

11-1977

A Comprehensive Summary of the Shrimp Fishery of the Gulf of Mexico United States: A Regional Management Plan

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technical report series, no. 2, part 2
November 1977



A Comprehensive Summary of the Shrimp Fishery of the Gulf of Mexico United States: A Regional Management Plan

A COOPERATIVE
STATE-FEDERAL-UNIVERSITY-USER
DEVELOPMENT



GULF COAST RESEARCH LABORATORY
Ocean Springs, Mississippi

Gulf Coast Research Laboratory

Ocean Springs, Mississippi

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THE SHRIMP FISHERY OF THE GULF OF MEXICO
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published by

Gulf Coast Research Laboratory
Ocean Springs, Mississippi 39564

NOVEMBER 1977

Preface

This document is a comprehensive summary of "The Shrimp Fishery of the Gulf of Mexico United States: A Regional Management Plan."* The plan is a cooperative State-Federal-University-User development. Representatives from each of the five Gulf States marine fisheries management agencies, the National Marine Fisheries Service (NMFS), universities and the Gulf of Mexico Fishery Management Council (GMFMC) participated in Task Force workshops and reviews.

In developing the contents of the plan and in writing the document, each member of the Task Force contributed in the area of his expertise and in discussions that resulted in changes of draft materials during the twelve workshops. Assignment of authorship includes all members of the Task Force and Planning Staff.*

Four special workshop sessions, held at locations selected by State and fishery organization representatives for the convenience of shrimp fishermen and other industry constituents in each of the five Gulf States, provided additional opportunity for direct workshop and review participation. In general it was evident that most problems are common to all of the Gulf States.

The Technical Coordinating Committee (TCC) of the Gulf States Marine Fisheries Commission (GSMFC) recommended adoption of the final draft by the Gulf State-Federal Fisheries Management Board (GS-FFMB). After adoption by GS-FFMB, NMFS approved publication of the plan. This comprehensive summary provides a condensed version for the convenience of decision making managers.

The study was supported by a contract agreement with the U. S. Department of Commerce, NMFS. For complete and detailed plan development, the reader should refer to the basic document,* or contact NMFS at St. Petersburg, Florida or GSMFC at Ocean Springs, Mississippi.

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*"The Shrimp Fishery of the Gulf of Mexico United States: A Regional Management Plan," edited by J. Y. Christmas and David J. Etzold; published by the Gulf Coast Research Laboratory, *Technical Report Series*, No. 2, August, 1977.

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A COMPREHENSIVE SUMMARY OF THE SHRIMP FISHERY OF THE GULF OF MEXICO UNITED STATES: A REGIONAL MANAGEMENT PLAN

OVERVIEW

The Gulf of Mexico shrimp fishery is the most valuable fishery in the United States. With over 90,000 commercial and recreational fishermen, utilizing over 60,000 boats and vessels harvesting seven species (brown, pink and white shrimp account for more than 98% by weight), it is also one of the most complex fisheries. The reported commercial catch for 1976 was 210,078,000 lb (heads-on), with a dockside value of \$275,187,000. Offshore (Gulf) and inshore (estuarine) segments of the fishery are generally recognized as separate but closely related entities.

Large numbers of recreational fishermen participate in the inshore harvest and many more depend on the bait shrimp fishery to satisfy their needs for bait. Fishing effort ranges from the individual fisherman with a cast net worked from a dock or seawall to large trawlers with sophisticated equipment capable of participation in distant water fisheries. Much of the bait and recreational landings are not recorded in reported landings data and considerable quantities of small shrimp are caught and discarded at sea. Consequently, catch and effort data are incomplete.

The annual landings (in weight) per unit of effort of the three major species have been declining, whereas total landings have increased indicating no serious negative biological effect on the shrimp populations. Regulation of the fishery has been confined to territorial waters under jurisdiction of the five Gulf States. Since 1960 valuable data have been collected by State and Federal agencies which provide for improved management of penaeid shrimp fisheries within State waters. Because regulations are often partially based on socio-economic factors without a sound data base for decision making, regulations vary considerably from State to State.

The Gulf States Marine Fisheries Commission's Technical Coordinating Committee (TCC) has primarily been responsible for identifying shrimp research and management problems for the Gulf and coordinating cooperative efforts of the State and Federal governments. This plan has been developed to show what inputs are needed and how these inputs may be used to arrive at policies to improve the shrimp fishery through better and more timely decision making. Because dynamic conditions will change some of the stated objectives, as well as their order of importance, the management system must be

capable of responding both when and where necessary. The users of this plan should consider the goal and objectives as guidelines for the future management of the Gulf shrimp fishery, and that adjustments will be required from time to time.

This summary document lists the goal and objectives of the Regional Plan, and describes the following sections.

The proposed (improved) Regional Plan is described and includes a conceptual model that will provide for determining management alternatives, management decisions, actions, implementation, measuring, monitoring and evaluating results of management actions and updating the data base as required.

A Management Action Program Summary is presented in chart form and shows time horizons, estimated funds needed, priorities, potential funding sources and suggested responsibilities for activities that will be undertaken to implement the plan.

The present State management systems, basically ones in which State natural resource agencies (with industry input) manage shrimp in their waters fairly independently of other State or Federal agencies, are summarized with selected State laws and regulations.

Last, the shrimp fishery is summarized and includes the complexity of the fishery and species involved; biology, including life history and habitat considerations; descriptions of the industry; economic and sociological considerations; as well as status of the resource and yields.

GOAL

To manage the U. S. shrimp resources of the Gulf of Mexico to provide for optimum sustained benefits for the Gulf States and the Nation.

OBJECTIVES

1. Describe the fishery.
2. Identify, preserve and improve (where possible) shrimp producing zones of the region.
 - a. Identify and preserve (maintain) high value "natural" shrimp habitats.
 - b. Provide protection of the spawning and juvenile populations of those shrimp where data indicate possibility of overharvesting.
 - c. Identify offshore shrimp stocks and their relationships to estuarine systems.

d. Identify habitats that might be altered to enhance shrimp productivity.

3. Facilitate the collection of improved statistics regarding the commercial and recreational shrimp fisheries which will include at least catch effort, price and cost.

a. Develop a fishing information acquisition, processing and dissemination system with sufficiently short turn-around time to be of use to management.

b. Determine the interaction between shrimp and other fisheries.

c. Encourage coordination and standardization of sampling programs.

4. Facilitate research in the development of a bio-socio-political-economic model to assess the impact of various management strategies.

a. Test the sensitivity of the model to define areas of research needed to continually update and improve the management schemes and to determine various data requirements.

b. Identify those items that a management authority might affect and the resulting impact on the fishery, including its participants.

c. Determine optimum sizes of harvest.

d. Determine optimum organizational structure for marketing shrimp.

e. Monitor and predict fluctuations in abundance and geographic distribution.

f. Determine causes (fishery and/or environmental) of fluctuations in yield.

5. Develop a regional management plan.

a. Determine institutional and legal barriers to regionalized management.

b. Incorporate where possible individual State management plans for internal waters into a regional management plan.

c. Encourage standardization of State management regulations as biological and socio-economic considerations allow.

d. Identify criteria, methods and schedule for evaluating effectiveness of management scheme.

6. Facilitate extension education to the shrimp industry that will promote:

a. Management techniques which will provide efficiency in harvest.

b. Changes in the industry to enhance implementation of optimum organizational structures for marketing shrimp.

c. Knowledge of alternatives with regard to diversification in the fishery.

The Goal and Objectives were developed by the entire Task Force membership, utilizing the "Management by Objectives" technique, and were reinforced by shrimp fishery constituents who participated in the several special industry workshops. From these objectives, together with

the existing condition of the resource and fishery, the Task Force developed alternative improved regional management systems. The next section summarizes the recommended, or proposed management systems for consideration by the Management Board.

PROPOSED SYSTEM

Under the proposed system, the Gulf States will continue to manage the shrimp fishery within their territorial waters, but will cooperate in managing those aspects of the fishery which can be best managed as a regional venture. Gulf States, working with the Gulf State-Federal Fishery Management Board (GS-FFMB), will be assisted in their effort by appropriate Federal agencies as may be required and requested by the Board.

The State-Federal Fisheries Management Program (S-FFMP) was established in 1971 to provide a mechanism for cooperative management of marine fisheries that transcend State and State-Federal jurisdictional boundaries; and Management Boards were established for the purpose of determining fisheries in need of management, developing management plans, identifying data requirements and implementing action programs necessary to achieve management goals and objectives.

The GS-FFMB was organized in April 1976, and since that time two significant planning efforts have been launched; namely, the development of management plans for the Gulf menhaden and Gulf shrimp fisheries.

Congress enacted PL 94-265, The Fishery Conservation and Management Act (FCMA) of 1976, establishing a Fishery Conservation Zone (FCZ) extending seaward from the outer limit of state territorial waters to a line 200 nautical miles from shore. In the Gulf of Mexico, State fisheries jurisdiction extends 3 nautical miles except for Texas (9 nautical miles) and the west coast of Florida (9 statute miles).

Responsibility for fishery management within the FCZ is delegated to the Secretary of Commerce. A Gulf of Mexico Fishery Management Council (GMFMC), appointed by the Secretary, is responsible for development of fishery management plans for all fisheries in the FCZ.

Under the FCMA, States will continue to manage the shrimp fishery within their waters, but with provision for Federal preemption only (when fishing is predominantly in the FCZ) if a State fails to take action, or takes action the results of which would substantially and adversely affect implementation of a fishery management plan. The FCMA includes (as a national standard) that to the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.

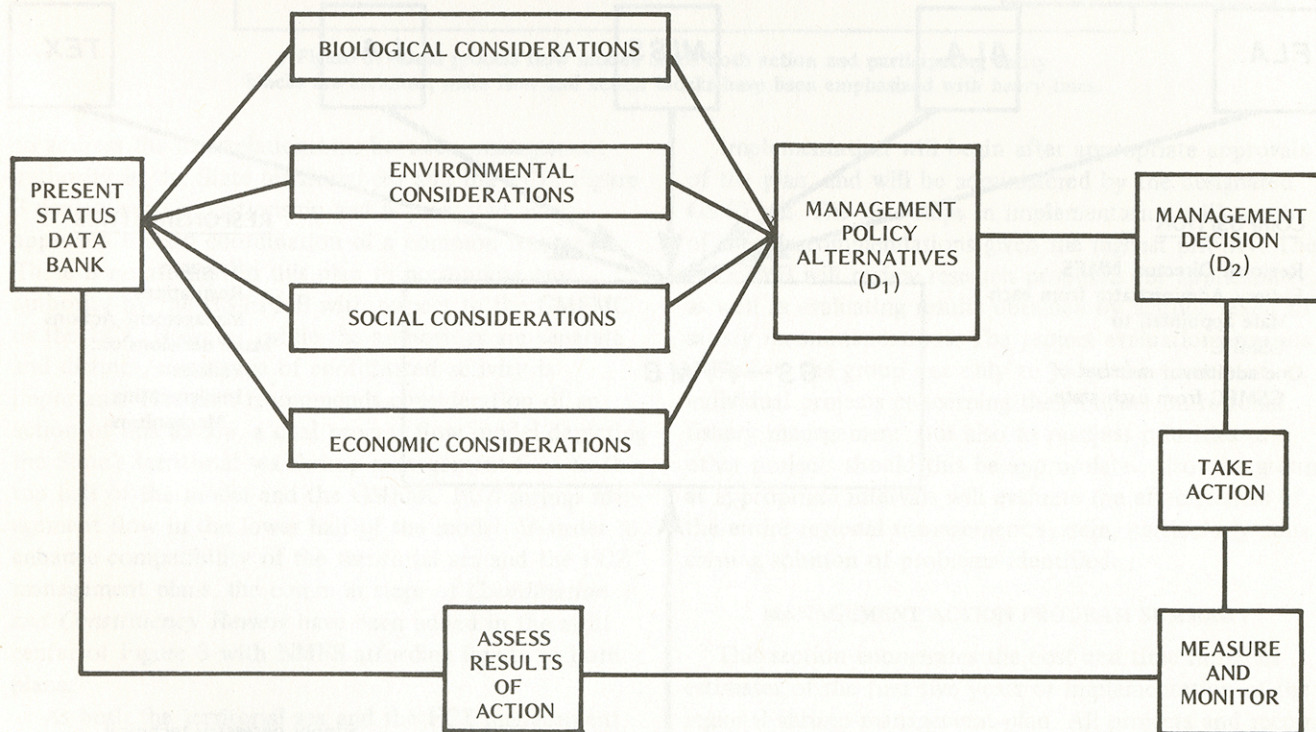
The orderly development and implementation of management plans will require a close working relationship

between the Council, the Board and State agencies if fisheries are to be addressed throughout their range.

The proposed system (Figure 1) is contingent upon a regional data base providing information for: (1) population models; (2) development of knowledge of the economic structure of the industry; (3) determination of social attributes of the fishing community; and (4) determination of hydrological and environmental parameters to be monitored, providing continuous information concerning the status of the resource. This information in turn will be used to: (1) develop harvest prediction models; (2) develop economic criteria to allow managers to judge the health of the fishing industry and evaluate the impact of management decisions; (3) formulate social and political criteria which can be used to determine (a) the potential acceptance of management policies, and (b) the social and legal impact of management decisions; and (4) suggest guidelines to advise members of industry and the public concerning current status of the shrimp resources and fishery. While these tasks are being accomplished, management policies will be developed that will consider bio-socio-economic conditions in the

fishery. The next step of this process will be to decide on the proper techniques for implementing policies. Following implementation, policies will be evaluated for their effectiveness and relevance to changing conditions.

The principal advantage of the new system is that management will coincide with geographic distribution of the resource and fishing industry. Other advantages are: (1) it may serve as a model for regional management of other fisheries; and (2) it will lead to development of a predictive capability that (a) should reduce economic loss resulting from overinvestment, thereby improving the financial climate of the fishery, (b) increase the effectiveness of management through coordinating field monitoring of the resource, (c) enable managers to evaluate the biological, economic, social and political effects of their decisions, (d) allow States to coordinate administrative, research and enforcement policies, (e) enable managers to advise industry concerning costs of fishing, (f) allow managers to document biological and economic trends in the shrimp fishery, (g) provide adequate catch and effort data should it be necessary for negotiations between the Federal government and other nations fishing in this area



EXPLANATION OF DECISIONS TO BE MADE

D₁ At this point biological, environmental, social, economic and other considerations must be taken into account to produce alternative actions which may be used to solve the problem under examination. All forms of action should be considered, ranging from the null alternative (the "do nothing" alternative) to drastic action. Those alternatives which appear to have the best chance of solving the problem, along with each option's advantages and disadvantages, should be used for decision (D₂).

The Technical Committee investigating the problems will develop these alternative solutions.

D₂ The Gulf State-Federal Fisheries Management Board will make this decision by choosing the best alternative in accordance with previously set policies.

Figure 1. Conceptual model of future management system.

and (h) establish a regional fisheries management information system data base that can be retrieved quickly and used to identify information needed for significantly improving resource management.

Disadvantages of the new plan include a high initial cost, particularly for a regional fisheries management information system. Also, there is a possibility that certain elements of the industry will oppose the plan on the grounds that their time is being taken up with few tangible benefits in return, and that their privacy is being invaded.

The basic organization of the recommended management structure is shown in Figure 2. The basic structure is the GS-FFMB, which will recommend management actions in the territorial sea. The Board will establish appropriate procedures and policies to take necessary actions to design, evaluate and recommend shrimp management activities.

It is recommended that GS-FFMB utilize the existing TCC as its advisory committee. Each year there should be at least two meetings of the TCC dealing specifically with Gulf shrimp regional technical problems and solutions as

deemed necessary by two or more members or at the discretion of GS-FFMB.

The chief advantages of this option are that all members of the Board have knowledge of and an interest in fishery management problems and the State administrators regularly advise the heads of their respective management bodies on fishery management problems as well as make recommendations to their legislators and/or governors. Also, they are members of the GSMFC and, therefore, can coordinate the activities of the Board and GSMFC. Inclusion of the NMFS Southeast Regional Director as a member provides representation of Federal interests.

There are two disadvantages of this option. The first is that the member State administrators can commit their respective State agencies to a course of action only with the approval of the head of their department or management body and through legislative or executive action. Second, this or any formalized regional management scheme would require legislative approval to enter into reciprocal management programs in most cases.

With the passage of PL 94-265 and the formation of the GMFMC for the Gulf, it is important and appropriate

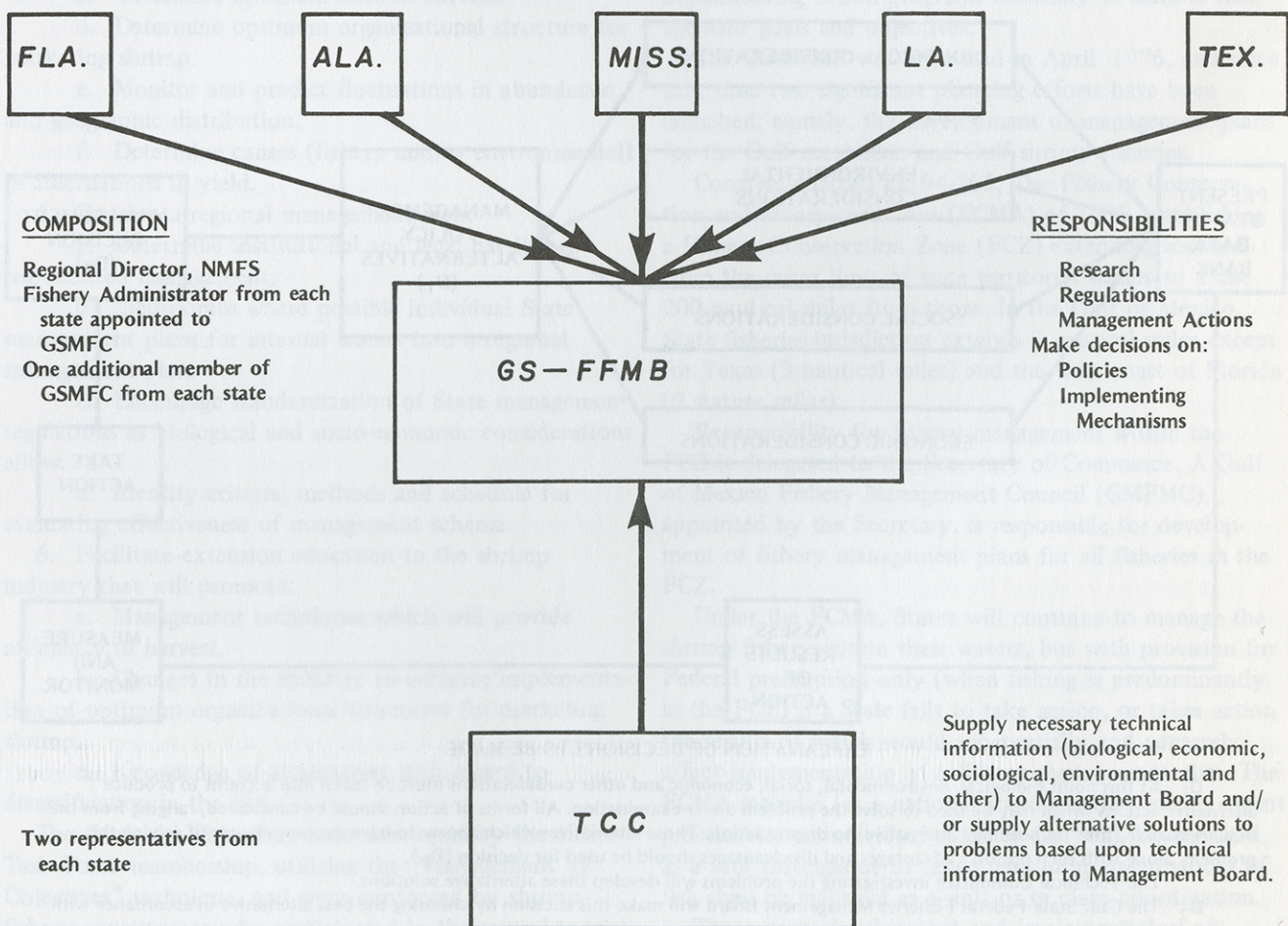


Figure 2. Recommended management structure.

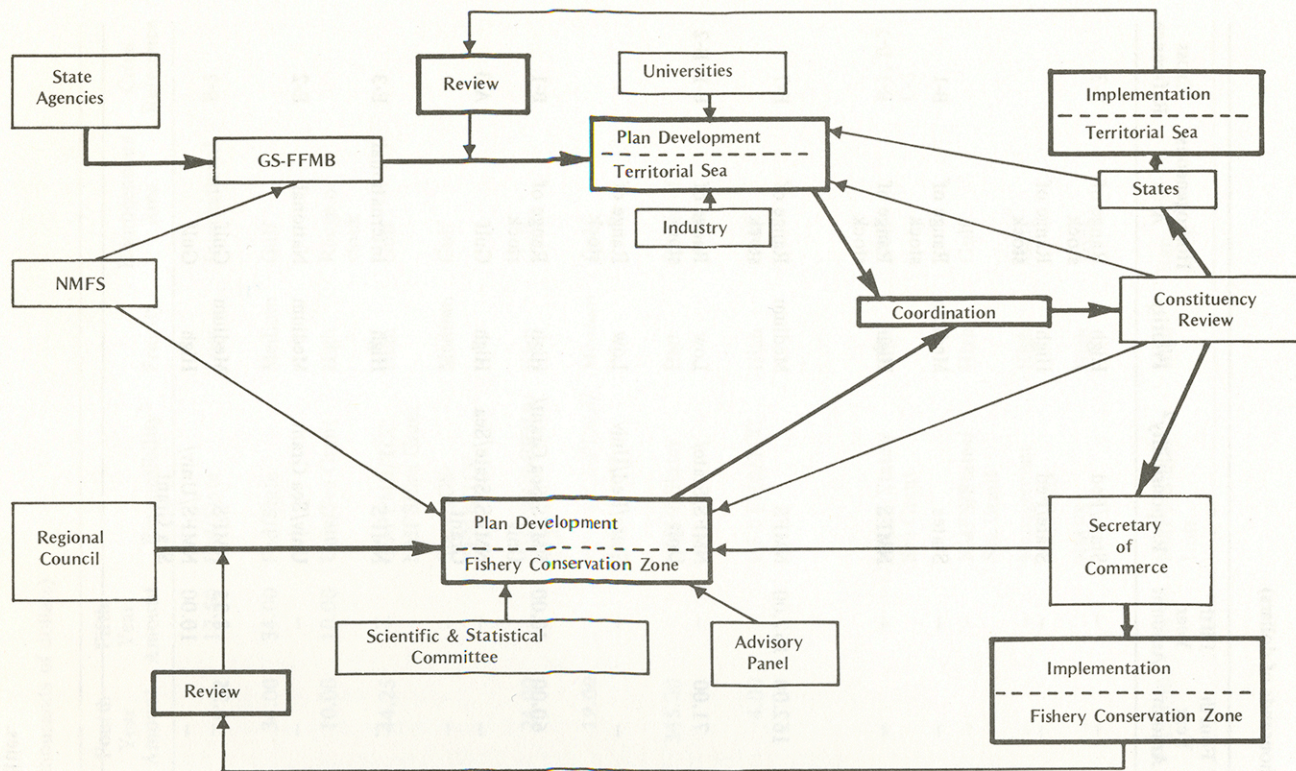


Figure 3. Dual process flow model. Since both action and participating entity blocks are included, main flow and action blocks have been emphasized with heavy lines.

to address the interrelationships between management authority in the State territorial sea and the FCZ. Figure 3 depicts such a relationship and is presented as an approach toward coordination of a common resource. There is no attempt in this plan to presuppose any authority by the GS-FFMB with respect to the GMFMC or the FCZ. However, while the authorities are separate and distinct, some type of coordinated activity is important. This plan recommends consideration of an action of this nature, a dual process flow model depicting the State's territorial sea shrimp management flow in the top half of the model and the GMFMC FCZ shrimp management flow in the lower half of the model. In order to enhance compatibility of the territorial sea and the FCZ management plans, the common steps of *Coordination and Constituency Review* have been added in the right center of Figure 3 with NMFS affording inputs to both plans.

As both the territorial sea and the FCZ management plans go into effect, this model (Figure 3) may continue to be used for consideration of changes which may be recommended by either or both entities. Also, along both paths of the flow model, such as at the GS-FFMB and the GMFMC, there currently exist personnel common to both bodies. A formal model adoption of this nature will enhance coordination and communications of all relevant plan initiations and changes thereto.

Implementation will begin after appropriate approvals of the plan, and will be administered by the designated GS-FFMB. The first steps in implementation will consist of those recommendations given the highest priority. The GS-FFMB will review research proposals for applicability, as well as evaluating results obtained by actions taken to satisfy recommendations. The project evaluations process will allow the group not only to judge the success of individual projects concerning their impact on regional fishery management, but also to readjust priorities of other projects should this be appropriate. Also, the group at appropriate intervals will evaluate the effectiveness of the entire regional management system, particularly concerning solution of problems identified.

MANAGEMENT ACTION PROGRAM SUMMARY

This section enumerates the cost and time horizons estimates of the first five years of implementation of the regional shrimp management plan. All projects and recommendations are important to the accomplishment of the goal and objectives. Criteria for assigning research priorities are based solely on the relative importance of the research activity for management, and provide for rational sequencing of implementation of recommended research activities without consideration of cost or time of beginning in assignment of priorities.

Table 1 describes the first five years of the plan. High

SUMMARY GULF SHRIMP MANAGEMENT PLAN

TABLE 1.
Management action program summary¹ (thousands of dollars)

Type of Action	Function of Task	Identifi- cation Number	First Year Amount	Second Year Amount	Third Year Amount	Fourth Year Amount	Fifth Year Amount	Responsibility ²	Priority	Homogeneous Area	Cross Reference
Biological	To develop data on natural mortality rate, age and growth rates	B-1	415.00	415.00	415.00	-	-	State/Fed	High	Range of stock	B-3
	To delineate the offshore spawning grounds of commercial shrimp; and to determine recruitment patterns for larvae and postlarvae.	B-2	4,760.00	510.00	310.00	-	-	State/Fed	High	Range of stock	
	To determine the effect of fishing the shrimp nursery grounds.	B-3	850.00	850.00	-	-	-	States	Medium	Range of stock	B-1
	To determine those commercial landings not reported and the accuracy and precision of data collection techniques.	B-4	105.00	60.00	-	-	-	NMFS	High	Range of stock	
	To determine the extent and effect of recreational trawling on the shrimp resource.	B-5	165.00	162.00	162.00	162.00	162.00	NMFS	Medium	Range of stock	E-7
Economic	To determine annual assessments of overwintering populations in the Gulf of Mexico.	B-6	75.00	71.00	71.00	71.00	-	NMFS/State/ Univ	Low	Range of stock	B-1, B-2
	To determine the implications of incidental harvest of non-target species.	B-7	30.00	25.00	25.00	-	-	State/Fed/Univ	Low	Range of stock	
	To determine yield relationships including MSY.	B-8	25.00	25.00	60.00	60.00	40.00	NMFS/Sea Grant/ Univ	High	Range of stock	B-1
	To determine the impact of seasonality of fishing and the consequences of dislocation of portions of the commercial fleet.	E-1	60.00	60.00	17.50	-	-	NMFS/State/Sea Grant	High	Gulf	A-3
	To determine the economic impact of uncontrolled shrimp imports on U.S. industry.	E-2	40.00	40.00	40.00	-	-	NMFS	High	International	E-3
	To increase understanding of industry, market structure and behavioral relationships among economic units.	E-3	32.50	35.00	-	-	-	Univ/Sea Grant	Medium	National	E-2
	To determine boat inventories	E-4	8.35	8.35	8.35	8.35	8.35	NMFS	Medium	Gulf	
	To determine cost and earnings data for vessels and boats, including vessel construction costs.	E-5	30.00	-	10.00	-	10.00	NMFS/Univ/ Sea Grant	High	Gulf	

¹ Funding may be cross referenced between several programs.

² Many of these items may relate to or be Gulf of Mexico Fishery Management Council responsibilities.

SUMMARY GULF SHRIMP MANAGEMENT PLAN

TABLE 1 (Continued)
Management action program summary¹ (thousands of dollars)

Type of Action	Function of Task	Identification Number	First Year Amount	Second Year Amount	Third Year Amount	Fourth Year Amount	Fifth Year Amount	Responsibility ²	Priority	Homogeneous Area	Cross Reference
Economic (Continued)	To develop a use and market for underutilized species.	E-6	17.50	-	17.50	-	17.50	Fed/State	Low	International	B-5
	To develop information on marine recreational fisheries benefits.	E-7	67.00	34.00	34.00	34.00	34.00	Fed/State	Medium	Gulf	
	To determine the MEY for the Gulf shrimp fishery.	E-8	10.00	40.00	10.00	10.00	10.00	Univ/Sea Grant	High	Range of stock	
Sociological	To collect sociological information on shrimp fishermen's communities.	S-1	96.00	60.00	63.00	44.25	-	GS-FFMB/TCC NMFS/Sea Grant	High	Gulf	
	To delineate various user interest groups within the Gulf shrimp fishery.	S-2	9.50	9.50	9.50	-	-	States/GS-FFMB/TCC	Medium	Gulf	
	To compile labor force statistics.	S-3	41.50	42.50	25.50	24.00	-	NMFS/GS-FFMB/TCC	High	Gulf	
Environmental	To determine what political and legal problems occur in Gulf regional shrimp management.	S-4	25.50	26.50	23.50	19.00	-	NMFS/GS-FFMB/TCC	Medium	Gulf	
	To determine the effects and consequences of habitat alteration on penaeid shrimp populations.	En-1	410.00	360.00	335.00	345.00	-	NMFS/States	High	Range of stock	
	To develop a formal system of information collection and display for the monitoring and review of the effects of management policies, decision and implementation.	A-1	9.25	31.00	18.50	4.00	-	GS-FFMB/TCC	High	Gulf	
Administrative	To determine the biological and economic effects of discarding undersized shrimp.	A-2	15.00	15.00	-	-	-	NMFS/States/ Sea Grant	High	Gulf	B-1, B-7 E-5
	To determine the effect of unrestricted entry.	A-3	47.50	47.50	47.50	-	-	NMFS/States/ Sea Grant	High	Gulf	
	To examine problems of limited jurisdiction	A-4	25.00	25.00	-	-	-	Management Authority	High	Gulf	
	To improve coordination and communication among data gathering and analysis programs.	A-5	35.00	15.00	-	-	-	NMFS	High	Gulf	
	To determine an estimate of the OY for the Gulf shrimp fishery	A-6	-	15.00	60.00	120.00	85.00	NMFS/States/ Univ	High	Range of stock	

¹Funding may be cross referenced between several programs.

²Many of these items may relate to or be Gulf of Mexico Fishery Management Council responsibilities.

TABLE 1 (Continued)
Management action program summary¹ (thousands of dollars)

Type of Action	Function of Task	Identifi- cation Number	First Year Amount	Second Year Amount	Third Year Amount	Fourth Year Amount	Fifth Year Amount	Responsibility ²	Priority	Homogeneous Area	Cross Reference
Other	To measure the change in the efficiency of fishing craft in the Gulf of Mexico shrimp fishery.	O-1	115.00	-	-	-	-	NMFS	Low	Gulf	
	To convert biological and environmental data to an accessible computerized form.	O-2	235.00	160.00	105.00	-	-	NMFS	Low	Gulf	A-5
	To identify jurisdictional boundaries.	O-3	44.00	11.00	16.00	11.00	11.00	NMFS/States/ Univ.	Low	Gulf	
	To examine problems associated with developing adequate law enforcement programs.	O-4	50.00	20.00	-	30.00	-	States/Coast Guard/Univ	High	Gulf	
	To identify locations of under-water obstructions and determine the extent of damage caused by these obstructions.	O-5	25.00	25.00	25.00	25.00	25.00	Coast Guard/ Industry	Low	Gulf	

¹ Funding may be cross referenced between several programs.

² Many of these items may relate to or be Gulf of Mexico Fishery Management Council responsibilities.

priorities, in general, were assigned to projects that are essential to the development of optimum yield (OY). Special consideration has been given to certain projects deemed especially important by the fishery constituency.

The entire cost of the plan for the first five year period in 1977 dollars will be approximately \$14,349,250. This total amount of money includes all costs necessary to perform the research projects, but is not necessarily new money in all cases. Some of the projects, or part of them, are already in process.

Table 1 includes information in addition to cost, time horizons and type of action. The "Function of Task" column denotes a short statement about each research project. The "Responsibility" column relates to Task Force recommendations as to who should have prime responsibility for carrying out the research once it is funded. The "Homogeneous Area" column refers to the magnitude of the problem area, such as state, international, range of stock or section of Gulf. Those projects which have an association with other projects are shown by a denoted cross reference. The "Priority" column has been designated as high, medium or low.

In addition to those projects enumerated in Table 1, the following high priority recommendations were developed by the Task Force for consideration of the Management Board:

1. That the Technical Coordinating Committee (TCC) of the Gulf States Marine Fisheries Commission (GSMFC) continue its present function at least until the Management Board assumes responsibility for regional management in territorial waters.

This is necessary to maintain the program in that interval between completion and implementation of the plan.

2. That each state participate in and support a Gulf regional management plan in territorial waters.

This is essential because management authority in territorial waters is vested in the five Gulf States.

3. That an advisory committee be appointed by the Board.

This committee is needed to supply input to the Board and/or to supply alternative solutions to current problems. (May be the same as the existing TCC.)

4. That the advisory committee should meet at least twice each year.

This is necessary to review current conditions and to make appropriate recommended changes to the Board to improve plan implementation.

5. That the Management Board interface with the Gulf of Mexico Fishery Management Council (GMFMC) on management problems and plans that involve both territorial and Fishery Conservation Zone (FCZ) waters.

Management in the FCZ is a Council responsibility. Cooperative efforts of the Board and the Council will be

required to accomplish Optimum Yield (OY) in the Gulf shrimp fishery.

To properly develop Table 1, knowledge of existing and potential problems within the Gulf shrimp fishery was necessary. The basic problems identified by the Shrimp Management Task Force are described below, and follow the same order as depicted in Table 1.

Biological Problems

1. *Lack of information on natural mortality rates*—A knowledge of natural mortality rates is needed to aid decision-makers in selecting the size of shrimp and/or time of harvest that will maximize yield. Because natural mortality rates are not well established, these decisions must be made subjectively until more information is available. (B-1)

2. *Inability to delineate the offshore spawning grounds of commercial shrimp species in the Gulf of Mexico and inadequate information on stock identification (postlarval recruitment)*—Spawning stocks of brown, pink and white shrimp are exploited by the commercial fishery. Precise location of spawning areas would facilitate protection of the spawning stock from overfishing and would determine the geographic area or areas which contribute to the postlarval immigration into given nursery areas and would be an integral part in developing parent-progeny relationships. (B-2)

3. *Exploitation of nursery and staging grounds in inside waters*—No clear delineation of shallow nursery grounds exists; consequently, indiscriminate fishing effort in nursery areas destroys countless numbers of small unusable juveniles. This is particularly true when the fishery for one species has an adverse effect on juveniles of another. (B-3)

4. *Need for determining the validity of present landing statistics including the accuracy and precision of data collecting techniques*—A considerable portion of the commercial shrimp landings are not reported to statistical agents. Many changes have taken place in the methods of collection and processing of landings and effort data from the Gulf shrimp fishery since 1956 when an improved system was established by the U. S. Bureau of Commercial Fisheries. These changes have been assumed to be "improvements," but their impacts on accuracy and precision of landings and effort estimates have not been evaluated statistically. Adequate catch and effort statistics are needed to estimate abundance, monitor biological and economic trends and evaluate management decisions. (B-4)

5. *The extent and effect of recreational trawling on the shrimp resource*—Recreational shrimping is assumed to make up a large portion of the shrimp fisheries in some areas and will probably continue to increase in popularity. Thus the need for precise accounting for the harvest effort and extent of recreational trawling is necessary in developing a management system. (B-5)

6. *Overwintering patterns*—Economic and management questions arise from the lack of information concerning the fate of shrimp, particularly whites, during the winter. Annual assessments of overwintering populations in the Gulf of Mexico would facilitate predictions concerning the size of the spring fishery. This would help managers to decide when the fishing season should be opened and aid industry to make wise investment decisions. (B-6)

7. *Incidental harvest of non-target species*—Other species, including large numbers of finfish and crabs, are taken by the gear presently in use. At present these species, which may have recreational or commercial value, may be discarded. Since large numbers of juveniles are taken, long range adverse effects may be felt by these other fishery resources. (B-7)

8. *Yield models*—In order to more fully utilize available stocks and achieve maximum benefits without damage or detrimental effects to the resource, it would be necessary to determine yield relationships including maximum sustainable yield. (B-8)

Economic Problems

1. *Seasonality of fishing and dislocation of the commercial fleet and facilities for processing*—Vessels have traditionally shrimped Mexican and other foreign waters during the winter and spring months. For example, the phasing out of the U. S. high seas shrimping fleet by extension of jurisdiction by Mexico has left the Brownsville-Port Isabel area (largest shrimp port) with a fringe location. Without a new treaty a substantial portion of the fleet may have to relocate and abandon plant facilities because shrimping will be primarily limited to the summer and fall months. This will adversely affect marketing, capital will be tied up in idle equipment for a portion of the year and the labor force will be unemployed during parts of the year. (E-1)

2. *Economic impact of uncontrolled shrimp imports on U. S. industry*—The arrival of large quantities of foreign shrimp causes instability in the U. S. market. Without a quota system or marketing program for U. S. shrimp products, imports may continue to have adverse effects on the price structure of domestic shrimp. (E-2)

3. *Inadequate understanding of industry, market structure and behavioral relationships among economic units*—The imposition of any fishery management plan will greatly impact most of the economic units involved in harvesting, processing, wholesaling and retailing. Understanding how they are impacted and the design of a plan which considers these potential impacts require a knowledge of the industry which we do not now have. (E-3)

4. *Lack of boat inventories*—A comprehensive inventory of boats less than 5 gross tons used in commercial shrimp harvesting and their characteristics would provide economic managerial information to fishermen, enhance the ability to include economic factors in any

determination of OY and provide a comprehensive current statement of the number of fishermen through economic status and factors affecting economic performance. (E-4)

5. *Lack of cost and earnings data for vessels and boats*—The costs involved in the shrimping industry, particularly below the processor level, are highly variable and depend upon many factors. As a result, the fishermen's incomes also fluctuate widely. The accumulation of costs (including vessel construction costs) and earnings data would aid in determining which factors contribute significantly to this variation and thus help industry make wise managerial decisions. It would also supply needed economic information which could be incorporated into the decision making process of a regional management program. (E-5)

6. *Fishery development of underutilized species and diversification of the fleet*—Fish, including large numbers of sciaenids, are taken by the gear presently in use and deep water species, such as the royal red shrimp, are not being utilized to their fullest potential. Management can reveal to the industry, through available information, stocks of potential importance and recommend how these might be utilized. Management might also work with other agencies or processors to initiate utilization of potentially valuable species. (E-6)

7. *Lack of information on marine recreational fisheries benefits*—Recreational shrimping will probably continue to increase in popularity and may have an impact on commercial landings depending upon the natural mortality rates of shrimp. The development and demonstration of methodologies for measurement of recreational benefits are necessary so that they may be reflected in any determination of OY. (E-7)

8. *Maximum economic yield*—To determine cost and returns to fishing effort at the industry level. Data collected should be that necessary to calculate economic sustainable yield and open access equilibrium. Separate calculations should be made by species for inshore and offshore areas and size class of vessels. (E-8)

Social Problems

1. *Sociological information on the shrimp fishermen's communities*—Management of the Gulf shrimp fishery under OY or any other comprehensive management objective should include an adequate and documented knowledge of the social and cultural structures in the fishermen's communities, their preferences, traditions, values and lifestyles. This information is largely un-researched and in any case unrecorded for the Gulf shrimp fishery. (S-1)

2. *Delineation of user interest groups*—Several different user groups in the Gulf are involved with the shrimp resource in different ways. These differences many times lead to competition or conflict over use of the resource. Generally, vessels operating offshore take larger

shrimp for freezing, while boats operating inshore take smaller shrimp for canning. These users and their operations must be described before their interests can be taken into account in a management plan. (S-2)

3. *Labor force statistics*—Since the Gulf shrimp industry is based upon a seasonal harvest, special needs and problems arise for the industry's labor force. Labor force statistics such as size, composition, residence patterns, employment skills, migration patterns, occupational mobility and others are not well documented. This information is necessary to predict the impact on the harvesting, product flows and fishermen's communities which may result from alternative local or regional management options. (S-3)

4. *Political and legal problems in Gulf regional management*—A regional plan will most probably be initiated through existing political and legal structures. Working with these structures will involve familiarity with jurisdictional problems, conflicting laws and regulations and traditional working relationships. Without knowledge of these political and legal systems, management may be based on misinformation, uninformed opinion or historical perceptions which create artificial and unnecessary impediments to cooperation and coordination. (S-4)

Environmental Problems

1. *Effects of habitat alteration on penaeid shrimp populations*—Changes in estuarine and offshore habitats through oil exploration, pollution, river controls, dredge and fill activities, industrial and farm drainage and fresh water usage have altered nursery area available to penaeid shrimp. Without effective coastal zone management to supervise future development of coastal areas, loss of nursery areas is likely to continue; consequently production losses may be experienced. (En-1)

Administrative Problems

1. *Formal system of information collection and display for monitoring and reviewing the effects of management policies, decisions and implementation*—With a system as complicated as the Gulf shrimp fishery, many of the effects and ramifications of management alternatives and actions, both beneficial and adverse, may go undetected or uncommunicated in the absence of a formal mechanism for their display. (A-1)

2. *To determine the effects of discarding undersized shrimp*—In states that have a minimum size limit on shrimp, vessel operators will discard undersized shrimp and keep those which make the count. The discard may be substantial depending on the season. (A-2)

3. *To determine the effects of unrestricted entry*—Shrimpers have no ownership rights over the shrimp resource; thus entry into the fishery is unlimited. Displaced U. S. fleet fishing foreign waters will increase effort on domestic territories. An unrestricted fishery will move to a level of effort at which total costs equal total

income. Investments into vessels and equipment will exceed an optimum level creating economic stress on the harvesting sector of the industry. (A-3)

4. *Limited jurisdiction*—States have jurisdiction over territorial waters; however, problems frequently arise because each of the states has its own set of fishing laws and regulations. Without the coordination of a state-regional management plan these problems cannot be overcome. (A-4)

5. *Lack of adequate coordination and communication among data gathering and analysis programs*—Despite many attempts to coordinate various activities of data gathering and analysis, coordination and communications have not been adequate to eliminate unnecessary duplication of efforts among groups interested in shrimp fisheries of the Gulf. For this reason efforts have been diluted and less effective. (A-5)

6. *Optimum yield*—In order to more adequately manage the shrimp resources of the Gulf of Mexico it is necessary to determine OY involving biological, sociological and economic factors. (A-6)

Other Problems

1. *Need for measuring the change in efficiency of fishing craft in the Gulf of Mexico shrimp fishery*—Improvements in fishing vessels and gear have influenced effective fishing effort. This influence has not been sufficiently accounted for in available measures of fishing effort. This is required to express measurements of fishing effort, in the entire time series, in comparable or standardized units. (O-1)

2. *Convert pertinent biological and environmental data to an accessible computerized form*—Development of a regional management plan would be aided by a coordinated assimilation of data relative to the shrimp fisheries which would be readily available to all concerned and at little or no cost to the user. Part of this effort would entail the identification and possible computerization of available time-series data on shrimp, shrimp environments and associated species. Data amenable to such computer analysis would be processed and stored in data banks available to all users, on a timely basis. (O-2)

3. *Identification of jurisdictional boundaries*—There is an enforcement problem within the territorial waters of the Gulf states near the vicinity of state lines because these boundaries are not determined in many cases. (O-3)

4. *Examination of the problems associated with adequate law enforcement programs*—Effective law enforcement is a problem because of understaffed enforcement agencies, lack of local court convictions and an uninformed public. A study is required to understand how these factors interact so that enforceable laws can be maintained. (O-4)

5. *Need for locating and marking underwater obstructions and determining their impact on the shrimp*

industry—Unmarked obstructions on the shrimping grounds of the northern Gulf cause serious damage to shrimping operations. Equipment loss and downtime annually cost boat operators considerable income. An accurate system of marking obstructions as they occur is necessary to alleviate this problem. (O-5)

PRESENT MANAGEMENT SYSTEM

Shrimp fishery data have been collected along the Gulf of Mexico in one form or another since about 1880. The systems in the various states have been based on available biological knowledge tempered by sociological inputs. Managers have been pressured by conflicting interests in various segments of the harvesting sector particularly since the inception of the offshore fishery. Inadequate catch and effort statistics, fluctuating markets, gaps in life history data and well meaning but often disabling legislation have further handicapped the managers.

Despite these handicaps, the resource remains healthy as evidenced by a general upward trend in reported landings and continued existence of a large recreational fishery in which the landings are largely unreported.

The fishery has generally been economically sound; however, large increases in fuel costs, construction costs, inflation in general and a dropping catch per unit effort (CPUE) have begun to erode the economic base of the fishery. Overcapitalization and a return to the domestic fishery by vessels from foreign waters for various reasons were not matched by as correspondingly large an increase in shrimp prices until mid-1975.

The general objectives of the present state management systems have been to protect the resource and maximize catch among the various user groups. Regulation of the size of harvestable shrimp has increased the economic return but has also led to needless wastage due to the discarding of undersized shrimp. Currently most States regulate the harvestable size by opening and closing of seasons; however, enforcement of regulations has always been a problem.

The fishery has principally been managed within the several Gulf States with little communication between the States until the inception of the Gulf States Marine Fisheries Commission (GSMFC) in 1949. Since that time the GSMFC has been able to resolve some differences between the various States, recognizing that the resource itself is not cognizant of State boundaries. The GSMFC has no regulatory power and reluctance by State legislatures to yield authority within their State boundaries has hampered implementation of a regional approach to management of the shrimp resource. A synoptic review of the States' management structures and other features pertinent to the Gulf shrimp fishery are presented in Table 2.

The Florida agency charged with the administration,

supervision, development and conservation of the natural resources is the Department of Natural Resources which is headed by an Executive Director. Within the Department there exists the Division of Marine Resources whose duties include the preservation, management and protection of marine fisheries and the regulation of all fishing operations in the State and of its citizens engaged in fishing activities within and without the State. There does not exist any separate board or commission of natural resources or conservation in Florida, and the Governor and the Cabinet sit as a board which approves all rules and regulations promulgated by the Director of the Department. The Division of Law Enforcement is responsible for enforcement of all rules and regulations of the Department.

The administrative organization of the State of Alabama with respect to coastal fisheries begins with the Department of Conservation and Natural Resources, which is headed by a Commissioner appointed by the Governor. He is advised by Division Directors and a citizens Conservation Advisory Board. The Advisory Board consists of certain State officers, ex-officio and gubernatorial appointees. In general, the Commissioner will consult with the Advisory Board and secure the Board's approval concerning the promulgation of rules and regulations which involve controversial issues. Within the Department there exists a Division of Marine Resources which has jurisdiction over marine fisheries matters with approval by the Commissioner. The Division has two sections; one concerning enforcement and the other, marine biology.

The administrative organization of the State of Mississippi with respect to coastal fisheries is the Mississippi Marine Conservation Commission. The Commission consists of 13 members, 9 of whom are appointed by the Governor. The remaining 4 are directors of the following agencies: Boat and Water Safety Commission, Marine Resources Council, Gulf Coast Research Laboratory and State Board of Health. The Commission is headed by a director hired by the Commission and has full power to manage, control, supervise and direct any matters pertaining to all salt water aquatic life not otherwise delegated to another agency.

The Department of Wildlife and Fisheries is one of 21 major administrative units of Louisiana State government. The Secretary of Wildlife and Fisheries is "the executive head and chief administrative officer of the department" and has "sole responsibility for the policies of the department and for the administration, control and operation of the functions, programs and affairs of the department." The Secretary is appointed by the Governor with consent of the Senate and serves at the Governor's pleasure. The Secretary may be advised by a seven member board, the Louisiana Wildlife and Fisheries Commission, which exercises control and supervision of the wildlife of the State, including all aquatic life.

TABLE 2.
State management systems—selected laws and regulations.

	Florida	Alabama	Mississippi	Louisiana	Texas
Administrative Organization	Department of Natural Resources, Division of Marine Resources	Department of Conservation and Natural Resources, Division of Marine Resources	Mississippi Marine Conservation Commission	Louisiana Department of Wildlife and Fisheries	Parks and Wildlife Department, Fisheries Division, Branch of Coastal Fisheries
Legislative Authorization	Chapter 370: Florida Statutes Annotated. Allows for local laws and "General Bills of Local Application."	Title 8, 1940: Code of Alabama. All statutory laws concerning fisheries.	Chapter 15: Article I, Mississippi Code of Statutes, annotated. Some statutes concerning fisheries.	Louisiana Constitution, Article VI, Section I. Some statutes concerning fisheries.	"Uniform Wildlife Regulator Act" (Vernon's Ann. P.C. Art. 978j-1). Two counties are excluded.
Regulations	Most are statutory provisions, little flexibility within the Management Agency.	Statutory and considerable flexibility within the Management Agency.	Statutory and considerable flexibility within the Management Agency.	Most are statutory with some flexibility within the Management Agency.	Most are statutory with little flexibility within the Management Agency—complicated by "County Option" system.
Reciprocal Agreements	Limited to fishery access, may not extend to Management Agreements.	Limited to fishery access, may not extend to Management Agreements.	Possible in all areas of fishery access, research and management	Limited to fishery access.	No statutory provisions.
Legal Count Size (heads-on)	47/lb all areas.	68/lb all areas.	68/lb all areas.	68/lb on white shrimp in Fall season only. No count on brown shrimp after November 15.	No count during spring season. 39/lb during other seasons.
Limited Entry	No provisions.	No provisions.	No provisions.	Provisions are available under the law.	No provisions.
Data Reporting Requirements	Processors and bait shrimp dealers must report statistics monthly.	No provisions.	Vessel captain must report: catch/species, area and depth fished, number of hours fished and size of shrimp. Out-of-state vessels must report catch of each trip. Bait dealers must keep daily records on sales.	Processors and wholesale dealers maintain records of date, quantity and point of origin of each lot of shrimp received, from whom purchased and to whom sold.	Monthly reports by dealers.

Within the administrative system, an assistant secretary is in charge of the Office of Coastal and Marine Resources. In this office, the Seafood Division, headed by the Division Chief, performs "the functions of the State relating to the administration, operation and law enforcement of programs, including research, relating to oysters, water-bottoms, and seafoods, including but not limited to the regulation of the oyster, shrimp and marine fishing industries; . . . the control of the shrimp fishery and shrimp industry of the state; and the licensing of persons engaged therein . . .".

The Texas Parks and Wildlife Department which is governed by a Commission, has responsibility for fisheries management in Texas waters. The Commission appoints an Executive Director who serves as the chief executive officer of the Department. Within the Department there exists the Fisheries Division and within that Division,

the Branch of Coastal Fisheries.

The Commission has authority to establish all rules and regulations permitted by statute concerning coastal fisheries within its jurisdiction. The Director and the remainder of the Department staff are concerned with the development of recommendations for regulations, and with their enforcement.

By comparing the laws and regulations of the several States, similarities and differences may be noted. For example, the heads-on legal count size of shrimp varies considerably among States. Alabama and Mississippi both have 68/lb in all areas for brown and white shrimp. Florida has a 47/lb count in all areas, and Louisiana and Texas do not have a count size during the spring season. Louisiana has a 68/lb count on white shrimp during the fall season; and from the opening of the fall season to November 14, a 68/lb count is in effect on brown shrimp.

Texas limits daily catch in inshore waters during the spring open season when there is no size limit, and has a 39/lb minimum size limit on other seasons and areas.

DESCRIPTION OF THE RESOURCE AND FISHERY

Introduction

The shrimp fishery of the United States Gulf of Mexico depends on production of three species of closely related shallow water shrimp for over 98% of the harvested weight. Brown, pink and white shrimp all belong to the genus *Penaeus*. Relatively small quantities of seabob, rock shrimp, sugar* shrimp and royal red shrimp are caught in the fishery.

Catch data are published by National Marine Fisheries Service in two forms. Reported landings data give, by State, volume (round weight) and value. Gulf Coast Shrimp Data, collected since 1956, provide data by species and size (number of tails per lb), by statistical area, depth, trips and fishing time. (Unless otherwise noted, weights in this summary are heads-off lbs.)

There are wide fluctuations of reported landings (Table 3) of all species. From 1956 through 1974, reported catches of brown shrimp averaged 65.1 million lbs ranging from 39.2 million lbs in 1961 to 100.9 million lbs in 1967. Reported white shrimp landings averaged 31.5 million lbs ranging from 11.1 million lbs in 1956 to 47.1 million lbs in 1963. There is an upward trend in reported catches of both species. Average pink shrimp production was 20.6 million lbs. The high occurred in 1956 at 29.0 million lbs and fell to a low of 12.8 million lbs in 1971.

Reported landings of other species, though relatively low, are locally important. Rock shrimp production landed in Florida has a very short history but wide annual changes are evident. It is not clear whether fluctuating prices are major factors in variability of landings. Seabob, landed principally in Louisiana, produced about 4 million lbs in 1975. Sugar shrimp occur principally in the bait fishery.

Royal red shrimp is a deep-water resource. Landings were first reported as 5,233 lbs in 1962 with a high of 230,794 lbs in 1973.

The Task Force examined the extensive literature on Gulf of Mexico shrimp, citing 177 papers and reports in summarizing available data to describe the extremely complex resource and fishery.

Distribution

Shallow-water shrimp in the U. S. Gulf of Mexico occur primarily on the continental shelf inside 60 fathoms (110 m) (Figure 4). The highest concentrations of brown

shrimp, as indicated by annual average catch per unit area, occur off the Texas coast with high catches extending eastward to waters off Alabama.

High white shrimp concentrations occur in shallower waters over most of the same area with highest catches being taken off Louisiana west of the Mississippi River delta. Pink shrimp concentrations are high south of Apalachicola off the Florida west coast. Catches are highest in the relatively small area of the Tortugas grounds. Inshore catches of brown and white shrimp are concentrated in the north central Gulf between Mobile Bay and Galveston Bay. Relatively few pink shrimp are taken from inshore waters.

Though shallow water shrimp are caught out to 60 fathoms (110 m), the majority of the reported catch is taken within 25 fathoms (45 m). The greatest portion of the reported offshore catch of brown shrimp is taken in 11–20 fathoms (20–37 m), that of white shrimp in less than 5 fathoms (9 m) and that of pink shrimp in 11–15 fathoms (20–27 m).

Life History

In general, shallow water shrimp follow the life history cycle of most estuarine dependent species (Figure 5). Spawning occurs offshore in the relatively stable open Gulf environment. Planktonic larvae complete metamorphosis to postlarvae and are carried by currents to inshore nursery areas, where they grow very rapidly. As maturation approaches, young adults migrate offshore to spawn.

Postlarval brown shrimp enter Texas waters throughout the year with peaks occurring between February and May and between July and October. The spring peak is dominant. In Louisiana, postlarval immigration to nursery areas usually begins in January with peak movement in March or April. East of the Delta immigration usually starts about a month later. In the north central Gulf area, postlarval movement inshore usually stops in November.

White shrimp postlarvae reach estuaries when 6 to 7 mm long. Immigration usually begins in May with two peaks occurring from summer to fall in Texas waters. The movement of white shrimp postlarvae into Louisiana, Mississippi and Alabama nurseries occurs from June through September. Pink shrimp postlarvae enter south Florida waters throughout the year but peaks of abundance vary from year to year.

In general, the supply of postlarvae entering estuaries is adequate. Their success depends on conditions in the nursery. The effects of temperature and salinity seem to depend on each other. Low salinity and low temperature may be fatal. Growth is slow when water temperature is below 20°C. Excessive fresh water during critical periods may reduce the area of useful nurseries and the subsequent harvestable crop.

Distributions of the young of the less abundant species

*Sugar shrimp include two species (*Trachypenaeus similis* and *T. constrictus*) that do not have well established common names.

TABLE 3.
Landing statistics for brown, white and pink shrimp (heads-off) in the Gulf of Mexico
in thousands of pounds and percentage of the catch from 1956 to 1974.

Year	Florida (West Coast)						Alabama						Mississippi					
	Brown Shrimp Lbs. (10 ³)	%	White Shrimp Lbs. (10 ³)	%	Pink Shrimp Lbs. (10 ³)	%	Brown Shrimp Lbs. (10 ³)	%	White Shrimp Lbs. (10 ³)	%	Pink Shrimp Lbs. (10 ³)	%	Brown Shrimp Lbs. (10 ³)	%	White Shrimp Lbs. (10 ³)	%	Pink Shrimp Lbs. (10 ³)	%
1956	557.0	02	617.4	02	28,013.4	96	3,067.8	67	1,249.9	27	261.9	06	6,095.4	70	2,355.6	27	200.4	02
1957	707.1	03	881.2	04	23,155.8	93	2,993.8	83	410.4	11	188.3	05	5,673.8	81	957.1	14	354.3	05
1958	1,024.0	04	1,573.4	06	24,539.4	90	2,261.5	72	829.2	26	68.9	02	2,973.0	65	1,512.6	33	103.8	02
1959	953.3	05	755.2	04	17,352.7	90	3,795.4	80	974.3	20	2.2	*	5,457.8	73	1,894.2	25	168.9	02
1960	688.2	03	1,325.6	05	24,305.1	92	3,355.3	79	856.2	20	52.7	01	4,997.4	76	1,519.5	23	49.2	01
1961	308.0	01	639.3	03	20,397.2	95	1,718.4	82	236.0	11	144.0	07	2,291.6	87	218.1	08	113.8	04
1962	579.7	03	468.1	02	18,999.7	94	1,825.2	78	490.7	21	33.5	01	2,760.2	72	1,047.7	27	20.7	01
1963	499.2	02	777.4	04	20,580.5	94	3,515.4	72	1,308.8	27	53.0	01	3,775.9	64	1,972.8	33	160.9	03
1964	498.3	02	1,336.8	05	23,140.5	92	2,847.1	63	1,624.2	36	81.1	02	2,874.7	71	1,127.6	28	32.1	01
1965	1,048.7	04	1,037.6	04	21,452.7	91	4,823.0	80	1,150.7	19	54.0	01	4,151.1	81	978.1	19	22.4	*
1966	1,094.0	06	555.0	03	16,332.5	90	5,825.8	88	776.6	12	20.4	*	3,888.5	82	804.0	17	38.4	01
1967	1,433.4	10	530.1	04	12,637.9	86	7,684.4	85	1,101.5	12	236.6	03	5,258.3	88	593.0	10	153.5	03
1968	1,686.9	10	847.2	05	14,465.6	85	8,388.1	87	939.9	10	281.5	03	5,780.7	91	378.8	06	187.1	03
1969	799.6	06	1,181.0	08	12,265.9	85	6,673.9	71	2,511.4	27	206.3	02	4,021.3	72	1,224.5	22	340.3	06
1970	856.8	05	1,218.9	07	14,527.7	87	6,710.0	71	2,536.0	27	201.5	02	4,795.7	80	1,127.8	19	87.4	01
1971	1,141.4	08	1,017.8	07	11,361.0	84	8,294.8	79	2,075.5	20	96.5	01	4,961.9	84	816.2	14	147.9	02
1972	1,027.0	07	637.5	04	12,155.4	85	9,398.0	86	1,338.4	12	223.1	02	4,243.3	87	460.9	09	149.6	03
1973	339.3	02	487.3	03	14,860.0	91	5,328.0	71	1,460.9	19	605.3	08	1,683.5	75	416.3	18	145.5	06
1974	697.0	04	711.2	04	14,865.8	84	5,944.0	68	1,935.9	22	594.2	07	2,676.9	81	343.2	10	241.3	07
Mean	838.9		873.6		18,179.4		4,971.0		1,253.0		179.2		4,124.3		1,039.4		143.0	
	Louisiana						Texas						Totals					
1956	12,123.2	40	17,131.6	57	0.8	*	33,139.7	90	3,135.7	08	496.3	01	55,023.1	50	24,490.2	22	28,972.8	26
1957	11,120.1	62	6,581.7	37	0.1	*	43,136.2	94	2,298.5	05	138.9	*	63,631.0	64	11,128.9	11	23,837.4	24
1958	8,324.2	35	14,454.8	61	9.9	*	36,669.9	82	7,369.8	17	294.4	*	51,252.6	50	25,739.8	25	25,016.4	24
1959	16,143.5	48	15,172.2	45	1.5	*	43,438.5	86	5,779.3	11	938.0	02	69,788.5	61	24,575.2	21	18,463.3	16
1960	18,933.3	52	16,365.3	45	9.8	*	37,922.3	78	8,314.9	17	2,094.6	04	65,896.5	54	28,381.5	23	26,511.4	22
1961	10,501.3	57	6,492.1	35	11.4	*	24,333.9	70	6,862.8	20	3,416.3	10	39,153.2	49	14,448.3	18	24,082.7	30
1962	11,773.2	42	14,136.5	51	6.5	*	24,478.7	69	7,021.8	20	3,025.1	09	41,417.0	46	23,164.8	26	22,085.5	25
1963	16,884.2	33	34,119.1	66	7.7	*	31,305.9	71	8,908.7	20	3,380.3	08	55,980.6	44	47,086.8	37	24,182.4	19
1964	10,011.4	26	27,800.3	73	-	-	25,929.8	62	12,089.1	29	3,553.4	09	42,161.3	37	43,978.0	39	26,807.1	24
1965	18,052.4	45	21,192.1	53	7.5	*	34,335.7	71	9,240.0	19	4,635.9	10	62,410.9	51	33,598.5	27	26,172.5	21
1966	19,210.9	49	19,929.7	50	8.2	*	33,949.7	78	7,851.8	18	1,972.4	05	63,968.9	57	29,917.1	26	18,371.9	16
1967	30,977.1	65	16,315.8	34	24.5	*	55,550.4	87	6,418.6	10	2,220.8	03	100,903.6	71	24,959.0	18	15,273.3	11
1968	25,985.1	61	16,279.9	38	8.5	*	37,040.6	71	12,472.1	24	2,697.5	05	78,881.4	62	30,917.9	24	17,640.2	14
1969	24,199.0	46	27,883.4	53	14.2	*	30,103.7	68	11,959.9	27	2,347.3	05	65,797.5	52	44,760.2	35	15,174.0	12
1970	26,975.6	47	28,698.3	50	29.7	*	41,596.2	75	12,381.4	22	1,428.7	03	80,934.3	56	45,962.4	32	16,275.0	11
1971	29,367.8	50	29,004.8	49	63.2	*	44,099.0	81	9,150.0	17	1,094.1	02	87,864.9	61	42,064.3	29	12,762.7	09
1972	27,090.4	51	24,091.6	46	105.9	*	48,295.5	79	11,388.8	19	1,411.8	02	90,054.2	63	37,917.2	26	14,045.8	10
1973	18,073.6	48	16,846.0	45	45.8	*	33,493.0	65	14,944.9	29	2,341.2	05	58,917.4	51	34,155.4	30	17,997.8	16
1974	17,551.8	46	16,876.3	45	20.2	*	35,551.4	72	11,506.0	23	1,426.4	03	62,421.1	53	31,372.6	27	17,147.9	15
Mean	18,594.6		19,440.6		19.8		36,547.9		8,899.7		2,048.1		65,076.7		31,506.2		20,569.5	

* less than 1%

- no reported catch

Source: *Fishery Statistics of the United States*, NMFS

are not as well documented. Seabobs off Louisiana and Texas complete their life cycle within a narrow zone near the shoreline. Very little is known about the distribution of postlarval rock shrimp. Sugar shrimp are most abundant at 10 fathoms (18 m) in summer and at 20 fathoms (37 m) in winter, and apparently spawning occurs at all seasons. The early life history of royal red shrimp is unknown.

Juvenile brown shrimp remain in the nursery for

varying periods of time depending on location around the coast and condition in the estuary. Offshore movement at 70–80 mm total length has been reported in Texas. In Louisiana young brown shrimp move to open bay staging areas when 60–70 mm long and the movement offshore consists of shrimp 90 to 110 mm long.

White shrimp juveniles penetrate rivers and tributaries farther than brown or pink shrimp, are usually found in

SUMMARY GULF SHRIMP MANAGEMENT PLAN

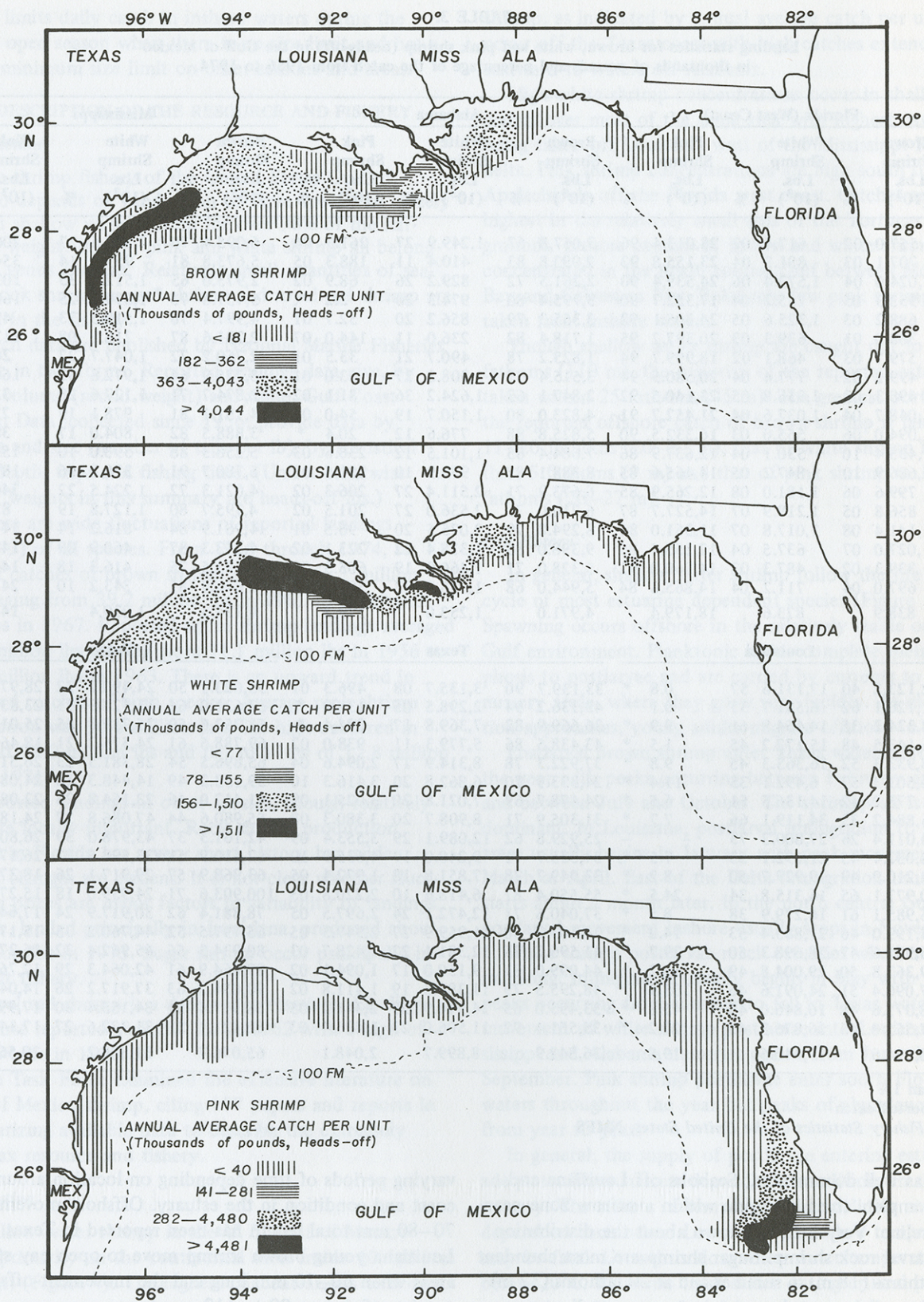


Figure 4. Distribution of reported offshore catches of brown, white and pink shrimp in the Gulf of Mexico, 1959-1963 [adapted from Shrimp Atlas GCF Circular 312; a unit represents the combination of one statistical area and one 5-fm (9 m) depth stratum].

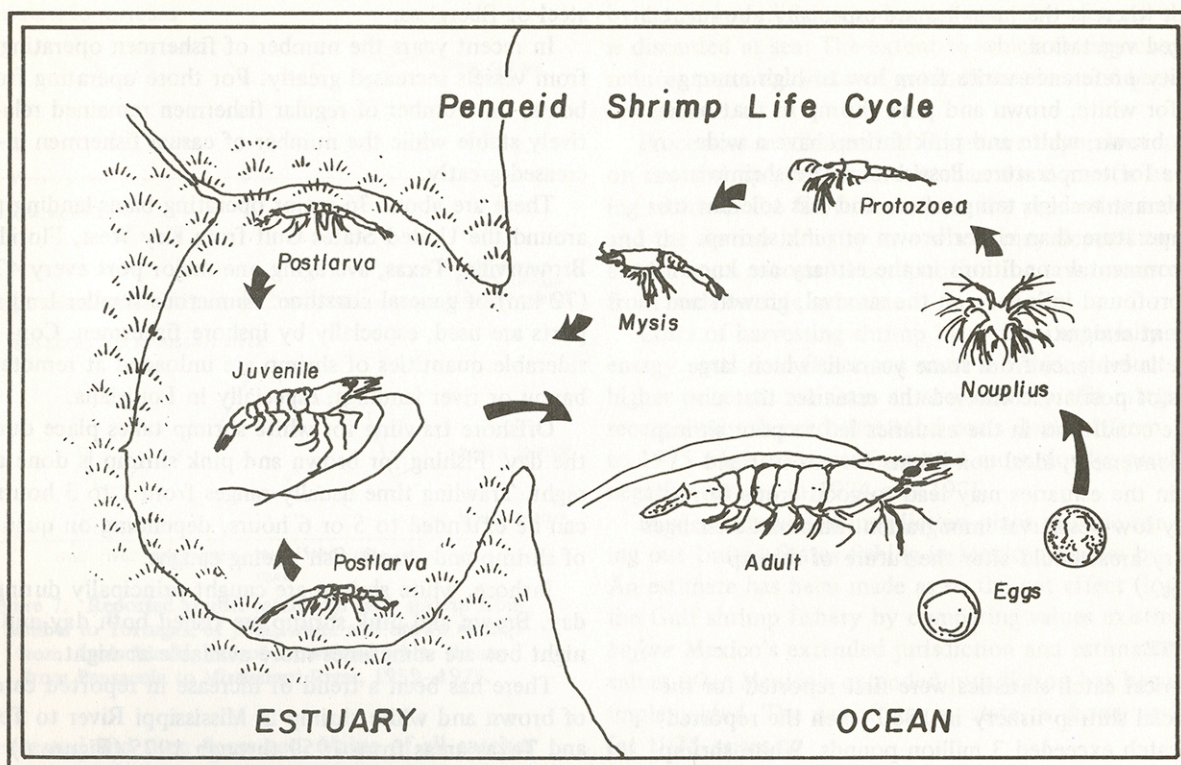


Figure 5. Diagram of life cycle of brown, white and pink shrimp.

lower salinities and remain inshore until they are larger. Young white shrimp begin migration to offshore waters when they are 100 to 120 mm long although smaller shrimp emigrate in the winter and may return when water temperature rises.

It has been estimated that pink shrimp remain inshore 2 to 6 months and begin their seaward movement at about 85 mm from May through July.

In addition to the inshore and offshore migrations, brown shrimp may move along the shore. A westerly drift of brown shrimp along the Louisiana coast has been demonstrated.

Offshore migration of white shrimp seems to comprise random feeding movements to 100 mi (160 km) or more. Some inshore-offshore movements occur in response to changes in temperature. There is evidence that white shrimp may move south from the lower Texas coast into Mexican waters in the fall and winter and back toward Texas in the summer.

There is some evidence that female shrimp may spawn more than once. Maximum numbers of nearly ripe or ripe eggs per female pink shrimp have been estimated at more than 600,000. Scattered estimates of the number of eggs per female have been made for brown and white shrimp but the relation between fecundity and shrimp size has not been determined for these species. Such high fecundity with the possibility of multiple spawnings shows a tremendous biotic potential for these shrimp. It has been

hypothesized that recruitment of young to the fishery bears little, if any, relationship to the number of spawners. Environmental factors affecting survival and successful distribution of the young are more important than the number of eggs spawned. No parent-progeny relationship has been established.

Growth rates are most rapid at smaller sizes. Female shrimp grow more rapidly and reach larger sizes than males. The rate of growth of shrimp varies seasonally with changes in water temperature but this is not well documented for wild stocks of shrimp. It has also been suggested that population density in the estuary affects growth rate.

Mark-recapture experiments have determined that some shrimp live at least 27 months but the bulk of the reported catch is made up of shrimp less than 1-year old. Shrimp are capable of reaching maturity, copulating and spawning within 1-year of hatching; therefore the shrimp crop is an annual one.

Habitat

Brown shrimp adults show a definite preference for mud and silt bottoms and juveniles show a preference for muddy sand, sandy mud or peat bottoms, especially in areas covered with vegetation and plant debris. Adult white shrimp have substrate preferences similar to brown shrimp but juvenile white shrimp prefer softer bottoms. Adult pink shrimp prefer sand, sand-shell and coral-mud

bottoms, whereas the juveniles are especially abundant in submerged vegetation.

Salinity preference varies from low to high among species for white, brown and pink shrimp in that order. Juvenile brown, white and pink shrimp have a wide tolerance for temperature. Postlarval white shrimp are more tolerant to high temperature and less tolerant of low temperature than either brown or pink shrimp.

Environmental conditions in the estuary are known to have a profound influence on the survival, growth and subsequent emigration.

There is evidence from some years in which large numbers of postlarvae entered the estuaries that unfavorable conditions in the estuaries led to poor shrimp crops. Conversely, ideal conditions for survival and growth in the estuaries may lead to good crops from relatively low postlarval immigration. Man-made changes in nursery areas could alter the future of shrimp resources.

The Fishery

Historical catch statistics were first reported for the commercial shrimp fishery in 1880 when the reported annual catch exceeded 3 million pounds. White shrimp accounted for most of the catch until discovery of major concentrations off Texas and market acceptance of brown shrimp in 1947. Pink shrimp were discovered on the Dry Tortugas grounds in 1949. (Table 3 shows percentage of annual Gulf catches for brown, pink and white shrimp since 1956.)

Three types of fishing have developed:

1. Non-commercial—composed of large numbers of sport fishermen taking shrimp principally for personal use from shallow coastal waters.
2. Commercial bait fishery—comprising professional fishermen taking shrimp, almost exclusively in inshore waters, for the purpose of supplying bait (live and dead) to recreational fishermen.
3. Commercial food—shrimp fishery representing the core of the Gulf shrimp industry and composed of large numbers of professional fishermen who traditionally fish either inshore or offshore.

Otter trawls are used almost exclusively in the shrimp fishery. Most offshore vessels are double-rigged but boats fishing inshore waters are generally restricted to pulling one trawl. An increasing catch is now being taken from Louisiana inshore waters with butterfly (wing) nets.

The classification used by NMFS identifies shrimp boats as less than 5 net registry tons, and vessels as 5 net tons or larger. Boats and vessels used in the inshore fishery generally do not exceed 40–50 feet in length.

Increasing numbers of smaller boats are being used in the inshore fishery. Current trends in the Gulf shrimp vessel fleet are towards larger trawlers made of aluminum,

steel or fiberglass.

In recent years the number of fishermen operating from vessels increased greatly. For those operating from boats, the number of regular fishermen remained relatively stable while the number of casual fishermen increased greatly.

There are about 36 major operating bases—landing ports around the United States Gulf from Key West, Florida to Brownsville, Texas, averaging one major port every 47 mi (72 km) of general coastline. Numerous smaller landing ports are used, especially by inshore fishermen. Considerable quantities of shrimp are unloaded at remote bayou or river landings, especially in Louisiana.

Offshore trawling for white shrimp takes place during the day. Fishing for brown and pink shrimp is done at night. Trawling time usually ranges from 1 to 3 hours but can be extended to 5 or 6 hours, depending on quantities of shrimp and "trash fish" being caught.

Inshore, white shrimp are caught principally during the day. Brown and pink shrimp are fished both day and night but are sometimes more available at night.

There has been a trend of increase in reported catches of brown and white shrimp in Mississippi River to Texas and Texas areas from 1959 through 1975 (Figure 6) while reported shrimp catches in Apalachicola and Sanibel to Tortugas areas have remained relatively constant (Figure 7). During the same period, reported catches of brown and white shrimp in the Pensacola to Mississippi River

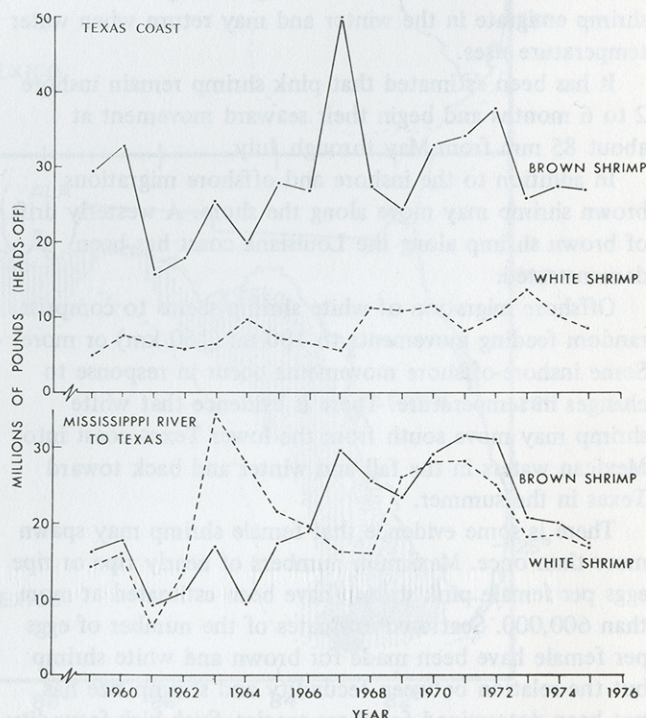


Figure 6. Reported annual catches of brown and white shrimp from Texas coast and Mississippi River to Texas, 1959–1975.

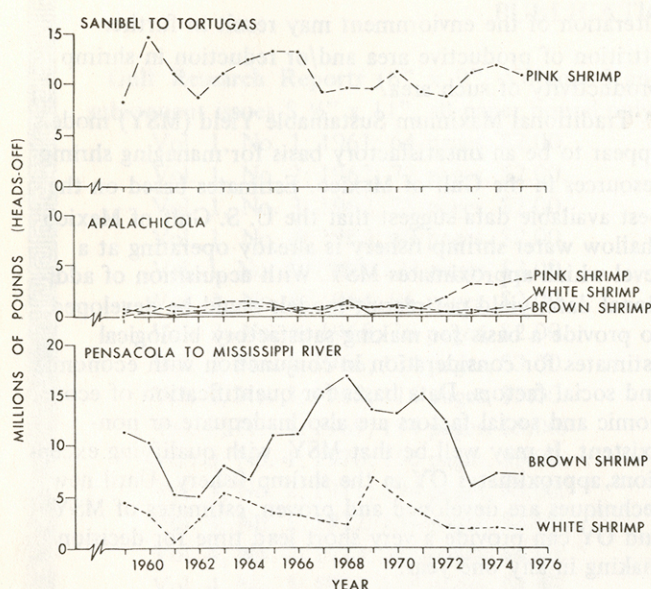


Figure 7. Reported annual catches of pink shrimp from Sanibel to Tortugas, of pink, white and brown shrimp from Apalachicola, and of brown and white shrimp from Pensacola to Mississippi River, 1959-1975.

area increased and then decreased. Value of all catches has increased. In 1976 the exvessel value of the reported shrimp catch (129 million lbs) in the Gulf States was \$267 million.

Offshore reported catches averaged 2.8 times as great as the inshore reported catches from 1963 through 1975. Both brown and white shrimp inshore fisheries reported highest catches in areas along the Louisiana coast west of the Mississippi River delta. There is usually close correlation each year between inshore and offshore reported catches in the same region. Inshore reported catches of pink shrimp are relatively low and the annual inshore-offshore relationship within regions is not evident.

Species and size composition of annual reported catch have remained relatively stable except in the Apalachicola area where the percentage of pink shrimp in reported catches has increased.

Reported effort has increased dramatically over the years. However, changes in relative efficiency and fishing power have not been taken into consideration, so the real change in fishing effort exceeds that depicted by reported effort. When increases in fishing power are considered there has been a downward trend in catch per unit of effort in the offshore fishery. However, there is no evidence that these declines represent a trend of biological overfishing; rather they are believed to reflect the distribution of catch among ever increasing numbers of fishing units with ever increasing fishing power.

By-catch from shrimping operations includes large quantities of many species. Aside from occasional food fishes taken for home consumption or for sale, the

by-catch, including an unknown quantity of small shrimp, is discarded at sea. The extent to which this by-catch reduces potential yield of groundfishes has not been determined.

Processors in all the Gulf States are dependent in part on raw shrimp products other than the domestic harvesting sector in the Gulf. Growth in the processing industry and the shrimp industry as a whole may depend to a large extent upon successful competition for raw resources from such outside sources.

Costs of harvesting shrimp have risen, especially the energy costs, and fishermen must sell their product at higher prices to maintain an acceptable profit margin. A recent study showed that total costs doubled from 1971 to 1975 while revenues increased more slowly, producing negative returns in 1974 and 1975.

Mexico's extended jurisdiction plans provide for phasing out United States fishing in Mexican waters by 1980. An estimate has been made as to the net effect (loss) on the Gulf shrimp fishery by comparing values existing *before* Mexico's extended jurisdiction and estimates of values *after* Mexico's extended jurisdiction has been fully implemented. The net effect, by state, is shown as follows (at 1975 prices):

State	Millions of Pounds	Millions of Dollars
Florida	-0.72	-1.44
Alabama	-0.43	-0.87
Mississippi	-0.16	-0.24
Louisiana	-1.07	-1.77
Texas	-2.22	-6.24

In addition, the estimated total impact (loss) on each state's economy has been calculated using the appropriate value added multipliers (3.08 for Texas and 3.4 for the other states).

State	Millions of Dollars
Florida	-4.9
Alabama	-2.96
Mississippi	-0.82
Louisiana	-6.02
Texas	-19.19
Total	-33.89

The above estimates (at 1975 prices) assume that the effort diverted from Mexico is uniformly distributed and that no adjustment is made for seasonality of harvesting.

The main area of concern for social characteristics of the shrimp fishery relates to the three major categories of fishing: non-commercial, commercial bait and commercial food shrimp fishing along with differences in inshore and offshore fishing. The non-commercial category of fishermen is increasing rapidly and, presumably, is taking an

increasing portion of inshore and near offshore catches. Commercial bait shrimping is relatively stable as compared to commercial food shrimp fishing which is expanding. An increasing portion of the catch is probably being sold to the consumer by the harvesting sector. If this is true, processors and other intermediate handlers may become more dependent than they already are upon sources outside the Gulf States for their products.

The inshore resource supports very large, increasing recreational and commercial fishing sectors. Although the offshore fishery in Texas and Louisiana is expanding, it still represents a substantially smaller number of fishing units and fishermen than does the inshore fishery. This increasing fishing pressure on both inshore and offshore stocks cannot go unabated indefinitely. There is good evidence that economic overfishing has already occurred.

Man's effect on the coastal environment which produces the shrimp resource is another concern. Continued

alteration of the environment may result in further attrition of productive area and/or reduction in shrimp productivity of such area.

Traditional Maximum Sustainable Yield (MSY) models appear to be an unsatisfactory basis for managing shrimp resources in the Gulf of Mexico. Estimates based on the best available data suggest that the U. S. Gulf of Mexico shallow water shrimp fishery is already operating at a level which approximates MSY. With acquisition of additional data, yield per recruit models could be developed to provide a basis for making satisfactory biological estimates for consideration in conjunction with economic and social factors. Data bases for quantification of economic and social factors are also inadequate or non-existent. It may well be that MSY, with qualifying exceptions, approximates OY in the shrimp fishery. Until new techniques are developed and proven, estimates of MSY and OY can provide a very short lead time for decision making in any one year.

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