Mobile. It's a matter of once you get something, how you get it out there. We have to rely on private companies to donate the tug to take barges out there.

We tried to get a marine sportfishing bill through our legislature this year, and I'm sure every one of you know exactly where that ended up. When a resource is outside your state's jurisdiction, there's not a whole lot you can do to really help it, unless you have the funds to do it. Certainly, more money needs to be directed into collecting biological information and statistics. As far as really helping the fishery, this is going to be based on the biological information, but you have to have some sort of way that you can take this information and put it to work. This would possibly come through state-Federal management.

Statement 4

Harmon W. Shields
Executive Director
Florida Department of Natural Resources
Tallahassee, Florida

In a snapper-grouper colloquium such as this, one major topic will always be the abundance and health of the reef habitats which support these species. These habitats do not have to be natural; indeed, one of the most successful fishery management techniques ever developed is the construction of artificial fishing reefs. To my knowledge, there has never been a properly planned reef construction project that was not totally successful. Even though they are often expensive to construct, they become permanently productive, returning their costs many, many times over the years. Our department has constructed many such reefs and are now involved in a program to sink five Liberty ships in specially selected areas of the state.

I certainly appreciate and agree with the remarks of the head boat captain. Florida has one of the largest populations of small boat fishermen of any state in the Nation, and they need places to fish. They both outnumber the commercial fishermen and outproduce him in total landings. The Department of Natural Resources is responsible for the marine resources, for the benefit of all Florida citizens. All user groups can and should be considered in our resource management plans, and I can assure you that they are.

A very serious problem relating to Florida's fishery management programs for snappers, groupers, and other species is the terrible inadequacy of landings statistics. We must accurately know how many pounds are being landed, before sound regulations can be promulgated. We do have reasonably good statistics on the commercial landings, but even these need improvement and expansion. Yet, the Federal agency which gathers these data is considering reductions in the program. Far worse is the fact that there are virtually no data on the sport catch. Yet, in one of our own department studies, using the best data available to us from our own and other sources, we found that the sport catch of king mackerel is on the order of 10 times the commercial landings. This is further complicated by the fact that many so-called sport fishermen actually sell their catches to pay for expenses. Someone said jokingly that a sport fisherman is a person who takes a picture of his catch before he sells it. This is, of course, an exaggeration, but it is also true in many instances.

The Florida Department of Natural Resources works hard to do the best possible job in managing Florida's marine resources for all Florida citizens. We have one of the largest and most active marine research laboratories in the world, gathering the scientific data needed for sound regulations. We also have our marine patrol, one of the finest law enforcement bodies in the state, to enforce these regulations. However, we cannot do it alone. All user groups must work together, with us, to assure that our valuable marine resources will be available for our children's use and enjoyment. We at the Department of Natural Resources are always open to opportunities for improving our activities toward this goal, and we would certainly welcome your suggestions.

Statement 5

Lyle S. St. Amant
Assistant Director
Louisiana Wildlife and Fisheries Commission
New Orleans, Louisiana

My name is St. Amant. I'm from Louisiana; and, according to the statistics, we don't even have a snapper fishery in Louisiana. But, I think the thing that this discussion this morning reminded me most of is the old fable about the blind men trying to describe an elephant. I think everybody knows a good bit about a small part of this problem, but we don't have any idea of the total picture --of how it interrelates between the resource, the location of the fish, the pressure in the areas, and the competition that has developed among the various interests. This goes back to some basic issue; and the one that's most basic, of course, is money -- the money to develop this information.

The first basic information we're going to have to have is adequate statistical evidence of what's really happening. I don't think we want to talk too much about landings; but we need information on where these fish are caught, the locations, the catch per unit of effort, and the amount of people, whether they be commercial or recreational, that's putting this effort into the fishery. We should gather this information not only for the snapper-grouper fisheries but all the fisheries in the Gulf, because we have the same problem when we address the problems of the shrimp fishery or anything else. We never seem to get the total picture. And, as has just been pointed out, the Federal agencies or the Federal budget is attempting to wipe out the statistical program as it now exists, instead of expanding the very thing that seems to be the most needed. It's also been pointed out by the State of Alabama that the jurisdiction stops at 3 miles, at least for most of the states. So if we're going to work farther offshore, it would appear to be a Federal problem and a need for Federal budgeting. I'm also a little -- I don't know whether I'm surprised or amazed or concerned -- that we seem to spend more Federal money and know more about the fish stocks in foreign waters than we do about the fish stocks on the United States coast. We can draw pictures about where the snapper are off Yucatan and off Barbados and other places, but nobody could tell us where they're off the Louisiana coast or where they're off the Texas coast,except for some work that's being done by Texas A&M but not by the Federal Government.

Other types of information that should be developed -- the question of artificial reefs is obviously one that needs to be looked at carefully. It might be interesting to know what has happened to fish stocks, for example, since we have some 2,300 or more oil platforms off the Louisiana coast that are producing fish as artificial reefs. Moreover, the rigs provide vertical stratification, which does not normally occur with boats that are sunk on the bottom, and this vertical stratification apparently gives better fishing, a better complex of fish. But we need to find out, either from the commercial or any fisherman, what has really happened on the Louisiana coast in shifting the catch in the Gulf since these rigs have come into being. Practically all these rigs have been in the Gulf since 1950. Has the production area shifted to this area because of these artificial reefs, or is this an invalid assumption? I think there's no question that these oil platforms have created recreational fisheries in the state. As Charlie Sebastian tells us, we're under some pressures from the commercial people from other areas, so there's evidently some use of these rigs.

I wasn't kidding about the fact that we don't have any snapper industry in the state. Yet, our figures show about 200,000 pounds of landings. After checking around a bit, I find out that we do have seven vessels operating out of Louisiana, with 25 fishermen, from the best figures we can get. These are Florida boats that have moved in; and, apparently for convenience, they work out of Louisiana ports. The fish are landed in Louisiana and shipped out for better prices than offered by New Orleans. It's not clear to me yet who supplies the Louisiana restaurants. We've been having snapper at a good many restaurants for an awful long time, so somebody does supply these restaurants, and I don't know whether they buy from Florida, from Texas, or some other place. The charter boats in Louisiana, as best we can determine -- this may be direct information from Charlie Sebastian or someone else -- indicate that about 90% of the time is fished around the rigs, and about 5% around wrecks that they can locate, and about 5% in open waters. I assume this latter may be fishing for billfish and trophy fish.

One of the things that needs to be developed, probably with statistical information, is whether or not we are really having a diminution of catch or whether we're just dividing and cutting the pie among more people. This is happening in the shrimp industry and everywhere else. Possibly in slow-growing fish, like snapper and grouper, there may be a real problem because we may begin to be able to drop the production in one area rather quickly and keep it down. In some of the fast-growing fishes though, like shrimp -- where you have a crop of the year -- what you simply do is divide it up among more people, and nobody makes a living out of it. The point that Sebastian brought up -- the great number of small boats that are in coastal waters and offshore since 1954 in Louisiana -- is valid, but almost unbelievable. Even if they are inefficient fishermen, they don't have to catch many pounds for the number of trips they make to make an impression on total production. This is a point that has to be answered. Are we dividing up a pie that's always there and not really hurting the population, or are we really knocking it down in some way? I think this is going to take some real work, and it's going to cost somebody some money. Only after we begin to get some type of picture of the total problem, can we then address the specific elements of research that might be needed.

The question of whether or not shrimp boats are really affecting the population by catching small fish is something that I think needs addressing. It's obvious that shrimp boats have always caught from 5 - 10 pounds of groundfish for about every pound of shrimp that they catch. The fish go overboard. From an ecological point of view, you might assume that this is really applying a nutrient back into the system, and we are not having any significant drop-off from it. We haven't seen too much trouble from it over the years. But there is evidence statistically, I think, developed by some of the people at the Galveston Laboratory and others, that show that we do have an increase of trawling pressure in the northern Gulf -- not only in the number of boats over the last 15-20 years, but in the efficiency of these boats, the horsepower, and the size of nets being used. I don't think there's any question that the trawling pressure in the estuaries had gone up several thousand percent. In Louisiana alone, the trawling pressure has jumped from roughly 3,000 or 4,000 boats in the mid-50's to something on the order of 15,000 boats now, with an unknown but estimated number of another 45,000 unlicensed trawling efforts by recreational interests in small boats. Until we develop enough accurate information on what is going on, and who is catching the product, and where it's going -- not only for the snapper-grouper fishery, but for all of the Gulf fisheries, I don't think we're going to get anywhere. I think we're going to continue to be like the blind people looking at the leg of the elephant or the tail, hither and yon; and everybody is going to be serving his own interest. We'll never have enough data to stand up in a forum like this and say somebody's right and somebody's wrong. And, until we develop this information, I think we're going to be in bad shape. There again, it comes to who's going to buy it, and it's not going to come cheap.

PANEL 3

DISCUSSION

KLIMA:

I'd like to address Dr. St. Amant concerning some of the information he gave. I was at that time working for FAO, so this was not Federal Government money investigating the resources of the western central Atlantic. And I would also like to echo a few other things. Concerning the structures, I think that there were some very good points made by Dr. Stevens, concerning the recruitment to these structures. There are other types of structures that could be used for recreational purposes. One is a subsurface artificial structure which was developed at Pascagoula, and it's not a very high-priced structure, and it could be used, not necessarily for snappers and groupers, but for mackerels, bonito, and so forth. I also would like to support Dr. St. Amant in determining how the share of this snapper and grouper resource is being divided at this point in time. And the only way this can be done is by collecting reliable and useful catch and effort information -- not only catch, but effort by areas, by seasons, etc. One other thing, and I'll finish this little discourse, and that is concerning the discards. While working for this FAO project, I made a preliminary estimate of the discards from the shrimp fleet in the northern Gulf. From Mississippi to the Mexican border, the preliminary estimate is around 500,000 metric tons per year discarded. Now, this is a rough figure, but it gives you some idea. Now, the species composition varies by area and so forth. It gives you a handle with which you can start looking at the shrimp catches, vis-a-vis the snappers, juvenile snappers, and so forth.

KIFFE:

I'd like to say something about this shrimp. I'm a shrimper. I think you're going to see less and less snapper caught by shrimpers, because a few years back there was a lot of virgin country for shrimpers. Offshore -- we wouldn't fish at all, in 40- to 50-fathom depths. Or a lot of places we weren't fishing -- those places are all fished now; and after a place has been shrimped awhile, you don't catch any more small snappers or stuff like that. We used to catch big snappers, too; but you're going to see less and less snappers caught by shrimpers.

PRICE:

I own a snapper boat; shrimping, I wouldn't know. But I fish off Louisiana; and I've gone across 10-mile slicks with spot, croakers, and stuff and see 132 shrimp boats actually in line, zigging straight through some waves. And they've done it -- even though it's a 10-mile strip. Sure there's no snapper being caught. They've killed them all! That bottom is wiped out. There's no bottom left.

BULLIS:

I'd like to address a question to Harmon Shields, because I think it's one of the real significant points facing the entire region right now. I think this Colloquium has laid out such a fantastically complex problem, that there's no way to get a hold of it at the present time and define it to our satisfaction. However, we do have the formation of the Western Central Atlantic Fisheries Commission, that's having it's inaugural meeting next week, and, presumably from this time forward, will be dealing with very similar problems. I think that the Gulf States of the United States, as we've identified this morning, have a very large interest in this species complex. Somehow or another, the representatives to the international commissions in the Federal Government are going to need some communication stepping stones back to the interests in this area -- to work back and forth to make sure that we're really representing the interests of the area. And this concerns me very much. There isn't any answer to it right now; but I think that it's a matter that the Gulf States Marine Fisheries Commission should be concerned with, and I think that it needs discussion. I think that we, the representatives (I'm going to be the U. S. representative of the first session) feel a great need for input from a group such as this. Obviously, we can't have a meeting like this every year. We can't look at snapper and grouper; we've got so many other problems. But, I think that somehow or another, the "Feds" who are representing the regional interests in this international group need something, some pipelines going back and forth. I was wondering if you had any feeling or any insight or any words of wisdom or encouragement on how we might more effectively deal through the Commission or through these interested parties.

SHIELDS:

In your opening remarks this morning, Harvey, you mentioned the fact this meeting was going to occur in Trinidad. I'm embarrassed to tell you that I didn't have any knowledge of this meeting taking place. I felt that Florida, of all places, was right in the middle of this particular area that's going to be considered. I pledge you all the knowledge from our hundred scientists and the industry people that we could muster together. In fact, I'd even like to send somebody down there. I agree with you that it's vital that we share an interest in this area and would be glad to cooperate. I just didn't know anything about it.

BULLIS:

Well, I think that certainly Florida has got a very great vested interest as a state, as important as this resource is to the state. But, I think that the same thing applies to the Gulf States community; and, therefore, I look to the Gulf States Marine Fisheries Commission or some mechanism of the Commission that needs to be tuned or adjusted. There's something that is not there now that needs to be developed.

Do you feel that there's an advantage to working out developing an element to the Technical Coordinating Committee that would depict the technical aspects of this purview that we've been talking about? To a large extent, our Technical Coordinating Committee has been concerned with our resources and our problems off our own coast, but now we're really being forced to look outward from a community of states and from a multiple of interests' point of view. And what is it that we can turn to to use in . . . . . ?

SHIELDS:

I certainly think we ought to be involved; and, as Chariman of this Commission, elect, for next year, I think we ought to look into it with the Technical Coordinating Committee. And, I can pledge you the cooperation of Florida, as long as the Commission doesn't try to tell us what to do -- and make suggestions to us. We'll go along and take our problems to our legislature and cooperate -- to the fullest. I don't see the problem with Florida's participation in it, and I would solicit the representatives; I think they ought to be involved. I think Lyle St. Amant wants to say something -- maybe to that effect.

ST. AMANT:

I just wanted to clarify a little bit the use of the Technical Coordinating Committee. I have no objection. I'm sure Ted Ford wouldn't. The problem is that the Technical Coordinating Committee of the Gulf States Marine Fisheries Commission is made up of technicians from each state who are familiar with the problems and the biological situations in their area and nearshore waters. What we attempt to do in these meetings is to take our information and work it against Federal information we have or other information from offshore areas; and from that,we try to develop this position to present to the Commission with respect to management or any other thing. But, if you get to working in foreign waters, in some instances, I don't know how we're going to react to you. We don't have any information to talk to you about. You're going to have all the information on what's going on in foreign waters, and I must assume you can interpret it as well as we can. It's only when we have two different bases for information or two different bases for an idea,that we develop a discourse on the thing. And I think this would be the only thing that might prevent the Technical Coordinating Committee from working with you effectively. But, I think as far as the Commission is concerned, if you feel like you need additional scientific participation in what you're doing, then maybe somebody could go or somebody could set up some special meetings. I don't know really what you have in mind.

BULLIS:

Well, what I had in mind, from the presentation and the material that we have put together, was to present to the Commission what we see as impending events coming down that will affect us and our interests as a region -- as multiple users of the resource with some 25 or 30 additional nations now all bordering on the same ecosystem, all with small propietary, large proprietary rights. How do we represent U. S. interests in here if we don't have a program? The Federal Government doesn't have a program right now. Maybe they should have. Maybe this should be a recommendation. Maybe there are other recommendations. This is the only point that I'm raising -- that we have prepared for the Commission's consideration the material that's been presented this morning,because we think that there's very large interests being represented, and we don't have, as yet, guidelines as to where the Commission would like to see us go with it.

SHIELDS:

Harvey, I don't want to delay this subject much longer. I would like to make this point -- concerning the importance of what you mentioned this morning, I'd like to visit with you and discuss some things that cross my mind. The first thing I thought about when you started talking about the Western Central Atlantic Fisheries Commission meeting was how important it was in the Bahamian situation to put together, with the Bahamian Government, the statistical catch data of that fishery. We found it to be much larger than we had anticipated, if their catch was right. And if that were true, so close to home, how important what your're about to do down there would be!

PUTNAM:

I'd like to take the position here of thanking the people responsible for this -- for consulting the fishermen and bringing the recreational and commercial people into this Colloquium to discuss these problems and to get a better understanding of our problems. And maybe, with a little better communication between the two of us, we can resolve a lot of these problems. I hope this won't be the last of the meetings. I hope there will be others. I'm going to see Mr. Shields after the meeting (it's a surprise to him) to see if we can't have some in the State of Florida. And, I'd like to see others do the same.

LYLES:

First of all, let me thank Mr. Harvey Bullis and his staff for the fine presentation they have made here this morning. This Colloquium is a new approach to discussing and evaluating problems of concern to the Gulf States Marine Fisheries Commission. We have seenthis morning, an excellent presentation of most of the background data that we have on this fishery. Unfortunately, since the fishery operates beyond the territorial limits of most of the states, there is a paucity of information available. Mr. Bullis and his staff have so adequately pointed this out. It is my hope, as Chairman of this Commission, that, as a result of this discussion, we can find solutions to maintaining the fishery at a level that will supply the needs of all of the users.

As one who has been familiar with this fishery for many, many years and witnessed a number of changes in the fishery, there are some areas that I would like to see explored. Unfortuantely, the records are not easily accessible, and some may not be available to do this kind of work. I have reference to many of the old established firms that operated in the red snapper business for many years. For example, the fleet of the Liberty Fish and Oyster Company (Galveston, Texas), which, in the years prior to 1940, fished almost exclusively for red snapper. The fleet has now disappeared; and, except for occasional landings by shrimp boats, few snapper are landed at Galveston. During the same time, there was a small fishery centered at Sabine and Sabine Pass, along the Texas-Louisiana border. Farther to the south at Port Isabel, a small fleet operated from that port and a few local boats operated out of the Port Aransas area. For the most part, these fleets have disappeared, and the question in my mind is, "What happened?" There was no major fishery operating in Louisiana. Only a single vessel operated out of Westwego, La., mostly for the local market. This, too, has disappeared. Occasional landings by vessels at Morgan City, La. were for the purpose of overland transportation of their catch to Florida firms.

In Alabama, the operation was centered around the Star Fish and Oyster Company in Mobile and the Loop Fish and Oyster Company, the latter being located at Bayou la Batre. An occasional boat operated out of Baldwin County in the vicinity of Bon Secour. The Bayou la Batre fleet has disappeared; there are few landings in Baldwin County at the present time, and the Star Fish and Oyster Company fleet is somewhat smaller than it was in previous years.

In Pensacola, Florida, we find both the Warren Fish Company and the Sanders Fish Company out of business, both fleets having been sold to other interests. The only remaining evidence of the snapper fleet is a vessel tied up at the municipal pier as a tourist attraction. Farther down the coast, there were sizeable fleets at Panama City, at Valparaiso, and at the Tampa-St. Petersburg area.

What caused the decline of these fleets? Has it been diminishing catches, or has it been changing economic conditions? Have imports affected price and market ability? Finally, what can the Gulf States Marine Fisheries Commission do to bring to the attention of those responsible, the necessity for adequate management of the stocks of this valuable resource? The resouce problems revealed in this Colloquium deserve the utmost consideration of the Commission.

SUMMARY AND RECOMMENDATIONS

Chairman of the Gulf States Marine Fisheries Commission
Charles H. Lyles
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I wish to take this opportunity to express my appreciation to Mr. Harvey Bullis and his staff for the excellent presentation of the Snapper-Grouper Colloquium. It was most timely, since the U. S. red snapper fishery began at Pensacola more than 100 years ago. I know that it took considerable time, effort, and some sacrifice in funding to prepare this presentation. As Chairman of the Commission, I feel that it was well worth the extra effort. The sessions were well attended, and a very keen interest was evident by all those attending.

In requesting that the Colloquium be organized and prepared, this Commission recognized that the snapper-grouper fishery resource forms the most important component of the reef fish assemblages of the western central Atlantic Ocean.

Although these species have supported a major commercial fishery for more than 100 years, a decline in commercial landings became evident after 1965. Concurrently, recreational fishing effort and landings increased rapidly. Commercial landings amounted to 18.3 million pounds in 1974, and recreational fishermen landed an estimated 83 million pounds in 1970. There appears to be increasing fishing pressure on traditional U. S. grounds by other nations as well.

Evidence presented in this Colloquium indicates that we now have resource problems in certain regional fisheries and that management is required. At the same time, it is clearly evident that the data base for management is inadequate.

The snapper-grouper resource has withstood commercial exploitation for more than 100 years; however, this fishery has, in recent years, been subjected to increased commercial and recreational pressure -- not only by the U. S. interest, but also by increasing numbers of other nations as well. It is also experiencing some environmental changes that may have a profound effect on the ability of this fishery to withstand continued increasing pressure.

We, in the Gulf States Marine Fisheries Commission, recognize the importance and necessity for a coordinated management policy to deal effectively with the problems of this resource at the state, national, and international level. It was the hope and intent of this Commission in prompting the Colloquium, that we could encourage and support the state and Federal agencies representing the various user groups to work together toward developing such a coordinated management policy for this resource. This excellent presentation will do much to insure this. The resulting publication should serve as a most useful basis for better comprehension, by all interests, and as a departure point in planning for future needs.

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