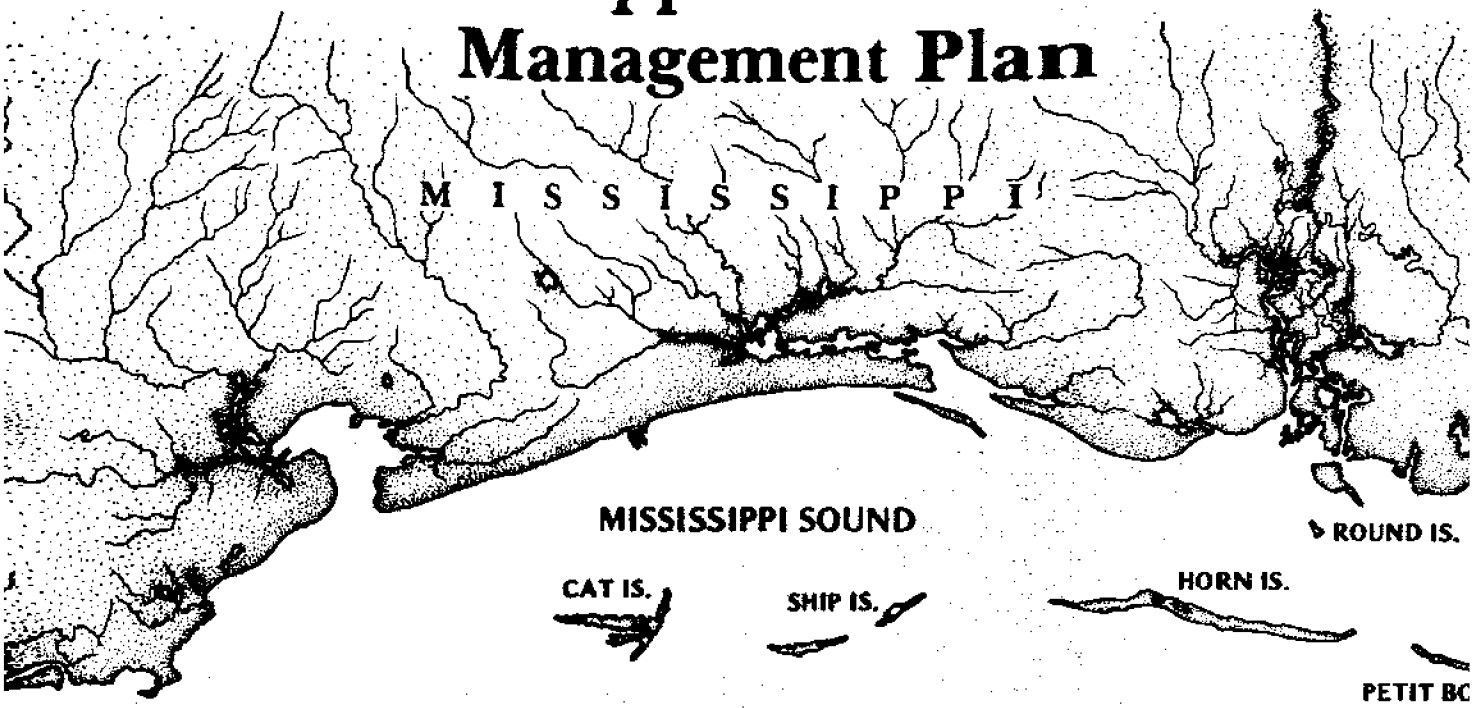
A Mississippi Marine Finfish Management Plan



MISSISSIPPI—ALABAMA
SEA GRANT CONSORTIUM

MASGP—78—046

A MISSISSIPPI MARINE FINFISH MANAGEMENT PLAN

edited by

David J. Etzold
University of Southern Mississippi
Hattiesburg, Mississippi 39401

and

J.Y. Christmas
Gulf Coast Research Laboratory
Ocean Springs, Mississippi 39564

This work is a result of research sponsored by NOAA Office of Sea Grant, Department of Commerce, under Grant #04-8-M01-92 and the Mississippi-Alabama Sea Grant Consortium. The U.S. Government is authorized to produce and distribute reprints for governmental purposes nothwithstanding any copyright notation that may appear hereon.

September 1979

Printed By Bloesman Printing, Incorporated, Ocean Springs, Mississippi

Preface

The Mississippi Marine Finfish Management Plan Working Group was established when the Mississippi-Alabama Sea Grant Consortium approved a proposal for development of a Proposed Mississippi Marine Finfish (selected) Management Plan (Project R-CP-1). Members of the Project Staff from Gulf Coast Research Laboratory and University of Southern Mississippi, Staff members of the Mississippi Marine Conservation Commission and Staff members of the Mississippi Sea Grant Advisory Service participated in the working group. The Working Group was comprised of the following:

J.Y. Christmas, Gulf Coast Research Laboratory
Dennis Chew, Mississippi Marine Conservation Commission
David Etzold, University of Southern Mississippi
Zach Lea, Sea Grant Advisory Service
Richard Leard, Mississippi Marine Conservation Commission
Tom McIlwain, Gulf Coast Research Laboratory
D.C. Williams, University of Southern Mississippi
David Veal, Sea Grant Advisory Service

In developing the contents of this plan and in writing this document, each member of the working group contributed in the area of his expertise, reviewed all draft material and participated in discussions that resulted in draft changes. Thus, any assignment of authorship must include all members of the working group.

Mississippi Marine Conservation Commission members kept abreast of plan development, selected the species to be considered for management, provided an Advisory Committee and reviewed the completed draft of the proposed plan. Commission members were as follows:

Wally H. Andrews
Ducre Bourgeois
Joe D. Brown
J.Y. Christmas
Joseph Gex
L.D. Gollot
Donn Murray
Bobby O'Barr
Mitchel Reeves
Mitchell Sevel, Jr.
J.E. Thomas
Glenn Williams

The *Ad Hoc* Advisory Committee participated in called meetings with the working group, reviewed draft material as it was developed and provided comments and advice throughout the plan development process. The twelve-member Advisory Committee, selected from the recreational fisherman, commercial fisherman, processor and consumer constituency was comprised of the following:

Mrs. Aileen Broome - Consumer - Jackson County
George Brumfield - Processor - Jackson County
Augustus Elmer - Recreational - Hancock County
Mrs. Eleanor Fleming - Consumer - Harrison County
David Frye - Recreational - Jackson County
Joseph Gill, Sr. - Recreational - Harrison County
Tommy Holzhauser - Commercial - Hancock County
Douglas Horn - Commercial - Jackson County
Wallace Jeanfreau - Processor - Hancock County

August J. Scafidi - Consumer - Hancock County
Michael D. Sevel - Commercial - Harrison County
Louis Suarez - Processor - Harrison County

Development of this plan provided for recommendation of specific strategic procedures. Identification of alternate regulatory needs, their evaluation and implementation are the function of the management entity selected by appropriate authorities to implement this plan.

This study was supported by a grant (Project R-CP-1) from Mississippi/Alabama Sea Grant Consortium. In addition, substantial contributions of time and effort not accounted for in the grant budget were provided by those participating in this plan development effort.

David J. Etzold
University of Southern Mississippi

J.Y. Christmas
Gulf Coast Research Laboratory

September 1979

The proposed finfish management plan completed under Sea Grant Project R-CP-1 was distributed to members of the Mississippi Marine Conservation Commission for review and consideration of adoption. In a duly constituted special session on June 27, 1979 the proposed plan was unanimously adopted and several revisions recommended by members of the Commission were unanimously accepted. Those revisions have been incorporated into the plan presented here.

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OVERVIEW

With increasing fishing pressure on Mississippi Gulf of Mexico finfish resources it is necessary to establish rational procedures for management if optimum yield from these resources is to be achieved. Rational management requires the formulation of management plans for each resource. Congress recognized these principles when, in 1976, U.S. jurisdiction in the Fishery Conservation Zone (FCZ - 200 mile limit) was established and management plan development throughout the range of each fishery in the FCZ was mandated. In this project an approved Mississippi Marine Finfish (selected species) Management Plan has been developed to provide for rational management of the State's marine finfish resources.

Mississippi's reported commercial landings of finfish and shellfish show a ten-year (1968-1977) average volume of 296.2 million pounds with a dockside average value of 14.9 million dollars. Marine finfish provided 96.5% of the volume and 60.5% of the value. The remaining production was comprised principally of shrimp, oysters and crabs. Industrial production (menhaden and bottomfish) accounted for 98.0% of the finfish volume and 84.2% of its value. Gulf menhaden (*Brevoortia patronus*) comprise over 97% of the number of fishes harvested by the menhaden fishery. Industrial bottomfish are harvested by trawls and include many species but Atlantic croaker, seatrout (sand and silver) and spot provide over 80% of the catch which is nearly all harvested in the FCZ.

Reported commercial landings of food fish (2.0% of volume and 15.8% of the value of finfish landings) include numerous species which are harvested by both recreational and commercial fishermen. A long-standing controversy between recreational and commercial fishermen who contend that they are competing for the same resources, has resulted in numerous claims and counterclaims which make rational management of these fisheries without a good management plan practically impossible.

Catch statistics for Mississippi's recreational fishery are limited to national surveys and a few local studies. None of these provides a satisfactory data base for rational management. It is clear that fishing success of Mississippi recreational fishermen is high. All available reports indicate that the recreational catch of favored target species generally exceeds reported commercial landings of these species. Since no license is required for Mississippi marine finfish recreational fishing, there is no historical data base for estimating recreational effort. However, national surveys and indirect indicators such as population increase, boat registration and personal observations of numbers of recreational fishermen and boats in Mississippi waters indicate that recreational fishing effort has increased at a phenomenal rate in the last 10 to 20 years.

Reported commercial landings of finfish in Mississippi during the period 1968-77 are characterized by large annual fluctuations ranging between 225.5 million pounds in 1968 and 384.5 million pounds in 1972. There was a slowly increasing trend in total finfish production which is closely correlated to time and price combined (Partial correlation coefficient = .86). However, time and price accounted for only 28.8% of the fluctuation in volume (Multiple correlation coefficient = .536). Other factors such as worldwide production of fish meal, production of other protein products, resource availability, etc., have an influence on Mississippi finfish production and dockside value. There is no evidence that overfishing is currently a factor in Mississippi's total finfish landings.

Nevertheless, preliminary catch records for some species (red drum, black drum and possibly others) indicate that new high catch records will be set in 1978. Changes in demand, fishing methods and price structure appear to be major factors as well as the availability of these resources. This situation emphasizes the need for a flexible, dynamic plan designed to accomplish rational management.

The Mississippi Marine Conservation Commission has primarily been responsible for identifying finfish research and management problems for the State and coordinating this research. 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 finfish 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 Mississippi finfish fishery, and that adjustment may be required from time to time.

Mississippi Marine Conservation Commission (MMCC) selected spotted seatrout, sand seatrout, red drum, flounder, menhaden, southern kingfish, croaker, mullet, sheepshead, and black drum for consideration in this plan. Several important species such as mackerel, snapper and grouper were not included because most of the harvest is taken outside the State's jurisdiction.

This summary document lists the goal and objectives of the proposed State plan, and describes the following sections.

The present State management system is summarized with selected laws and regulations.

The proposed State 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.

Last, the Mississippi (selected) finfish fishery is summarized and includes a discussion of 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 resources and yields. A detailed referenced copy of this section is on file at the GCRL.

GOAL

To manage the Gulf of Mexico Marine finfish resources of the Mississippi territorial and internal waters to provide for optimum sustained benefits for the State, Gulf States, and the Nation.

OBJECTIVES

1. Describe the fishery.

2. Identify, preserve and improve (where possible) finfish producing zones of the region.

   a. Identify and preserve (maintain) high value "natural" finfish habitats.

   b. Provide protection of the spawning and juvenile populations of those finfish where data indicate the possibility of overharvesting.

   c. Identify offshore finfish stocks and their relationships to estuarine systems.

   d. Identify habitats that might be maintained or altered to enhance finfish productivity.

3. Facilitate the collection of improved statistics regarding the commercial and recreational finfish 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 finfish 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 (catcher to consumer).

   c. Determine optimum sizes of harvest.

   d. Determine optimum organizational structure for marketing finfish.

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

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

5. Facilitate extension education to the finfish industry that will promote:

   a. Management techniques which will provide efficiency in harvest.

   b. Changes in the industry to enchance implementation of optimum organizational structures for marketing finfish.

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

6. Incorporate the above objectives into a dynamic state marine finfish management plan.

The Goal and Objectives have been developed by the Working Group membership, utilizing the "Management by Objectives" technique, and were reinforced by an Advisory Group appointed by the Mississippi Marine Conservation Commission from the three coastal counties. The Advisory Group consisted of three members representing the commercial fishermen, three members representing the recreational fishermen, three members representing the processors and three members representing the consumers. The Advisory Group participated in two

workshops and reviewed drafts of all materials prepared in the formulation of this plan. From these objectives, together with the existing condition of the resource and fishery, the Working Group developed alternative improved State Management Systems. The next section summarizes the present management system.

PRESENT MANAGEMENT SYSTEM

Commercial finfish fishery data have been collected from Mississippi in one form or another since about 1887. The present system in the State has been based on available biological knowledge tempered by sociological inputs. Managers have been pressured by conflicting interests in various segments of the harvesting sector. 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 appears to remain 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, and inflation in general have begun to erode the economic base of the fishery.

The general objectives of the present state management system have been to protect the resource and maximize catch among the various user groups. Currently the state regulates the harvest of fish by setting net size, areas to fish and 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 conception 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 powers and reluctance by State legislatures to yield anything within their State boundaries has hampered implementation of a regional approach to management of the finfish resource. A review of the States' management structure and other features pertinent to the Mississippi finfish fishery follows.

The administrative organization of the State of Mississippi with respect to coastal fisheries is the Mississippi Marine Conservation Commission (MMCC). The Commission consists of thirteen members, nine of which are appointed by the governor. The remaining four are directors of the following agencies: Boat and Water Safety Commission, Marine Resources Council, Gulf Coast Research Laboratory and State Board of Health. The statutory authority of the Commission provides full power to "manage, control, supervise and direct any matters pertaining to all salt water aquatic life not otherwise delegated to another agency" [Miss. Code Ann. 49-15-11(1)].

Statutory provisions are set forth in Chapter 15, Art. 1, paragraphs 49-15-1 through 49-15-69 of the Mississippi Code annotated (1972). Fishing seasons and gear types are set by the MMCC. Therefore it appears that Mississippi has a relatively flexible management system which would lend itself to a reciprocal or coordinated interstate fisheries management plan.

License requirements for fishing operations conducted in Mississippi (except Menhaden) waters are as follows:

Hook and line commercial fishing	$1.00
Boats using trammel nets, gill nets or seines not more than 200 fathoms in length	$7.50
Boats using trammel nets, gill nets or seines over 200 fathoms in length but not more than 300 fathoms in length	$15.00
Boats using seines or other nets over 300 fathoms but not over 400 fathoms in length	$25.00
Boats using seines or other nets over 400 fathoms but not over 500 fathoms in length	$50.00

All licenses issued shall expire on July 1, there-after, irrespective of the date of issuance of same.

Each factory canning fish in the State of Mississippi shall pay a privilege tax of $100.00.

Licenses necessary for catching, processing, and selling menhaden include:

License for each plant or factory	$500.00
License for each net, type or size	$50.00
License for each boat or vessel used in catching or transporting menhaden	$50.00

There are no taxes levied on menhaden taken from Mississippi waters.

The Mississippi reciprocal agreement provision is found in Miss. Code Ann. 49-15-15 (i) which provides that the Mississippi Marine Conservation Commission:

May enter into advantageous interstate

> and intrastate agreements with proper officials, which agreements directly or indirectly result in the protection, propagation and conservation of the seafood of the State of Mississippi, or continue any such agreements now in existence.

Unlike the reciprocal agreement authorizations in some states, this clause could clearly contemplate agreements relating to resource management as well as to reciprocation concerning access by residents to the respective states' waters.

The Commission has the power to promulgate regulations not set forth by legislative act. Any regulations or ordinances, before becoming effective, are to be published in a newspaper having general circulation in counties affected by such a regulation. Right of appeal through a public hearing and a circuit court is granted to "any person aggrieved by an order of the Commission."

Limit of State Jurisdiction is shown in Figure 1.

There are six ordinances which regulate all net fishing except menhaden. These are:

Ordinance 71 requires that all firms purchasing littoral species and fishermen catching littoral species keep records on those fish bought and/or caught and report same to MMCC upon request.

Ordinance 84 which exempts mullet fishing from certain regulations for catching other species with nets.

Ordinance 85 which spells out those areas in Mississippi waters which are closed to all netting (Figure 2).

Ordinance 87 as amended by Ordinance 91 which defines saltwater sport fishermen as those unlicensed individuals fishing with rods, reels, poles, or hand lines within the jurisdiction of the MMCC for the purpose of catching saltwater finfish for recreational or personal consumption. The ordinance sets daily bag limits on spotted seatrout and redfish, establishes size and possession limit on redfish, and establishes minimum sizes for spotted seatrout, redfish and mullet which are marketed commercially.

Ordinance 91 sets limits where nets may be set in relation to public and private piers, length of nets and mesh sizes, methods on how nets should be marked and attended and prohibits their use within a one (1) mile radius of named islands between 15 May and 15 September each year. It also sets an upper limit on the total weight of redfish which may be harvested from Mississippi territorial waters.

There are four ordinances which regulate menhaden fishing in Mississippi. These are:

Ordinances 28 and 55 which prohibit menhaden fishing within one (1) mile of the shoreline of Harrison and Hancock counties.

Ordinance 66 in compliance with the Miss. Code Ann. 49-15-15 (3) (n) (1974 Supp.) which sets the menhaden season to open on the 3rd Monday of April and close on the 2nd Tuesday in October. Seasons may be opened earlier or closed later by actions of the MMCC. The closing date is now set by Ordinance 77 to be on the 1st Friday after the 2nd Tuesday in October.

Ordinance 71 requires each menhaden company to report its landings and pertinent catch data to MMCC.

Areas closed to menhaden fishing by purse-seining in Mississippi are shown in Figure 3.

General penalities for violation are set forth in paragraphs 49-15-21 (3) and 49-15-63 of the Mississippi Code Annotated (1972). Jurisdiction of courts is set forth in paragraph 49-15-65 of the Mississippi Code Annotated (1972). Paragraph 49-15-2 (3) states that inspectors shall at all times seize any and all aquatic life caught, taken or transported in a manner contrary to the laws of this state, and shall confiscate and dispose of same, as well as any net or other paraphernalia used or employed in connection with such violation, in accordance with the regulations of the commission established by ordinance or ordinances of the commission; provided that the net and paraphernalia so seized may be returned by a court of competent jurisdiction and further provided that a person's nets and paraphernalia shall not be confiscated upon said person's conviction for a first offense. Paragraph 49-15-63 states that any person, firm or corporation violating any of the provisions of this chapter or any act amendatory hereto, or any ordinance duly adopted by the commission, unless otherwise specifically provided for herein, shall on conviction, be fined not less than $50.00, nor more than $100.00, for the first offense, and not more than $100.00, nor more than $500.00, or imprisonment in jail for a period not exceeding 30 days for any subsequent offense; and upon conviction of a third offense, it shall be the duty of the court to revoke the license of the convicted party and of the boat or vessel used in such violation, and no further license shall issue to such person or for said boat to engage in catching or taking of any sea foods from the waters of the State of Mississippi for a period of one year following such conviction.

Paragraph 49-15-65 dealing with jurisdiction of courts states that the justices of the peace of the various beats of the respective counties or county courts in which the Mississippi Marine Conservation Commission functions, shall have original jurisdiction of any prosecution or suit brought under authority of this chapter, or of any ordinance duly

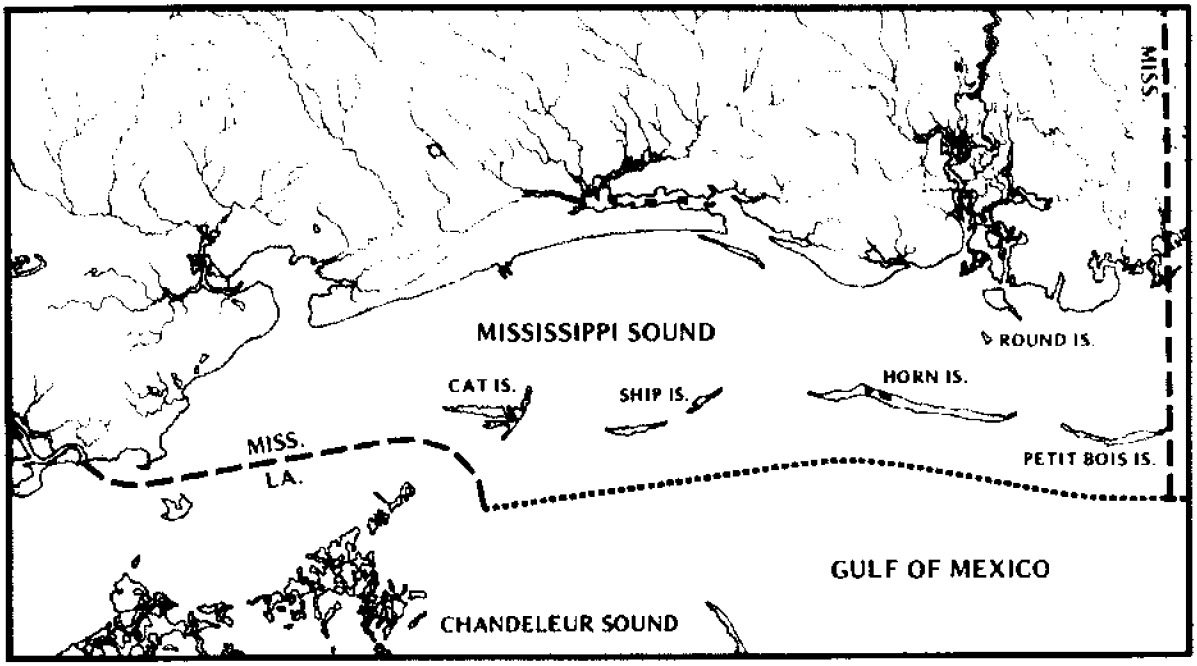


Figure 1. Extent (3 nautical miles) of territorial waters in Mississippi.

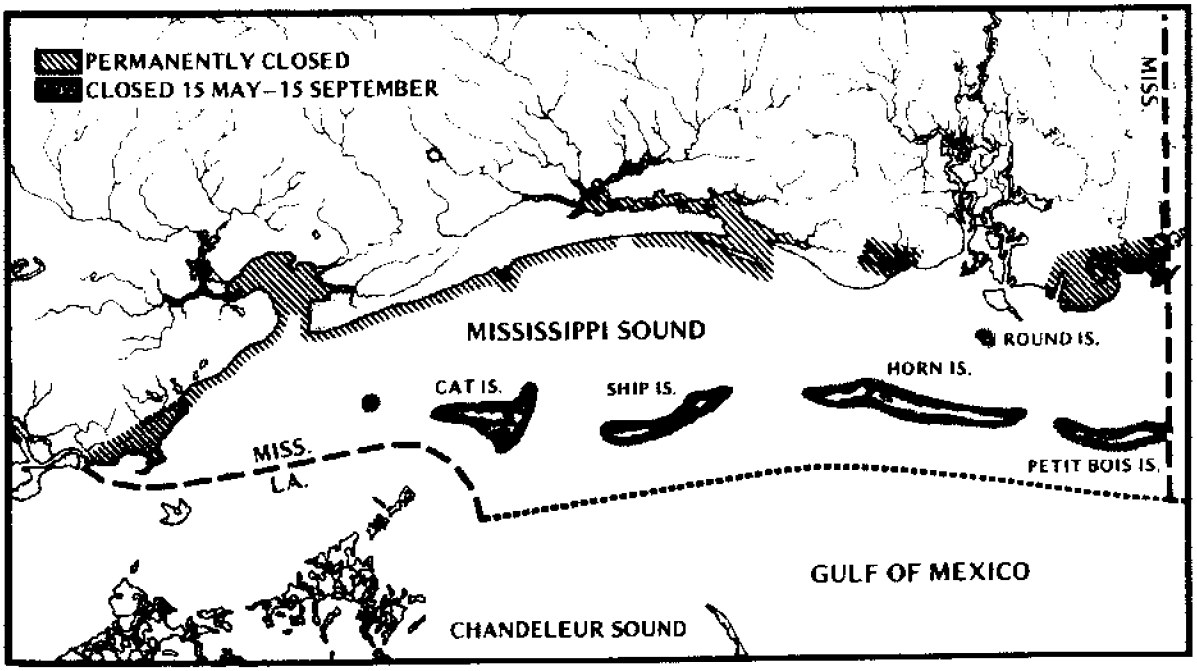


Figure 2. Areas closed to net fishing other than menhaden nets.

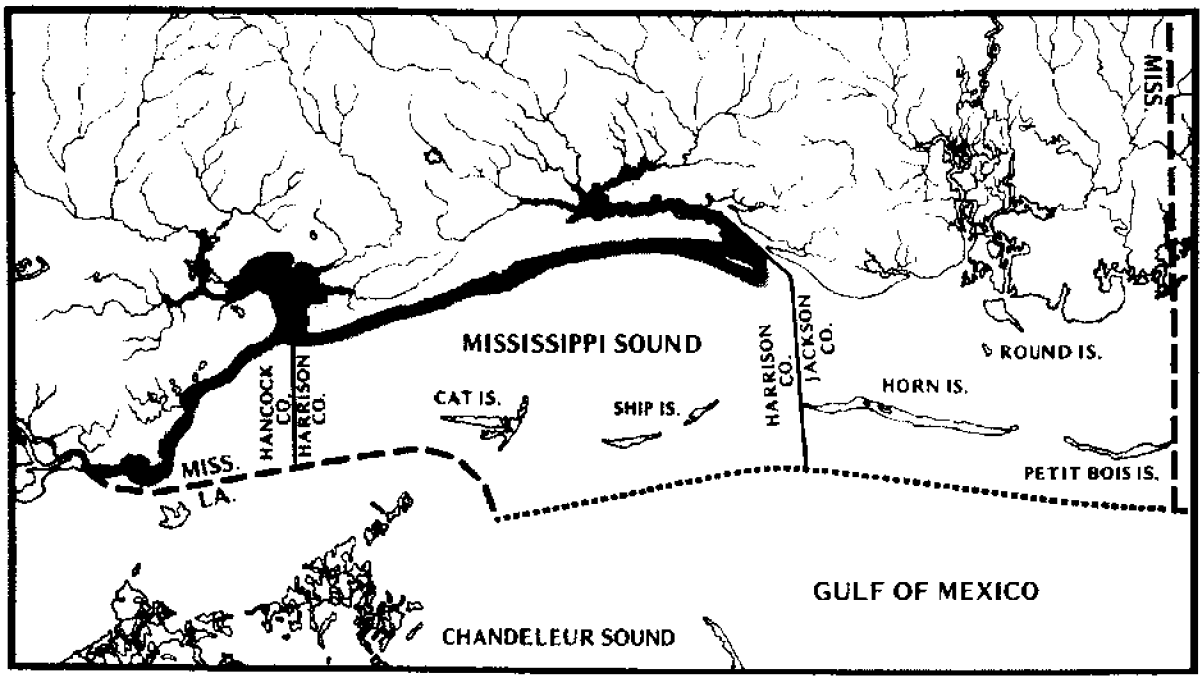


Figure 3. Areas closed to menhaden fishing by purse-seine in Mississippi.

enacted by the commission, shall likewise have jurisdiction of all seizures of property carried out by the Chief inspector or any of his deputies for violation of any of the provisions herein, or any legal ordinance of the commission, including the right to order and direct the sale of such property in the manner that property is sold under civil execution proceeding from any judgement rendered. However, from each decision or judgment, whether from a fine, imprisonment, or the seizure or order of sale of any property, there shall be allowed an appeal, and such appeals and trials shall be had as now provided by law.

Scientific collecting permits are issued by the Director, Mississippi Marine Conservation Commission.

No precedents warranting a discussion of limited entry in the context of Mississippi coastal fisheries management were found.

The next section summarizes the recommended or proposed management systems for consideration.

PROPOSED SYSTEM

Under the proposed system, Mississippi will continue to manage marine finfish fisheries in Mississippi waters and will cooperate with other states and the Gulf of Mexico Fisheries Management Council in managing those aspects of the fishery which can best be managed as a regional venture. Responsible entities in the existing regional system are described in the following paragraphs.

Congress enacted PL 94-265, The Fishery Conservation and Management Act (FCMA) of 1976, establishing a Fishery Conservation Zone (FCZ) existing seaward from the outer limit of state territorial waters to a line 200 nautical miles from shore (Figure 4). In the Gulf of Mexico, state fisheries jurisdiction extends from the beach gulfward 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 marine finfish fisheries within their waters with provisions for Federal preemption only when fishing is predominantly in the conservation zone, if a state fails to take action or takes action the results of which would adversely affect implementation of a fishery management plan. The FCMA requires (as a national standard) that to the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and inter-related stocks of fish shall be managed as a unit or in close coordination and that management and conservation measures shall be based upon the best scientific information available.

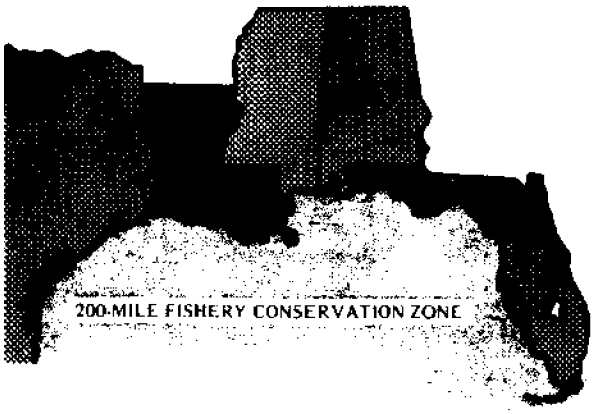


Figure 4. Extent of the Fisher Conservation Zone in the Gulf of Mexico.

Interpretation of PL 94-265 has led, for fishery management purposes, to establishment of three categories of area: (1) state internal waters, (2) the territorial sea in state boundaries and (3) the FCZ. Planning procedures require that Councils consider each management unit throughout its range i.e. in all three areas.

The State-Federal Fishery Management Program (S-FFMP) was established in 1971 to provide a mechanism for cooperative management of marine fisheries that transcend State and State-Federal jurisdiction boundaries.

State-Federal Fishery Management Boards (S-FFMB) were established for the purpose of determining fisheries in need of regional management in State waters, developing management plans, identifying data requirements and implementing action programs necessary to achieve management goals and objectives.

In the Southeast Region, two State-Federal Boards were organized - one for the South Atlantic States and one for the Gulf States - under the authority of the respective interstate marine fisheries compacts existing within those areas. The GS-FFMB was organized in April 1976, and since that time Gulf shrimp and menhaden planning efforts have been completed and implemented.

The orderly development and implementation of management plans will require a close working relationship between the Councils, the Boards and the State agencies if fisheries are to be addressed throughout their range.

Any proposed system for Mississippi finfish fishery management should provide for the interfacing and coordination of State and Federal responsibilities. Only 5% of the species of fishes and invertebrates harvested in the NMFS Southeast Region are clearly under either State or Federal jurisdiction (Figure 5). All species selected for consideration in this plan are interjurisdictional. Croaker are principally harvested in the FCZ and management is principally a Federal (GMFMC) responsibility. This plan provides options through which implementation of a management plan is to be accomplished. Various organizational structures for coordinating inshore management with other States and with the Council are suggested as options.

Existing organizational structures for fishery management or coordination with other Gulf States include:

A. State Conservation Agencies - Responsible for fishery planning and management in State waters.

1. Alabama Department of Conservation and National Resources.
2. Florida Department of Natural Resources.
3. Louisiana Department of Wildlife and Fisheries.
4. Mississippi Marine Conservation Commission.
5. Texas Parks and Wildlife Department.

B. Federal

1. Department of Commerce - Secretary is responsible for approval of fishery management plans and management of FCZ (Figure 4).

National Marine Fisheries Service - Responsible for marine fishery research for Federal Government, GMFMC, GSMFC.

Sea Grant Program
Coastal Zone Management

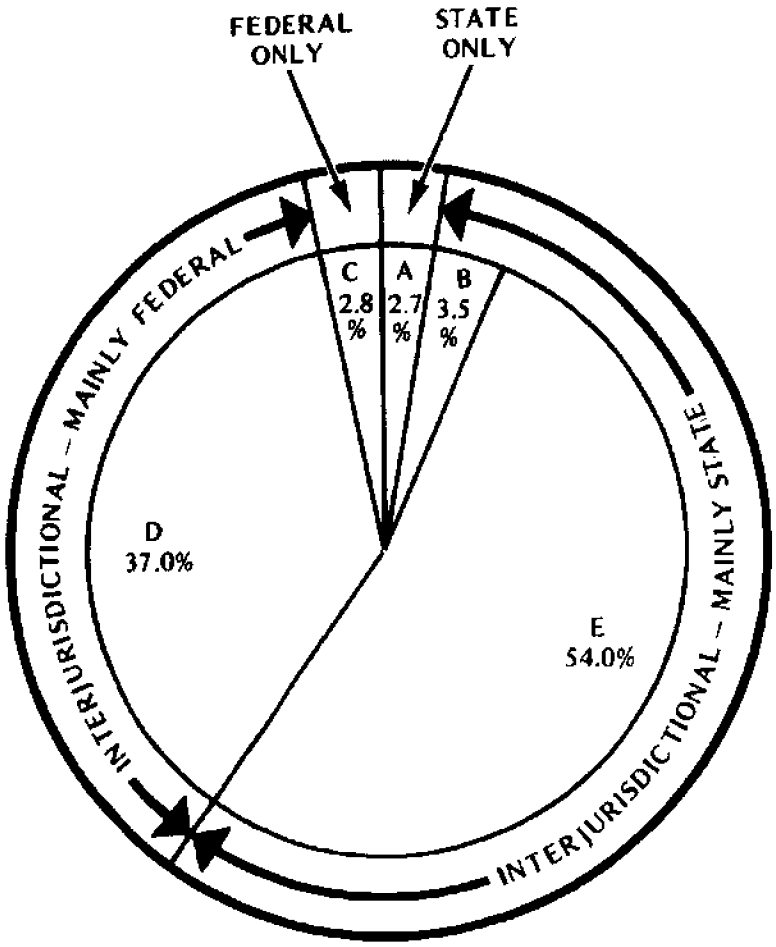
2. Department of Interior
Fish and Wildlife Service

C. Regional Institutions

1. Gulf of Mexico Fishery Management Council - Responsible for fishery management plan development in FCZ.

Membership:
Voting.
Five state fishery administrators (one each state)
11 appointees by Secretary of Commerce (one each state, six at large)
Regional Director NMFS (Southeast Region)
Non-Voting.
U.S. Coast Guard
Gulf States Marine Fisheries Commission, Executive Director
U.S. State Department
U.S. Department of Interior, Fish & Wildlife Service

2. Gulf States Marine Fisheries Commission
Reviews and coordinates needs of fisheries for Congress and States.



A. Species which occur totally within the Territorial Sea and/or internal waters, and are under state jurisdiction.

B. Migratory and/or interjurisdictional species for which fishing occurs predominately in internal waters of a state, i.e., inside harbor mouths.

C. Species which occur totally outside the Territorial Sea and are under Council jurisdiction.

D. Migratory and/or interjurisdictional species for which fishing occurs predominately within the Fishery Conservation Zone or beyond.

E. Migratory and/or interjurisdictional species for which fishing occurs predominately in the Territorial Sea.

Figure 5. The distribution of fish and invertebrate species by jurisdictional categories in the NMFS Southeast Region. All species considered in the Proposed Mississippi Marine Finfish Management Plan except croaker fall in E. Croaker are in category D.

Membership:

Five State fishery administrators (one each state)

Five Appointees by Governors (one each state)

Five Legislative members (one each state) appointed by their respective governors.

3. Gulf State-Federal Fishery Management Board - Coordinates fishery research and planning in territorial sea.

Membership:

Voting (one vote per state).

Five State fishery administrators (one each state)

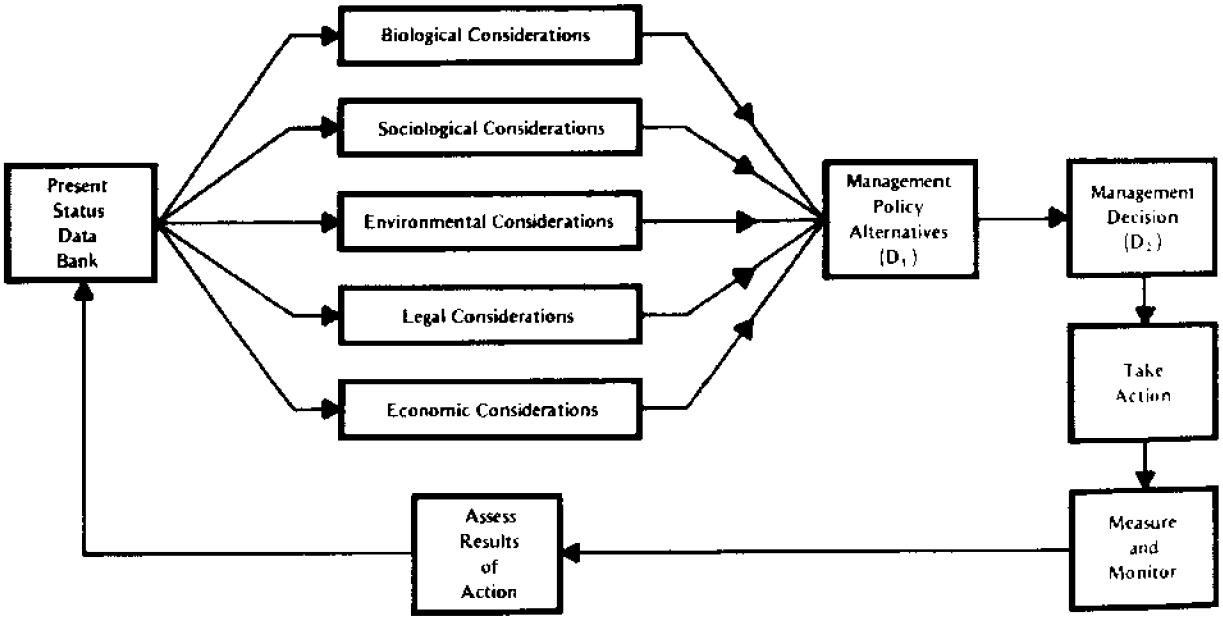
Five other Gulf States Marine Fisheries Commissioners (one each state)

Non-Voting.

Regional Director NMFS (Southeast Region)

Executive Director GSMFC

The proposed system (Figure 6) is contingent upon an appropriate data base providing information for: (1) population dynamics 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, which 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 finfish resources and fishery. While these tasks are being accomplished, management policies



EXPLANATION OF DECISIONS TO BE MADE

D_1 At this point biological, sociological, environmental, legal and economic 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 options' advantages and disadvantages should be used for decision (D_2).

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

D_2 The Mississippi Marine Conservation Commission will make this decision by choosing the best alternative in accordance with previously set policies.

Figure 6. Conceptual model of future management systems.

will be developed that will consider biological, social and economic conditions in the fishery. The next step of this process will be to decide on the proper techniques for implementing policies. After implementation, policies will be evaluated for their effectiveness and relevance to changing conditions.

Some advantages of the proposed system are: (1) management in Mississippi will be based upon the best scientific information; (2) it has been adopted and is being successfully implemented by the S-FFMB; (3) a similar system is being used by the GMFMC; and (4) 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, environmental, economic, social and political effects of their decisions, (d) allow for coordination of administrative, research and enforcement policies with other states (e) enable managers to advise industry concerning costs of fishing, (f) allow managers to document biological and economic trends in the finfish fishery, (g) provide adequate catch and effort data should it be necessary for negotiations between Mississippi and other states fishing in this area and (h) establish a fisheries management information system data base that can be retrieved quickly and used to identify information gaps needed for significantly improving resource management.

Disadvantages of this plan include, but are not necessarily limited to, a high initial cost, particularly for a 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.

In this plan we are concerned with ten species harvested by both commercial and recreational fisheries. Production management schemes, if directed at only one particular species, could possibly be in conflict with management schemes for the others.

One of the two problems encountered in finfish studies involves the fact that two or more species of equal value that have overlapping life cycles exist in the same waters. An important decision must be made, not concerning one species at its optimum value at the time, but rather the overall effect of the fisheries and the total value that may be achieved.

Because of the various biological, economic, social and political factors involved, a management program must be flexible to function, sustain and improve the economy of the entire fishing community.

This section will provide a more elaborate overview of the management of the major finfish species. The biological models that will be discussed fall under Biological Considerations in Figure 6. All finfish selected for this plan except menhaden are harvested by both recreational and commercial fisheries but there is no historical catch data for the Mississippi recreational fishery. There is also interaction between shellfish (especially shrimp) fisheries (not included in this planning effort) and finfish fisheries. Interaction must be considered in biological models. Consequently only preliminary and partial biological modeling for those species included in this plan are possible until all data on Mississippi fisheries can be documented and considered.

MANAGEMENT SYSTEMS CONSIDERED

In-State

This section contrasts the capabilities of management systems for solving problems associated with the finfish fishery of Mississippi. The first of these, the Present System, was discussed above.

Another system is a modification of the Present System. Under this system there would be no formal attempt at regional management and there would be no appropriate catch and effort data acquisition. Instead, Mississippi would continue to manage the resource and fishery on an individual basis and would attempt to better coordinate research, management and administrative activities.

Another system examined is the proposed system and management structure which is as follows:

The basic organization of the recommended management structure is shown in Figure 7 which illustrates the currently preferred choice of the Marine Finfish working group with the understanding that the new structure established by the 1977 Legislature will be effective on 1 July 1979.

Implementing legislation will follow guidelines prepared by the National Task Force on Effective State Marine Finfisheries Management Programs.

The basic structure is the MMCC which will be responsible for management actions in State waters. The Commission will establish appropriate procedures and policies to take the necessary actions to design, evaluate and implement finfish management activities in the proposed system (Figure 6).

The MMCC utilizes existing technical capability and an Advisory Committee or Committees to provide the required data base and indicated options for the decision making process.

The chief advantages of this option are that members of the Commission have knowledge of and an interest in marine finfish fishery management problems and the Commission Director is a voting member of GSMFC and GMFMC where regional as-

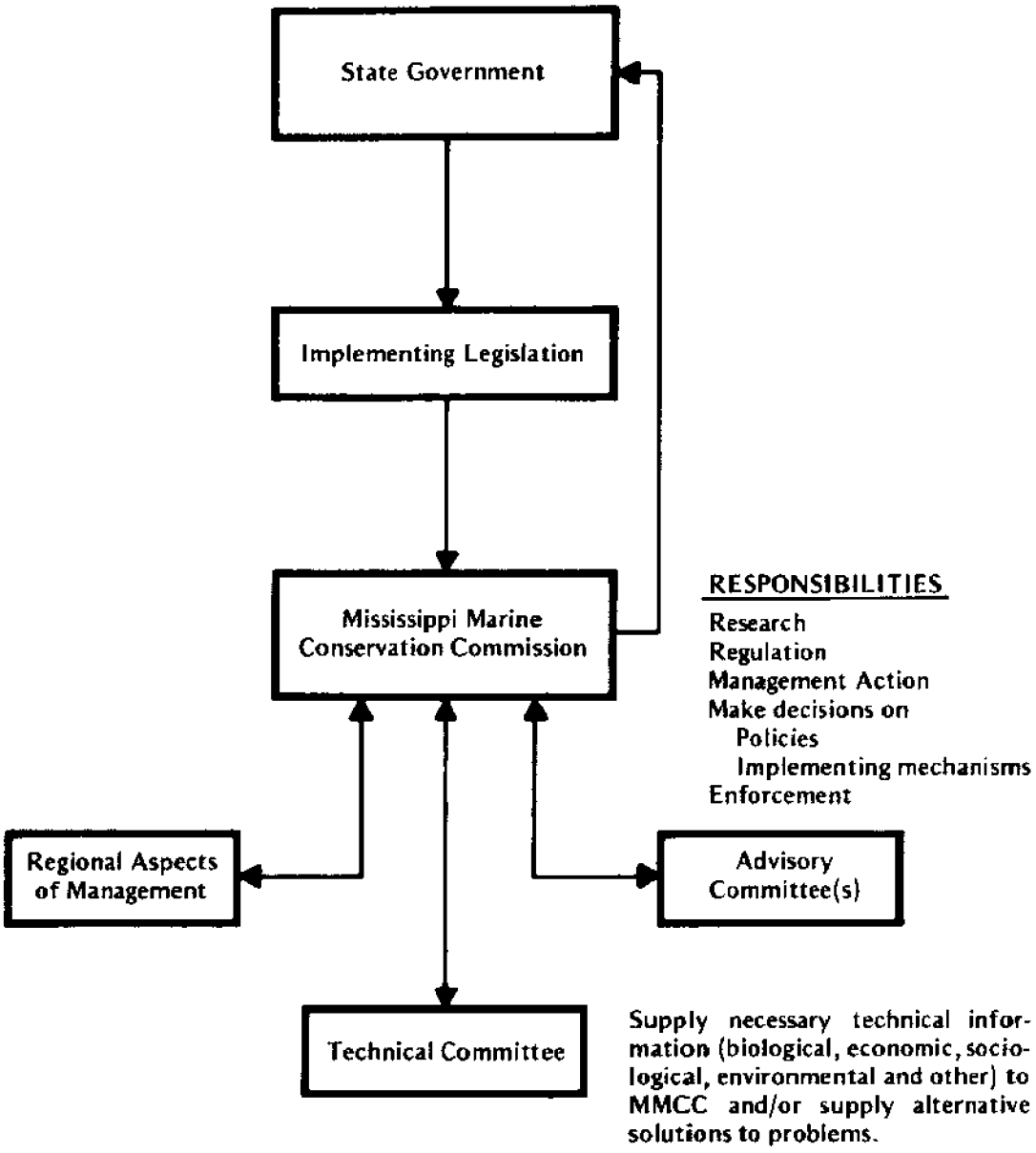


Figure 7. Management structure recommended by Marine Finfish Working Group.

pects of management are promulgated.

The disadvantages of this alternative are principally political. Commission members appointed by a governor may have overriding personal interest in a fishery that could lead to serious conflict of interest and may be subject to political pressure leading to actions that are not based on the best available scientific information. Under State law (Mississippi Code 1972, Annotated, 1978 Cumulative Supplement, Title 49, Chapters 4 and 15) the MMCC will be abolished at the end of June 1979 when the newly created Department of Wildlife Conservation takes authority.

Management structure of the new Department is shown in Figure 8. The Mississippi Department of Wildlife Conservation (MDWC) appointed by the Governor, with Senate confirmation, has five members, one from each Congressional District, with provision that:

1. The MDWC shall be composed of persons with extensive knowledge of or practical experience in at least one of the matters of jurisdiction of the Com-

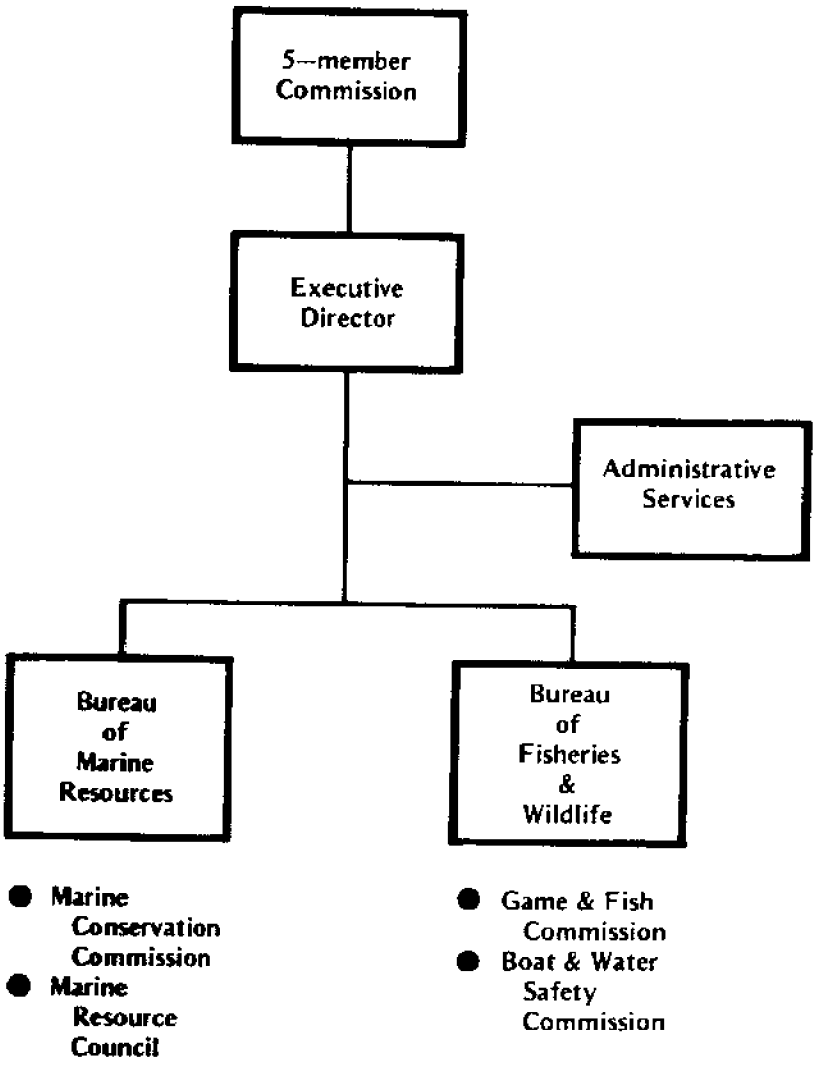


Figure 8. Management structure of the Department of Wildlife Conservation.

mission.

2. One of the Commissioners shall be knowledgeable and experienced in marine fisheries management and shall have at least a bachelor's degree in marine technology and at least three of the Commissioners shall be knowledgeable and experienced in the management of game and freshwater fisheries.

The Department is charged with responsibility for conserving, managing, developing and protecting the wildlife of the State of Mississippi with powers to:

(a) formulate the policy of the department regarding wildlife within the jurisdiction of the department.

(b) adopt, amend and repeal such regulations and rules as may be necessary for the operation of the department.

(c) apply for, receive and expend any federal or state funds, etc.

(d) commission or conduct studies determining alternative methods of managing and conserving wildlife of the State in a manner to insure efficiency and maximum productivity.

(e) receive the counsel of the Advisory Committees created for the Bureau of Marine Resources and the Bureau of Fisheries and Wildlife.

(f) discharge such other duties, responsibilities and powers as are necessary to implement the provisions of the Act.

Nominal qualifications for the positions of Executive Director and Bureau Directors are described in the Act. The Executive Directors are responsible for organization, with MDWC approval, of the Bureaus.

The principal advantages of this management structure is reorganization of various agencies into a department with management responsibility concentrated in a single Commission responsible to the Governor and to consolidate Administrative Services required by the abolished agencies. Enforcement is administered by the MDWC and enforcement personnel are employees of the MDWC.

The principal disadvantages include limitation of regulatory flexibility in marine finfish management resulting from the retention of certain regulatory sections of existing law, removal of marine fisheries management responsibility from the coastal area, probable lack of adequate marine fishery representation on the new Commission, dilution of attention to marine finfish management because of expanded responsibility in the Bureau of Marine Resources and possible delay in response to emergency regulatory requirements.

Regional Management

With passage of PL 94-265 and the formation of the GMFMC for the Gulf, it is important and appropriate to address the interrelationships between management authority in Mississippi's internal waters, the territorial sea and the FCZ. Figure 9 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 State, 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 the nature of Figure 9.

Figure 9 is a dual process flow model depicting the State's territorial sea finfish management flow in the top half of the model and the Gulf Council's FCZ finfish management flow in the lower half of the model. In order to enhance compatibility of the territorial sea and the FCZ regional management plan, the common steps of Coordination and Constituency Review have been added in the right center of Figure 9 with NMFS affording inputs to both plans.

As both the territorial sea and the FCZ management plans go into effect, this model (Figure 9) 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 exists personnel common to both bodies. Adoption of a formal model of this nature will enhance coordination and communications of all relavant plan initiations and changes thereto.

Advantages and disadvantages of the configuration represented by Figure 9 are:

A. Advantages

1. Territorial sea treated as a continuum, rather than a group of five adjacent territorial seas.

2. Uniformity in management strategy within territorial sea.

3. Management units treated for the most part without regard to state boundaries. (Split by territorial sea and FCZ boundaries)

4. Enforcement less difficult.

5. State cooperation expanded.

B. Disadvantages

1. More than one authority (States, GMFMC and GS-FFMB) required for management of the fishery.

2. Potential conflicts between management strategies within territorial sea and FCZ.

Other management structure options considered by the Working Group were:

A. Continue to manage the Gulf finfish fishery in the same manner that currently exists (no action).

1. Advantages

a. With limitations, the system is working.

b. The cost of management under the present system is relatively low for a fishery of great value.

2. Disadvantages

a. Management responsibility in the territorial sea has not been delegated to a regional agency that can provide for implementation of the proposed system.

b. Economic, environmental and social factors are not usually considered adequately under the present system nor is any concentrated effort underway to acquire necessary data from a Gulf-wide approach.

c. Conflicts will continue to plague the industry if states continue to act separately.

d. It is difficult for states to coordinate with GMFMC on an individual basis.

B. Manage the fishery by the GMFMC

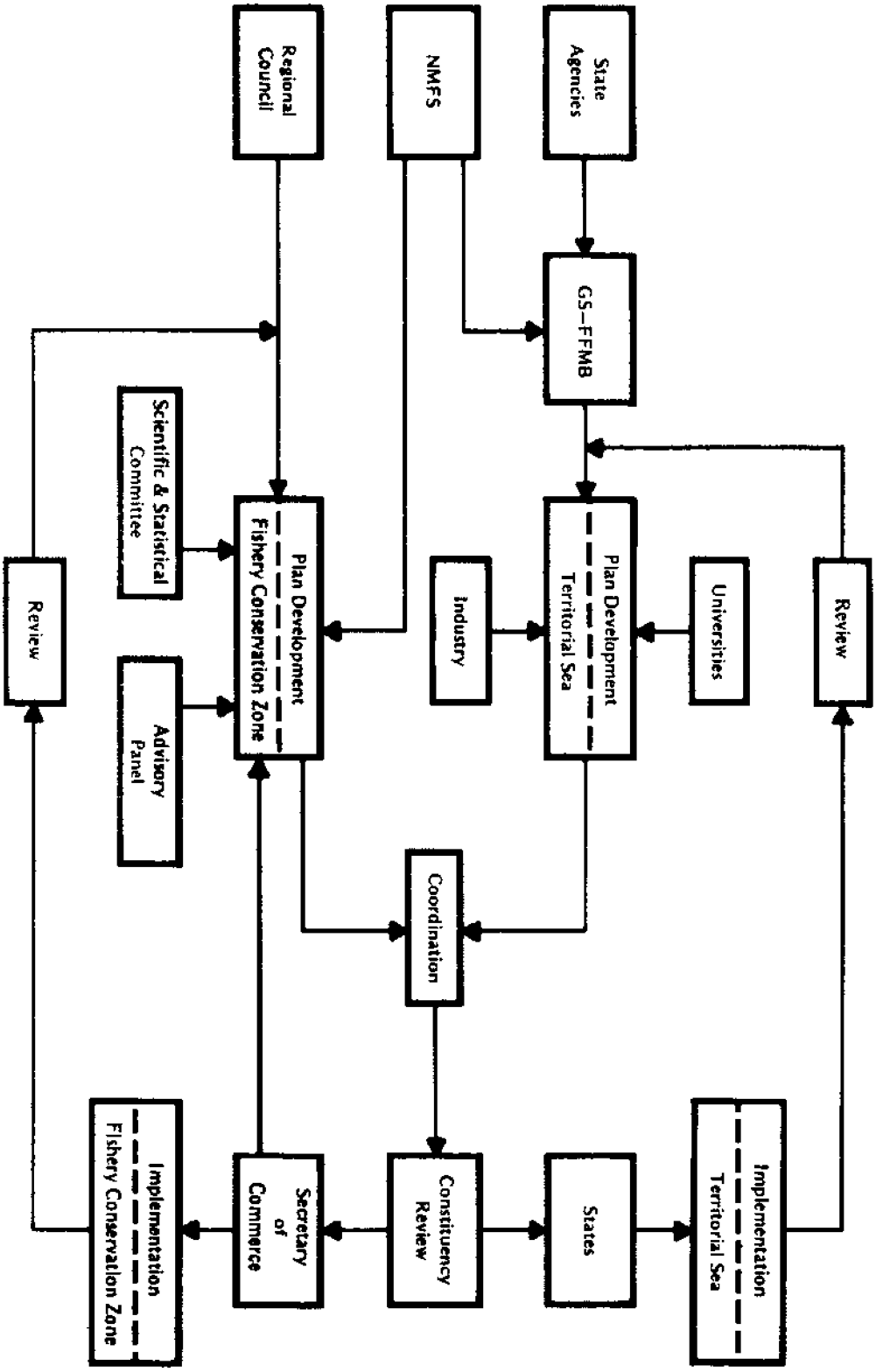


Figure 9. Dual process flow model.

1. Advantages

a. The council is funded and required to develop management plans and to recommend management practices for fisheries in the FCZ.

b. The Secretary of Commerce may accept, implement and enforce regulations in the FCZ as recommended by the Council.

c. Most species in the finfish population spend part of their life cycle offshore.

2. Disadvantages

a. A large portion of the marine finfish harvest is taken in territorial waters where states have jurisdiction.

b. The marine finfish industry prefers to communicate with state agencies on pertinent matters where possible, rather than a central body.

c. Fish production depends on maintenance of estuarine nursery areas located in territorial waters as well as successful spawning in offshore waters.

C. Manage the marine finfish fishery by some regional body yet to be created.

1. Since several regional management bodies are already established, neither the working groups nor Advisory Committee members found any advantages in the creation of a new management body.

In management of marine finfish, it is imperative that adequate funding be made available for implementation of the necessary research and development programs. A listing of recommended programs is presented in the Management Action Program Summary of this document.

Also, it must be emphasized that because of the cyclic nature of marine finfish populations and associated hydrological and/or environmental changes and fluctuations, monitoring is an ongoing program; therefore, funding must be available on a continuing basis.

Of prime importance in monitoring is the collection of catch and effort statistical information which is necessary for a successful management program. The amount necessary is dependent on needs of the management system. Conversely the amount of information available will be a constraint in the development and use of a management system. The following options may be considered for gathering necessary statistical information.

Current System. The State-Federal Catch and Effort Data is the system currently in operation in the Gulf of Mexico. Advantages of this system are its relatively low cost and its acceptability to industry. Its primary disadvantages are the lack of biological and economic data, and the failure to verify the accuracy of data that are gathered. Also, a significant time period elapses between collection and publication of data.

Alternative Systems.

1. Improved State-Federal Catch and Effort Data - This system would be an improvement and expansion of the current system. The State would continue to assist in data collection; the Federal Government would intensify sampling efforts, improve data analysis and provide for more rapid dissemination. The Federal Government would provide the bulk of the cost. This system would allow managers to monitor biological and economic trends, to document changes in efficiency of vessels and gear, better estimate fishing and natural mortality rates, evaluate management decisions such as closing certain areas to fishing, estimate abundance and evaluate forecasting techniques derived from biological sampling of postlarvae, juveniles and adult stocks. Additional advantages would be improved verification of data and quantitative experience gained by States. Disadvantages would include increased cost and the possibility that it might not be acceptable to some members of industry.

2. Improved Federal-State Catch and Effort Data - This section would be essentially the same as No. 1, but the Federal Government would pay for the entire cost of the program. This program would have the same advantages and disadvantages as No. 1. Moreover, this system could be implemented realtively quickly by States if Federal funds were available.

3. State Only Catch Data - This system would cost approximately the same as the State-Federal system but would be paid for entirely by the State. Its advantages and disadvantages are basically the same as the first option. However, States would be collecting data, while NMFS would be processing it. Thus, personnel collecting data would not be verifying it. Moreover, the increased cost per State would make it less attractive to the State due to difficulty of budgeting funds specifically for statistics.

Implementation of this plan will begin after appropriate approvals of the plan. The plan will be administered by the MMCC or its successor. The first steps in implementation will consist of those recommendations given the highest priority. The State Management Agency will review research proposals for applicability, as well as evaluating results obtained by actions taken to satisfy recommendations. The project evaluation process will allow the group not only to judge the success of individual projects concerning their impact on fishery management, but also to readjust priorities of the other projects should this be appropriate. The group at appropriate intervals will evaluate the effectiveness of the entire management system, particularly

concerning solution of problems identified.

The next section will describe a Management Action program detailing problems, recommendations, establishing priorities and estimates of funding needs and suggestions of who should be responsible for providing for the funding.

MANAGEMENT ACTION PROGRAM SUMMARY

Identification of Problems.

To properly develop a management plan for any fishery resource an awareness of problems and potential problems within the fishery is required. The Finfish Working Group, with the help of the *Ad Hoc* Finfish Advisory Committee addressed this question and identified problem areas in six categories with some problem areas recurring in more than one category.

Numerical listing here does not imply any attempt to assign priority, or subsequent research time frame and implementation. These considerations and more specific treatment as indicated by data gaps and their relationship to goals and objectives are included in recommendations and the Management Action Program Summary.

Problem Areas and Annotations

Biological

1. Inadequate catch statistics.

No continuous data on recreational catch are available. Catch data on commercial finfish fisheries provide information on reported landings by species in a series that is reasonably continuous since 1880. Although "Catch by waters" data for finfish is available for the period since 1963, it remains unpublished and is not released on a timely schedule. Effort expended to achieve the reported catch and biological information such as the size of fish in the catch are not being recorded.

There is a paramount need to collect, analyze and disseminate on a timely basis marine finfish catch and effort data required for estimating abundance; monitoring biological, economic and sociological trends and evaluating management decisions. Both commercial and recreational catch statistics are required for rational resource management.

2. Monitoring and assessment of adult finfish populations in State waters. Although an ongoing, effective monitoring and assessment program for most juvenile finfish has been established in Mississippi waters, funding constraints have prevented expansion to include adult populations of these species. An adult finfish monitoring and assessment program should be designed to provide real time reporting of results to potential users.

3. Inadequate knowledge of population dynamics for Mississippi Marine finfish. There is very little data on stock size, age composition, size composition, natural and fishing mortality rates and other parameters required for model development.

4. Finfish by-catch in other fisheries. Very large numbers of small usable juveniles of marine finfish are caught, killed and discarded by the shrimp trawl fishery. The by-catch of the shrimp fleet should be investigated to determine its impact on the population of exploited marine finfish.

5. Gaps in life history information of some of the selected species. These include precise local knowledge of time and location of spawning for a few. On-going research will provide the necessary information on some species. Complete life history data for each species are required to provide a basis for conservation regulations when such regulations are necessary.

6. Lack of yield models. Available data are inadequate for the development of useful yield models for Mississippi finfish stocks. The range of these stocks extends beyond Mississippi waters and yield models should be developed on a regional basis. In order to more fully utilize available stocks of the several species under consideration and achieve maximum benefits, it would be necessary to determine yield relationships throughout the range of stocks. These would require data such as mortality rates that are not available. The required data base and OSY model development should be accomplished as soon as practicable.

Economic

1. Lack of adequate statistical data disseminated on a timely basis. Collection, analysis and timely dissemination of catch and effort data, economic statistics and sociological information on both commercial and recreational fisheries are essential to rational management of finfish resources to achieve optimum yield. There is a need to make these data available to potential users on a real-time basis.

2. No clear understanding of the relationship between the volume of catch in Mississippi waters, landings in Mississippi and price. Lack of information about alternative markets, the way fish are marketed and the overall market probably contribute to the apparently irrational relationship currently existing. Gaps in data on these items should be filled.

3. Lack of current information on potential markets (location, price, etc.) for fish caught in Mississippi waters. The markets for most of the species are rather small and erratic. Some wholesalers and retailers indicate they would use more fish

from Mississippi fishermen if the supply were dependable. Yet, the local demand may be insufficient to warrant much larger catches of some species.

4. Inadequate understanding of industry, market structure and behavioral relationships among economic units. The imposition of regulations will impact most of the economic units involved in harvesting, processing and retailing. Understanding of potential economic impacts is required for rational regulatory decisions.

5. User conflict between recreational and commercial fishing industries. This conflict has resulted in the implementation of restrictive regulation without fully understanding the economic impact. The development and demonstration of methodologies for accurate measurement of benefits derived from both recreational and commercial harvesting is necessary for application in optimum yield models.

6. Waste of finfish resources in the shrimp fleet by-catch. Much greater economic return could be realized if the entire harvest from finfish resources could be utilized. Collection and marketing schemes as well as reduction in the catch of small unmarketable fish should be developed.

7. Lack of data for development of maximum economic yield models to determine cost and returns of fishing effort at the industry level. Data necessary for calculation of economic sustainable yield should be collected. Separate calculations should be made by species and size class of boats and vessels.

Social

1. Lack of sociological information on fishery communities. Management of the Mississippi finfish fisheries under optimum yield or any other comprehensive management goal should include an adequate and documented knowledge of the social and cultural structures of fishery communities; their preferences, traditions, values and lifestyles. This information is largely unresearched and, in any case, unrecorded in Mississippi.

2. Inadequate communication and misunderstanding of management principles among competing resource users. Failure to communicate data needs for understanding renewable resource management constraints, including biological, economic, social, and legal have resulted in uncompromising attitudes among competing harvesting sectors.

3. Lack of adequate labor force statistics. Since the Mississippi finfish harvest by species is based on a seasonal harvest, special needs and problems arise from 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 for prediction of the impact of alternative management options on harvesting, product flow and fishing communities.

Environmental

1. Loss of habitat. Extensive losses of estuarine habitat have occured in Mississippi and proposed development, if executed without full consideration of environmental effects, will result in very large losses in the future. Offshore, advancing technology and energy demands might conceivably cause deterioration of the quality of large areas to the extent that successful reproduction cannot occur. In either case, finfish production will be reduced or eliminated. Optimum production of finfish resources requires optimum habitat conditions for all life history stages.

While Mississippi has a strong wetlands program, there are many exceptions in the law and continuing industrial expansion in the state. Fishery management agencies should have an aggressive program to promote maintenance and improvement of marine finfish habitat.

2. Fresh-water flow to estuarine habitat. Optimum production from marine finfish habitat in the estuaries depends on the volume and quality of fresh water flow to the estuary. Mississippi River levees prevent the flow of river water with its nutrient load to western Mississippi nursery areas. Channeling of streams and reservoir construction in Mississippi may have serious effects on marine finfish production.

The Corps of Engineers is conducting feasibility studies on controlled introduction of additional fresh water to estuarine areas to enhance fish and wildlife production. The Gulf of Mexico Fisheries Management Council, with endorsement by Gulf States Marine Fisheries Commission, has established an environmental committee. Assessment of the effects on marine finfish production that may result from projects that would change fresh water flow should be diligently pursued by the fishery management entity.

3. Domestic pollution. Recurring finfish kills in Mississippi waters have been observed for many years. Their frequency and the number of areas in which they occur have increased with the increase in human population density. Although most of those investigated have been charged to oxygen depletion resulting from the introduction of excessive amounts of nutrients or organic pollutants, precise determination of cause has been clearly demonstrated in very few cases.

Provision should be made for determining the

cause and effect of fish kills and recommending action.

4. Industrial pollution. Continuing industrial expansion with associated effluents constitute a potential danger to finfish resources. Effective control of industrial effluents to assure that heavy metals and other toxic materials that may accumulate in fish in sufficient quantities to prevent its use as human food, inhibit or prevent survival and growth of young animals or kill mature stocks is essential to continuing finfish production.

Provision should be made for continuous liason with pollution control agencies to assure that the effects of all effluents on finfish resources are given full consideration.

Administration

1. Statutory regulations. Statutory regulations have been retained to satisfy special interest groups. These statutory regulations limit the flexibility of the management agency to make management decisions based on the best available information.

2. Lack of adequate coordination among data-gathering and analysis programs, implementing agency and user groups. Although several attempts to coordinate activities of data gathering and analysis, coordination and communication have not been adequate to define data needs or to completely eliminate duplication of efforts among groups interested in finfish fisheries of Mississippi. As a result these efforts have sometimes been diluted and less effective.

3. Lack of a formal system of information collection and display for monitoring and assessment of the effects of management policies, decisions and implementation. Many of the effects and ramifications of management alternatives and action, both detrimental and beneficial, may go undetected or uncommunicated in the absence of a formal mechanism for their display.

4. Lack of a formalized management plan for all Mississippi fisheries. A system of management implemented through the management structure is essential to rational solution of complex fishery problems in all fisheries.

Other

1. Inadequate understanding and knowledge of existing and required facilities to achieve optimum yield from Mississippi finfish fisheries. A study is needed to identify existing and future facilities, who should be responsible for them and methodologies of financing their construction as needed.

2. Clarity of Mississippi's jurisdication in fishery management. Alteration of Mississippi's (and other state's) jurisdiction in fisheries management is eminent unless the State's position is clarified and maintained. Interpretation of PL. 94-265 defines three distinct areas of coastal waters as follows:

1) The Fisheries Conservation Zone where Federal Management authority has been established.

2) Territorial Waters where there is a potential for pre-emption of State authority by the Federal government.

3) Internal State waters.

Boundaries of Mississippi's territorial waters are in question. Current charts of Mississippi Sound show extensive areas as being outside territorial waters and the inshore boundary of territorial waters is placed along the mainland coast line, leaving very little area in internal waters.

Hearings on the establishment of wilderness area in Gulf Island National Seashore included strong statements favoring inclusion of Park waterbottoms around the barrier islands in wilderness areas. This designation would prohibit all commercial fishing within one mile of the designated island areas, and leave all fishery management in those areas to the National Park Service. Further efforts to accomplish this inclusion can be expected.

Careful examination of the State's jurisdiction and energetic defense of its position is urgently needed.

Recommendations

The following recommendations have been developed by the working group for consideration by the State Management Agency. Recommendations are classified as high, medium or low priority. Priorities were determined by concensus in the working group. Each recommendation is followed by a code number in parenthesis which refers the recommendation back to a specific problem in the previous section.

High Priority

1. That this plan be adopted by Mississippi Marine Conservation Commission.

Official adoption by the Commission is needed to provide a plan for effective management of marine finfish in State waters that will interface with plans implemented outside state waters.

2. That a management plan for all Mississippi marine fishery resources be developed and implemented.

The proposed management plan does not cover Mississippi's shellfish (oysters, crabs, shrimp, etc.) and some important finfish caught predominantly in the FCZ. Planned management of all marine fishery resources is required if the complex interrelationship of problems involved in achieving

optimum yield are to be solved. (A 4)

9. That a mechanism be developed to provide for the collection and timely dissemination of all catch data required for rational management of Mississippi's marine finfish resource. (B 1)

Catch data from both recreational and commercial fisheries is required and must include both landings and "catch by waters". Current failure to report considerable quantities of finfish caught and landed must be corrected.

4. That current monitoring and assessment of Mississippi finfish resources be continued and expanded to include adult populations not adequately sampled by gear in use now.

An ongoing monitoring and assessment procedure to provide continuous long-term data on abundance and related environmental parameters for all life history stages is required if rational management of finfish stocks is to be achieved. Prediction of year class abundance provides economically important information to industry. (B 2)

5. That adequate economic data be included in catch statistics. (E 1)

See Recommendation 3 above.

6. That studies be conducted to determine all benefits accruing from finfish resources harvested by commercial and recreational fishermen. (E 5)

This information is required for rational consideration of options for regulatory decisions that involve user conflict for resources.

7. That an effective communication mechanism be developed to provide for better understanding of renewable resource management constraints (including biological, economic, social and legal) among all management and user sectors. (S 2)

Successful implementation of the proposed plan will depend on understanding and support from the entire community.

8. That feasible controlled fresh-water introduction to Mississippi estuarine areas be supported. (EN 2)

Introduction of controlled amounts of fresh-water with suitable quality to finfish habitat would increase production.

9. That all statuatory regulations concerning marine finfish be reviewed and their impact on management for optimum yield be determined. (A 1)

Appropriate legislative action could provide the flexibility required for finfish management to achieve optimum yield.

10. That a study be conducted to provide formal procedures for improved coordination among data gathering and analysis programs, implementing agencies and user groups. (A 2)

Effective coordination of all entities involved in finfish management is essential to successful implementation. Improved coordination can be accomplished through formal procedures.

11. That a study be conducted to develop a formal system of information collection and display for monitoring and review of the effects of management policies, decisions and implementation. (A 3)

This system would provide users with a clear and convenient display package. It would enable them to assess as completely as possible the biological, ecological, economic and social effects of their plans and policies before making subsequent management decisions.

12. That a study be conducted to clarify the limits of Mississippi's jurisdiction for fishery management. (O 2)

A clear understanding of jurisdictional constraints is essential to State management for optimum yield.

Medium Priority

1. That studies be initiated to provide data necessary for determination of population dynamics of Mississippi marine finfish stocks. (B 3)

This information is required for subsequent development of useful yield models. Necessary parameters include, but are not limited to, stocks size, age composition, size composition and natural and fishing mortality rates.

2. That a study be conducted to determine the marine finfish catch taken by harvesting directed at other species and the impact of that catch on finfish resources. (B 4)

This information is required for determination of the impact of the by-catch of other fisheries on finfish populations and subsequent harvest.

3. That studies be conducted to fill gaps in local knowledge of the life history of each marine finfish species included in this plan. (B 5)

Complete life history data for each species are required to provide an adequate data base for conservation of regulations when such regulations are necessary.

4. That yield models be developed for marine finfish stocks harvested in Mississippi waters. (B 6)

Yield models for stocks throughout their range will allow management to more fully utilize available stocks without damage to the resource.

5. That studies be conducted to provide adequate understanding of industry, market structure and behavioral relationships among economic units. (F 4)

This information is needed for an understanding of potential economic impact of regulatory decision options.

6. That economic impact of marine finfish by-

catch taken by directed fisheries for other species, with emphasis on discards and their potential utilization, be determined. (E 6)

This information is needed for consideration of management options that would provide for reduction and/or utilization of finfish by-catch taken by fisheries for other resources.

7. That adequate labor force statistics be compiled. (E 3)

This information is necessary for prediction of impact of alternative management options on harvesting, product flow and fishing communities.

8. That the effects of physical changes in estuarine habitat on marine finfish resources be determined. (EN 1)

Quantitative evaluation of the effects of habitat changes, i.e. marsh destruction, dredge and fill operations etc., are needed for selection of the best management options to provide optimum habitat conditions for finfish resources.

Low Priority

1. That studies be conducted to determine and fill gaps in data needed for a clear understanding of the relationship between catch, landings and price paid for Mississippi marine finfish. (E 2)

This information is needed to assess the economic impact of management decisions and for achievement of optimum economic returns from marine finfish resources.

2. That Maximum Economic Yield (MEY) models for Mississippi marine finfish resources be developed. (E 7)

MEY from available finfish resources should be available when options for optimum yield determinations are considered by management agencies.

3. That a study be conducted to determine key sociological variables required for management of the finfish industry and initiate collection of the required data. (S 1)

This information is needed for developing optimum yield estimates and to assess the social impact of alternative management decisions.

4. That investigations to determine the cause and effect of recurring fish kills in Mississippi waters be carried out. (EN 3)

This information is needed for determination of the effects of pollution on marine finfish production.

5. That the potential impact of all existing and proposed introduction of effluents to Mississippi coastal waters on marine finfish populations be determined. (EN 4)

This information is required for making rational decisions that will lead to maintenance of optimum conditions in the finfish environment.

6. That a study be conducted to determine the adequacy of existing facilities and provide for development of additional facilities required for achievement of optimum yield for Mississippi's marine finfish resources. (O 1)

This information is needed to provide for optimum production and utilization of marine finfish resources.

Tabular Summary of Management Action Program

This section enumerates the cost and time horizon estimates of the first five years of implementation of the proposed management plan for the selected species of marine finfish. All projects and recommendations are important to the accomplishment of goals 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 priorities, in general, were assigned to projects that are essential to the development of 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 1979 dollars will be approximately $2,537,700. This total amount of money includes all costs necessary to perform the research projects, but is not necessarily new money. Some of the projects, or part of them are already in progress. In many cases recommended action will apply to all fisheries. These costs should not be included in estimates provided in plans for other fisheries. Estimates for cost of monitoring and assessment (B-2) are in addition to the current monitoring and assessment program which includes all important species except oysters. Table 2 shows cost estimates broken down by type of action and year.

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(m) should have prime responsibility for funding once project proposals have been developed. The "Homogeneous Area" column refers to the magnitude of the program 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.

TABLE 1.

Management action program summary[1] (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 of Funding	Priority	Homogeneous Area	Cross Reference
Biological	To collect and disseminate catch statistics required for optimum yield management of Mississippi Marine Finfish	B-1	130.0	65.0	45.0	45.0	45.0	NMFS/State/CZM	High	Range of stock	E-1, S-1
	To monitor and assess all life history stages of selected species of finfish in Mississippi waters	B-2	40.0	35.0	35.0	35.0	35.0	State/NMFS/Univ.	High	Range of stock in State	B-3
	To design and initiate projects for collection and analysis of data required for population dynamics estimates	B-3	25.0	115.0	120.0	125.0	65.0	Fed/State/Univ/CZM	Medium	Range of stock	B-6
	To determine the amount and effect of finfish by-catch in other fisheries	B-4	30.0	30.0	30.0	—	—	State/Univ	Medium		E-6, B-6
	To fill data gaps in life history of selected finfish species	B-5	50.0	50.0	50.0	50.0	50.0	State/Fed/Univ/Sea Grant	Medium	Range of stock	B-3
	To develop yield models for selected species of marine finfish	B-6	—	10.0	10.0	35.0	50.0	Fed/State/Univ/Sea Grant	Medium	Range of stock	B-3
Economic	To provide yield for adequate economic data in catch statistics	E-1	SEE	B-1	—	—	—	NMFS/State/CZM	High	Range of stock	B-1
	To determine interrelationship of catch, landings and price paid for Mississippi marine fisheries	E-2	25.0	25.0	10.0	—	—	Univ./Fed/Sea Grant	Low	International	
	To determine potential markets for marine finfish available to Mississippi fishermen	E-3	30.0	30.0	30.0	—	—	Sea Grant/Univ/State	Medium	International	
	To increase understanding of industry, market structures and behavorial relationships among economic units	E-4	25.0	25.0	—	—	—	Sea Grant/State/NMFS/Univ	Medium	National	
	To determine benefits derived from finfish resources harvested by recreational and commercial fisheries	E-5	30.0	30.0	30.0	—	—	Sea Grant/State	High	State	
	To determine economic impact of finfish by-catch taken by fisheries directed at other species	E-6	—	—	15.0	10.0	10.0	State/Univ Sea Grant	Medium	Range of stock	B-4

TABLE 1 (Continued)

Management action program summary[1] (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 of funding	Priority	Homogeneous Area	Cross Reference
Economic (Continued)	To determine MEY for selected finfish species	E-7	20.0	30.0	10.0	10.0	10.0	Sea Grant/ State/NMFS	Low	Range of stock	
Social	To determine key sociological variables required and initiate their collection and documentation	S-1	16.0	30.0	20.5	12.5	—	Sea Grant/ State/CZM	Low	State	B-1
	To develop and implement an effective communication system among all management and user sectors	S-2	20.0	10.5	10.5	10.5	10.5	Sea Grant/ State	High	State	
	To compile adequate labor force statistics	S-3	12.5	18.0	—	—	—	Sea Grant/ State/CZM	Medium	Gulf	
Environmental	To determine quantitative effects of physical habitat changes on selected marine finfish	EN-1	15.0	50.0	50.0	50.0	50.0	NMFS/State/ Sea Grant/ FCZ	Medium	Range of stock	
	To support controlled introduction of fresh water to Mississippi estuarine areas as feasible	EN-2	2.5	1.5	1.5	1.5	1.5	Sea Grant/ Univ/CZM	High	State	EN-3
	To determine cause and effect of fish kills in Mississippi coastal waters	EN-3	28.5	25.5	25.5	—	—	State/Univ/ NMFS/CZM	Low	State	EN-4
	To determine impact of effluents on Mississippi Marine finfish populations	EN-4	38.5	18.0	18.0	18.0	18.0	State/Sea Grant/CZM	Low	State	
Administrative	To review Mississippi's statutory regulations and assess their impact on finfish management	A-1	7.5	—	—	—	—	Sea Grant/State	High	Gulf	
	To improve coordination among data gathering and analyses programs, implementing agencies and user groups	A-2	3.5	0.8	0.8	0.8	0.8	State	High	State	
	To develop a formal system of information collection and review on the effects of management, policies, decisions and implementation	A-3	3.0	—	—	—	—	State	High	State	
	To develop management plan for all marine fishery resources in Mississippi	A-4	70.0	25.5	—	—	—	Sea Grant/ State	High	Gulf	
Other	To determine facility requirements for achieving optimum utilization of Mississippi finfish resources	O-1	3.0	9.5	—	—	—	Sea Grant/ State/FCZ	Low	State	
	To identify jurisdictional constraints on Mississippi marine finfish management	O-2	7.5	—	—	—	—	State/Sea Grant/FCZ	High	Gulf	

[1]Funding may be cross referenced between several programs.

TABLE 2.
Costs estimates (Table 1) broken down by type of action and year.

Type of Action	Year 1	2	3	4	5	Totals $	Percent
Biological*	275.0	305.0	290.0	290.0	245.0	1405.0	55.6
Economics	130.0	140.0	95.0	20.0	20.0	405.0	16.0
Social	48.5	58.5	31.0	23.0	10.5	171.5	6.8
Environmental	84.5	95.0	95.0	69.5	69.5	413.5	16.4
Administrative	84.0	26.3	0.8	0.8	0.8	112.7	4.4
Other	10.5	9.5	—	—	—	20.0	0.8
Totals	632.5	634.3	511.8	403.3	345.8	2527.7	100.0
Percent	25.0	25.1	20.2	16.0	13.7		

*Includes economic catch data development.

DESCRIPTION OF THE RESOURCE AND FISHERY

Introduction

The Mississippi Marine Conservation Commission selected ten species of finfish to be addressed in the formulation of this plan. These species were selected on the basis of their commercial and recreational value. The ten species selected were the spotted seatrout, sand seatrout, red drum, flounder, menhaden, southern kingfish (ground mullet), croaker, mullet, sheepshead and black drum.

Commercial catch data for these ten species are reported by the National Marine Fisheries service (NMFS). Reported landings data give, by state, volume (round weight) and dockside value. NMFS also collects finfish data by statistical area (catch by waters). Although not published, it is available upon request. Landings data by statistical area are currently available for the period 1963 through 1975.

Mississippi's reported commercial landings of finfish and shellfish show a ten-year (1967-1977) average volume of 296.2 million pounds. Marine finfish provided 96.5% of the volume. The remaining production was comprised principally of shrimp, oysters and crabs. Industrial production (menhaden and bottomfish) accounted for 98.0% of the finfish volume while food fish accounted for only 2.0% of the finfish volume. Food fish include numerous species which are harvested by both recreational and commercial fishermen. All species considered in this plan except menhaden are considered to be food fish and comprise a portion of the total 2.0% volume of food fish landed. With the exception of several national surveys and two local surveys there are no data available on recreational landings of these species, therefore only commercial landings will be discussed.

Commercial landings of spotted seatrout, sand seatrout, red drum, flounder, southern kingfish, croaker, mullet, sheepshead and black drum during the period 1963-75 have ranged from 995,000 to 3,654,000 pounds (Table 3).

Black drum make up only 1.9 percent of the total landings of these nine species landed in Mississippi while croaker and mullet account for 25.2 and 24.2 percent, respectively.

The percentage of landings caught in Mississippi ranges from 1.9 percent for croaker up to 114.7 percent for mullet. There is considerable variation in the percentages of the various species harvested from Mississippi Sound and landed in Mississippi. The overall percentages of Mississippi spotted seatrout and red drum landings caught in Mississippi Sound have shown a general decline over the 1963-75 time period. It is generally held by Gulf fishery workers that this apparent decline is a function of regulation of the fishery rather than a decrease in the population size. This is further confirmed when one evaluates the preliminary 1978 landings where a large increase in red and black drum landings is noted. This increase in the landings reflects a change in fishing gear, demand and price. Southern kingfish have shown a trend of increased catches from the Sound. This increase appears to be a function of increased market demand for this species and the majority of the increase in landings is coming from the industrial bottomfish fishery and the shrimp trawler fleets by-catch. Sand sea-trout,

TABLE 3.

Commercial catch and landing statistics (1963-75) for spotted seatrout, sand seatrout, red drum, flounder, southern kingfish, croaker, mullet, sheepshead and black drum in Mississippi in thousands of pounds showing percentage of landings caught in Mississippi Sound and contribution of each species to total catch of these species.

SPOTTED SEATROUT

Year	Catch Ms Sd	MS Land.	%	MS Land.	Tot. Land.	%
63	40	80	50.0	80	955	8.4
64	105	148	70.9	148	949	15.6
65	98	149	65.8	149	849	17.6
66	88	145	60.7	145	1576	9.2
67	96	171	56.1	171	3160	5.4
68	86	269	32.0	269	3654	7.4
69	56	221	25.3	221	2144	10.3
70	45	255	17.6	255	1467	17.4
71	40	393	10.2	393	1854	21.2
72	33	255	12.9	255	1779	14.3
73	62	366	16.9	366	1966	18.6
74	36	295	12.2	295	2966	9.9
75	23	262	8.8	262	2792	9.4
Mean	62	231	26.9	231	2009	11.5

SAND SEATROUT

Year	Catch Ms Sd	MS. Land.	%	MS. Land	Tot. Land.	%
63	8	68	11.8	68	955	7.1
64	8	26	30.8	26	949	2.7
65	5	27	18.5	27	849	3.2
66	11	74	14.9	74	1576	4.7
67	20	74	27.0	74	3160	2.3
68	19	311	6.1	311	3654	8.5
69	20	132	15.2	132	2144	6.2
70	23	105	21.9	105	1467	7.2
71	29	163	17.8	163	1854	8.8
72	27	157	17.2	157	1779	8.8
73	43	118	36.4	118	1966	6.0
74	34	267	12.7	267	2966	9.0
75	59	264	22.3	264	2792	9.5
Mean	24	137	17.1	137	2009	6.8

RED DRUM

Year	Catch Ms Sd	MS. Land.	%	MS. Land.	Tot. Land.	%
63	39	59	66.1	59	955	6.2
64	34	50	68.0	50	949	5.3
65	20	33	60.6	33	849	3.9
66	25	37	67.6	37	1576	2.3
67	69	96	71.9	96	3160	3.0
68	75	215	34.9	215	3654	5.9
69	25	100	25.0	100	2144	4.7
70	19	70	27.1	70	1467	4.8
71	18	59	30.5	59	1854	3.2
72	11	55	20.0	55	1779	3.1
73	20	86	23.3	86	1966	4.4
74	11	80	13.8	80	2966	2.7
75	19	71	26.8	71	2792	2.5
Mean	30	78	38.1	78	2009	3.9

FLOUNDER

Year	Catch Ms Sd	MS. Land.	%	MS. Land.	Tot. Land.	%
63	21	59	35.6	59	955	6.2
64	19	57	33.3	57	949	6.0
65	26	69	37.7	69	849	8.1
66	33	50	66.0	50	1576	3.2
67	39	138	28.3	138	3160	4.4
68	26	138	18.8	138	3654	3.8
69	24	123	19.5	123	2144	5.7
70	45	152	29.6	152	1467	10.4
71	49	172	28.5	172	1854	9.3
72	34	153	22.2	153	1779	8.6
73	32	97	33.0	97	1966	4.9
74	37	98	37.8	98	2966	3.3
75	41	105	39.0	105	2792	3.8
Mean	33	109	30.2	109	2009	5.4

SOUTHERN KINGFISH

Year	Catch Ms Sd	MS. Land.	%	MS. Land.	Tot. Land.	%
63	46	257	17.9	257	955	26.9
64	54	323	16.7	323	949	34.0
65	47	271	17.3	271	849	31.9
66	56	354	15.8	354	1576	22.5
67	100	403	24.8	403	3160	12.8
68	65	237	27.4	237	3654	6.5
69	56	254	22.0	254	2144	11.8
70	61	269	22.7	269	1467	18.3
71	52	312	16.7	312	1854	16.8
72	117	375	31.2	375	1779	21.1
73	122	295	41.4	295	1966	15.0
74	64	215	29.8	215	2966	7.2
75	60	153	39.2	153	2792	5.5
Mean	69	286	24.2	286	2009	14.2

CROAKER

Year	Catch Ms Sd	MS. Land.	%	MS. Land	Tot. Land.	%
63	1	3	33.3	3	955	0.3
64	0	0	0.0	0	949	0.0
65	0	0	0.0	0	849	0.0
66	4	127	3.1	127	1576	8.1
67	11	389	2.8	389	3160	12.3
68	15	1400	1.1	1400	3654	38.3
69	2	647	0.3	647	2144	30.2
70	26	332	7.8	332	1467	22.6
71	26	498	5.2	498	1854	26.9
72	13	484	2.7	484	1779	27.2
73	9	453	2.0	453	1966	23.0
74	10	1500	0.7	1500	2966	50.6
75	10	1001	1.0	1001	2792	35.9
Mean	10	526	1.9	526	2009	26.2

MULLET

Year	Catch Ms Sd	MS. Land.	%	MS. Land.	Tot. Land.	%
63	319	382	83.5	382	955	40.0
64	303	250	121.2	250	949	26.3
65	336	241	139.4	241	849	28.4
66	807	636	126.9	636	1576	40.4
67	941	1705	55.2	1705	3160	54.0
68	535	947	56.5	947	3654	25.9
69	533	388	137.4	388	2144	18.1
70	473	162	292.0	162	1467	11.0
71	486	177	274.6	177	1854	9.5
72	420	221	190.0	221	1779	12.4
73	775	482	160.8	482	1966	24.5
74	754	452	166.8	452	2966	15.2
75	576	284	202.8	284	2792	10.2
Mean	558	487	114.7	487	2009	24.2

SHEEPSHEAD

Year	Catch Ms Sd	MS. Land.	%	MS. Land.	Tot. Land.	%
63	14	30	46.7	30	955	3.1
64	30	49	61.2	49	949	5.2
65	15	26	57.7	26	849	3.1
66	22	33	66.7	33	1576	2.1
67	45	51	88.2	51	3160	1.6
68	37	63	58.7	63	3654	1.7
69	34	165	20.6	165	2144	7.7
70	20	69	29.0	69	1467	4.7
71	18	59	30.5	59	1854	3.2
72	14	56	25.0	56	1779	3.1
73	13	55	23.6	55	1966	2.8
74	12	48	25.0	48	2966	1.6
75	26	32	81.3	32	2792	1.1
Mean	23	57	40.8	57	2009	2.8

BLACK DRUM

Year	Catch Ms Sd	MS. Land.	%	MS. Land.	Tot. Land.	%
63	10	17	58.8	17	955	1.8
64	25	46	54.3	46	949	4.8
65	19	33	57.6	33	849	3.9
66	16	20	80.0	20	1576	1.3
67	25	33	75.8	33	3160	1.0
68	27	74	36.5	74	3654	2.0
69	15	114	13.2	114	2144	5.3
70	8	53	15.1	53	1467	3.6
71	4	21	19.0	21	1854	1.1
72	3	23	13.0	23	1779	1.3
73	3	14	21.4	14	1966	0.7
74	4	11	36.4	11	2966	0.4
75	5	20	25.0	20	2792	0.7
Mean	13	37	34.2	37	2009	1.8

flounder and mullet exhibit no specific trends.

Because of the magnitude of the menhaden landings they are considered separately. There is considerable variation in the Mississippi Sound catch during the 1963-75 time period, but overall Mississippi Sound contributed 59.5 percent of those menhaden landed in Mississippi. Over the period 1963-75 menhaden accounted for 99.1 percent of Mississippi landings of the ten species of fish under consideration in this plan (Table 4).

The Working Group examined the extensive literature on the ten species under consideration, citing 235 papers and reports in summarizing available data to describe the extremely complex resource and fishery.

Distribution

The ten species of finfish under consideration in this plan are generally distributed along the south Atlantic and northern Gulf Coasts. There are variations in the extent of the overall distribution of these species but generally they are most abundant along the northern Gulf. Any management plan developed for Mississippi has to be aware of the fact that only a very small percentage of the total population of these several species is subject to management by Mississippi.

An additional consideration is that these several species are considered to be estuarine dependent, meaning that they spend only a portion of their life in waters under the jurisdiction of Mississippi. National Marine Fisheries Service examined the jurisdictional distribution of fish and invertebrate species in the NMFS Southeast Region. According to this estimate 94.5% (Fig. 5) of these species are inter-jurisdictional. Therefore, any plan developed for Mississippi waters will have to be compatiable with plans developed in adjoining states and the Fishery Conservation Zone (FCZ).

Life History

Following is a brief life history description of the ten selected species. Table 5 summarizes those life history items which are deemed most important for management.

Spotted Seatrout - *Cynoscion nebulosus* (Cuvier)

The spawning season of the spotted seatrout is protracted in the Gulf of Mexico extending from late winter through fall and being tempered somewhat by latitude. It has been noted that spotted seatrout spawn in late spring and early summer in Mississippi (Table 5). Young of the year spotted seatrout are collected each year beginning in May and continue to occur in samples until early fall with the peak occurence in the summer. The optimal spawning temperature has been determined to be 20-30 C; optimal salinity 20-35‰.

Spotted seatrout spawn in Mississippi Sound. It is currently held that spawning area is a function of environmental condition at spawning time each

TABLE 4.

Reported commercial catch and landings of menhaden in Mississippi (1963-1975) showing percentage caught in Mississippi Sound and percentage of total landings of ten species contributed by menhaden.

Year	Catch Ms Sd	MS. Land.	%	MS. Land.	Tot. Land.	%
63	180500	250429	72.1	250429	251384	99.6
64	112198	237833	47.2	237835	238782	99.6
65	157891	278104	56.8	278104	278953	99.7
66	77685	190654	40.7	190654	192230	99.2
67	98000	166527	58.8	166527	169687	98.1
68	36660	149535	24.5	149535	153189	97.6
69	92815	225377	41.2	225377	227521	99.1
70	125296	205980	60.8	205980	207447	99.3
71	213709	308358	69.3	308351	310205	99.4
72	123185	178273	69.1	178273	180052	99.0
73	127856	177856	71.9	177856	179822	98.9
74	150000	215674	69.5	215674	218640	98.6
75	168583	212071	79.5	212071	214863	98.7
Mean	128029	215129	59.5	215128	217137	99.1

TABLE 5.

Summary tabulation of principal migrate life history data required for rational management of Mississippi Finfish.

Name	Spawning Time	Spawning Location	Larval Migration	Age and Size (SL)	cm.	in.	Fecundity	Population Dynamics	Physio-Chemical Factors	Migration
Cynoscion nebulosus Speckled trout[1]	July[2] April - Sept.	Miss. Sound	Larvae migrate to inshore marsh nursery grounds, May - October	I II III IV V VI VII VIII	13.15 - 5.1 21.85 - 8.6 28.15 - 11.0[3] 33.96 - 13.3 39.55 - 15.5 45.05 - 17.7 47.00 - 18.5 53.10 - 20.0		15,000 1,500,000	No local data	Salinity Range 2.0 - 35.3 ppt Temperature Range 5.0 - 34.9C 41.0 - 94.8F	Migration seasonal and in response to changes in salinity and temperature. No other local data.
Cynoscion arenarius White Trout[1]	July[2] March - Sept.	Offshore	Larvae migrate to inshore marsh nursery grounds, May - October	I	18.5 - 7.2		No data	No local data	Salinity Range 0.0 - 35.5 ppt Temperature Range 7.0 - 30+C 44.6 - 86+F	Migration seasonal and in response to changes in salinity and temperature. No other local data.
Sciaenops ocellata Red Fish[1]	October[2] Sept. - Feb.	Near Offshore	Larvae migrate to inshore marsh nursery grounds, Sept. - Nov.	I II III IV V	34.0 - 13.5 54.0 - 21.5 64.0 - 25.25 75.0 - 29.50[3] 84.0 - 33.25		 500,000 3,500,000	No local data	Salinity Range 0.0 - 30.0 ppt Temperature Range 2.0 - 31.0C 35.6 - 87.8F	Migration seasonal and in response to changes in salinity and temperature. No other local data.
Paralichthys lethostigma Flounder[1]	October [2] Sept. - Jan.	Near Offshore	Larvae migrate to inshore marsh nursery grounds, December - May	I II III IV	--- 23.0 - 9.0 34.0 - 13.3[4] 48.0 - 18.8		No data	No local data	Salinity Range 0.0 - 36.2 ppt Temperature Range 5.0 - 34.9C 41.0 - 94.8F	Migration seasonal and in response to changes in salinity and temperature. No other local data.
Brevoortia patronus Menhaden[1] Pogey[1]	Dec. - Feb.[2] Oct. - March	Offshore	Larvae migrate to inshore marsh nursery grounds, Oct. - April	I II III	14.0 - 5.5[4] 15.5 - 6.1 16.7 - 6.5		21,960 68,655 122,062	Population structure Population size - Life cycles Distribution Movements Age and Size Composition	Salinity Range 0.0 - 67.0 ppt Temperature Range 5.0 - 34.9C 41.0 - 94.8F	Migrate offshore at 1 yr. - back inshore after spawning
Menticirrhus americanus Ground mullet[1]	April - Oct.	Near Offshore	Larvae migrate to inshore marsh nursery grounds, Oct. - April	I II	21.2 - 8.3 -[5]		No data	No local data	Salinity Range 5.0 - 35.5 ppt Temperature Range 10.0 - 34.9C 50.0 - 94.8F	Migration seasonal and in response to changes in salinity and temperature. No other local data
Micropogon undulatus Croaker[1]	Nov. - Dec.[2] Sept. - April	Near Offshore	Larvae migrate to inshore marsh nursery grounds, October - June	I II III IV V VI	14.13 - 5.5 21.31 - 8.3[3] 27.04 - 10.6 31.74 - 12.4 35.59 - 14.0 38.64 - 15.2		 180,000 	Population structure Population size Life cycles Distribution Movements Age and size Composition	Salinity Range 0.3 - 35.5 ppt Temperature Range 5.0 - 34.9C 41.0 - 94.8F	Migrate offshore at 1 yr. back inshore after spawning - May make several inshore movements during life time
Mugil cephalus Mullet[1]	Dec. - March[2] Nov. - May	Offshore	Larvae migrate to inshore marsh nursery grounds, Nov. - May	I II II	11.22 - 4.4 22.50 - 8.8[4] 35.25 - 13.8		76,000 1,530,000	Little local data	Salinity Range 0.0 - 35.5 ppt Temperature Range 7.0 - 30.0C 44.6 - 86.0F	Migration seasonal and in response to change in salinity and temperature. No other local data.
Archosargus probatocephalus Sheepshead	Feb. - March	Near Offshore	Larvae migrate to inshore marsh nursery grounds, March	No local data			No data	No local data	Salinity Range 0.0 - 35.0 ppt Temperature Range 5.0 - 34.9C 41.0 - 94.8F	Migration seasonal and in response to change in salinity and temperature. No other local data
Pogonias cronis Black Drum	Feb. - March[2]	Near Barrier Islands & Miss. Sound	Spawning area and nursery area may be one & the same	No local data			No data	No local data	Salinity Range 9.0 - 25.6 ppt Temperature Range 12.2 - 29.9C 53.9 - 85.8F	No local data

[1]Local Common Names
[2]Peak Spawning Time
[3]All Fish Mature
[4]Fork Length

year. If the salinity and temperature are high in Mississippi Sound spawning may occur throughout the Sound. If salinities are depressed, spawning is probably limited to the area immediately around the barrier islands.

After hatching, young spotted seatrout migrate into the inshore nursery areas from May through October.

Spotted seatrout are generally believed to mature at one to three years of age. Some males mature at one year, all are mature at two years. Females begin to mature at two years and all are mature at three years. Fish eight to thirteen inches (203.2-330.2mm) standard length (SL) make up the majority of the spawning stock in Mississippi. Depending on age of the fish, spotted seatrout produce 15,000 to 1,500,000 eggs per spawn.

In general spotted seatrout show wide variation in growth rate. Growth differs by sex, and growth is not constant throughout the year. Female growth rate always exceeds that of the males. Spotted seatrout have pelagic eggs which are about 0.77 mm (0.03 in) in diameter. At hatching spotted seatrout are about 1.5 mm (.05 in) long. By the end of the first year they average 13.15 cm (5.1 in) SL. See Table 5 for lengths of spotted seatrout for successive years. It has been estimated that in the total population of fish over 1 year old, year class one accounts for 26.8%, year class two accounts for 20.1%, year class three accounts for 15.9%, year class four accounts for 15.9%, year class five accounts for 10.6%, year class 6 accounts for 6.0% and 4.7% are over 6 years old. Sex ratio changes with age. At age one only 19% of the population was female and by age five 82% of the population was female.

There is no local information on population abundance, mortality rates or migratory habits of spotted seatrout in Mississippi Waters.

Spotted seatrout are caught in Mississippi waters in temperatures and salinities which varied from 5.0 to 34.9 C (41-94.2F) and 2.0 to 35.5°/₀₀, respectively. Catastrophic mortalities of spotted seatrout have been attributed to severe cold, hurricanes and excessive fresh water. Kills of spotted seatrout have also been found in oxygen depletion kills along the Mississippi Coast.

The habitat for spotted seatrout in Mississippi appears to be in good condition at the present time. Little is known of the quantitative effects of human encroachment into the estuarine environment on spotted seatrout populations. In recent years there have been increased demands on the estuaries for sewage disposal, oil exploration, dredging, filling, laying of pipelines, installation of marinas, treatment ponds for industrial plants and cooling ponds for generating plants, etc. Since spotted seatrout may spawn in the estuaries and are dependent upon them for food throughout their lives and since the evidence is very strong that each estuary maintains a distinct subpopulation of seatrout, it is clear that the estuarine environment is a particularly critical one for this species. Unfavorable conditions for spawning or feeding in a particular estuary, resulting in declines in seatrout populations, may result in long-term recovery times due to lack of immigrating stock from other estuaries.

The spotted seatrout is an opportunistic carnivore, feeding on whatever animal is predominant in the estuary, but usually fish and crustaceans. Those species of fish and crustaceans which are fed on by spotted seatrout change as the fish grow larger.

The spotted seatrout ranges from Cape Cod to the Gulf of Campeche in Mexico. It is most abundant along the Gulf coast.

There are a number of parasites and diseases of the spotted seatrout but there is only one which is of concern to Man. This is a cestode worm which occurs in the muscle of these fish along the backbone. It is not a health problem for Man, although a "wormy" seatrout is not very attractive. There is no evidence that parasites have any serious effect on wild populations of this species.

Sand seatrout - *Cynoscion arenarius* (Ginsburg)

Sand seatrout spawn in the Gulf off Mississippi from March through September. Postlarval sand seatrout immigrate to the inshore nursery grounds beginning usually in April and continue to move in through the early fall. Peak migration time varies from year to year.

Sand seatrout have been reported to be mature at 350 mm (13.7 in) for males and 357 mm (14.0 in) total length (TL) for females. There is no data available on the number of eggs produced. Growth rates for juveniles appear to be greatly influenced by temperature. Growth rates for spring spawned fish in Mississippi were greater than rates for fish spawned in late summer and fall. Estimates of growth ranged from 27.7 mm (1.09 in)/ month for April to 10.3 mm (0.4 in)/month for July larvae.

Little data exists on the identity and age composition of sand seatrout stocks. Recent studies in Mississippi Sound indicate that modal lengths of fish tended to decrease from fall through winter suggesting a continued emigration of older juveniles from Mississippi Sound. Conversely there was an increase in modal lengths offshore in the spring indicating either the return of older fish and/or the movement of over-wintering juveniles toward high

salinity waters.

Without fecundity estimates, population size and structure information no discussion of population dynamics is feasible.

The sand seatrout is considered to be euryhaline. It has been found in Mississippi in salinities from 0 to 35.5 °/₀₀. The greatest number of trawl caught fish were taken in salinities from 5 to 14.9°/₀₀. The largest number of recreationally caught fish were hooked in salinities of 10.6 to 25.6°/₀₀. Juveniles (20-90 mm 0.3-3.5 in. long) were caught most frequently in salinities below 15°/₀₀ and most were captured in salinities of less than 5°/₀₀.

The primary habitat of the sand seatrout is estuarine. In Mississippi they are most frequently caught in Mississippi Sound.

The sand seatrout is dependent on the estuarine nursery area although spawning occurs at least to depths of 50 fathoms. The condition of the estuary will ultimately have a positive or negative effect on the sand seatrout population.

The sand seatrout is piscivorous, changing from a strictly planktonic diet at an early age. Shrimp were the second most important food item.

Sand seatrout range from the west coast of Florida to Campeche, Mexico.

There are a number of parasites and diseases of the sand seatrout, none of which constitute a health hazard to Man. There is no evidence that parasites have any serious effect on wild populations of this species.

Red drum - *Sciaenops ocellata* (Linnaeus)

Red drum generally spawn from mid-September through mid-February. Peak spawning occurs in late September through October. Although the exact location of spawning is unknown it is thought to occur offshore in the Gulf possibly near the mouth of passes. This assumption is supported by the fact that the smallest larvae are found near the passes and larger larvae are found in the inshore nursery areas.

Male red drum mature earlier than the female red drum. Males mature when they reach approximately 40 cm (16 in) SL and females mature when they reach approximately 75 cm (29 in) in length. Depending on size, females have been reported to produce from 20,000 to 3,500,000 eggs per spawn.

Red drum eggs average 0.92 mm (.036 in) in diameter. Upon hatching the larvae are approximately 1.5 mm TL (0.6 in). Growth is rapid the first year. By the end of the first year red drum average 34 cm SL (13.3 in) and weigh on the average 0.4 kg (1.1 lb). By the end of the second year they average 54 cm (21.5 in) SL, the third year they average 64 cm (25.25 in) SL, the fourth year they average 75 cm (29.5 in) SL and by the end of the fifth year they average 84 cm (33.25 in) SL in length.

Red drum are generally aged using hard structures such as otoliths, scales, dorsal rays and the second anal spine.

As with the spotted seatrout and sand seatrout a discussion of population dynamics is impossible because of the lack of data. There are limited amounts of mortality data and population estimates from other Gulf States but generalization of this information to Mississippi waters may not be accurate for it appears from the literature that each area may have a distinct population of red drum. The red drum in other areas are basically non-migratory. They appear to exhibit only an onshore-offshore migration in association with spawning activities.

Red drum are broadly euryhaline. They occur in salinities ranging from 0-50°/₀₀, although they are rare at the higher salinities. A direct relationship between size and salinity has been established and large fish are found in high salinities. Small red drum 3.0-31 mm (.11-1.2 in) SL have been taken over a salinity range of 8.5-27.5°/₀₀. Juvenile red drum [43.0-111.0mm (1.6-4.3 in) SL] from Mississippi were taken over a salinity range of 0.0-30.0°/₀₀ with the largest percentage catch coming from salinities of 20.0-25.0°/₀₀.

Red drum are also eurythermal. Red drum have been taken in waters with a temperature range of 2-29C (35.6-84.2F). Young red fish (3.0-31.0 mm/.11-1.2 in SL) were taken from Mississippi over a temperature range of 20.5-31.0C (68.9-87.8F) while juveniles (45.0-111.0 mm/1.6-4.3 in SL) were taken from temperatures of 13.8-28.8C (56.6-83.8F) with the highest catches occurring at temperatures between 20.0-25.0C (68-77F).

Red drum have been reported killed in severe winter cold spells.

At this time it appears that the red drum habitat in Mississippi is in good condition. Like the two species discussed previously the red drum is estuarine dependent and any degradation of the estuarine habitat will ultimately have an effect on the success of the red drum population in this area.

It has been found that red drum < 15mm (.59 in) feed selectively on copepods and copepods nauplii. Red drum 15-50 mm (.59-2.0 in) feed selectively on mysid shrimp and to a lesser extent on fish, amphipods, other decapods (grass shrimp, penaeid shrimp, young blue crabs) and polychaete worms. In general the larger fish feed on crustaceans and fishes. The percentages of these food items varied with

geographic location, season and size of fish. Red drum gorged with sand dollars have been taken in Mississippi.

The known range of the red drum on the Atlantic coast is from Buzzards Bay, Massachusetts to Key West, though they occur irregularly north of New Jersey. In the Gulf, they occur continuously from southwest Florida across the northern Gulf and southward into northern Mexico.

Red drum apparently spawn offshore. The resulting larvae make their way to inshore nursery areas. As sub-adults (1-3 yr) they remain inshore. At three years of age or greater they move back into the open Gulf or Sound waters where they generally remain in large schools.

There are a number of parasites and diseases which are known to occur in and on red drum. The only one of concern to Man is the cestode worm described in the spotted seatrout. It presents no hazard to Man although it makes the flesh of the fish unattractive for consumption by Man. There is no evidence that any of the parasites or diseases are harmful to red drum populations.

Flounder - *Paralichthys lethostigma* (Jordan and Gilbert)

The flounder moves offshore into the Gulf waters to spawn in the fall and early winter. The resulting larvae move back into the inshore nursery areas through about May.

Flounder first mature in Mississippi when they reach a standard length of approximately 250 mm (9.0 in). All fish appear to be mature when they reach a standard length of approximately 340 mm (13.3 in).

There is no information on the fecundity, growth rate of larvae and juveniles and on the identity and age composition of the flounder stocks.

As with the three previous species discussed there is inadequate data on population dynamics.

The flounder is euryhaline. Flounder have been reported from salinities of 0.0 to 29.9°/$_{oo}$ and temperatures of 5.0-34.9C (41.0-94.8F).

The flounder is generally distributed down the Atlantic coast from North Carolina southward and across the northern Gulf to Texas. It appears that flounder occur most frequently on mud and muddy sand bottom types. The habitat of flounder in this area appears to be in good condition. Like the species discussed previously the flounder is estuarine dependent and degradation of the estuarine habitat may have an effect on the flounder population.

The larval and early juvenile forms are primarily planktonic feeders. The late juveniles and adults feed principally on crustaceans (shrimp) and small species of fish.

Ectoparasites are fairly common on flounders and large numbers can stress the fish to the point of death. There is no evidence that any of the parasites and diseases known to occur on the flounder present a threat to human health.

Menhaden - *Brevoortia patronus* (Goode)

Gulf of Mexico menhaden landings include three species, one of which predominates. Gulf Menhaden (*Brevoortia patronus*) is the principal species landed in Mississippi. Incidental catches of yellowfin (*B. smithi*) and finescale (*B. gunteri*) are landed in other areas. A few specimens of the yellowfin and finescale menhaden have been collected in Mississippi waters.

The menhaden life cycle follows the general pattern of estuarine dependent species as previously discussed. Actual spawning of the menhaden has not been observed but the best evidence indicates that spawning of Gulf menhaden is accomplished for the most part from October through March. There is evidence that spawning may occur as early as September and as late as May in some years. Menhaden spawn in Gulf waters off Mississippi from near shore to as much as 60 miles offshore where water depth ranges from 1 to 60 fathoms.

Larvae (9.0-25 mm/.31-.98 in SL) move from the spawning grounds back to the Mississippi inshore estuaries where they transform into juveniles and reside for several months before returning to the Gulf. Beginning in October with some annual variation they move through the barrier island passes and are distributed throughout the nursery area. Immigration continues through April and into May in some years. Peaks occur from December to April.

Migration of adults into Mississippi Sound occur in March and April, controlling opening of the menhaden fishing season.

Menhaden migrate to offshore Gulf waters when they are about one year old [100 mm 4 in fork length (FL)] to spawn before they are subjected to fishing pressure. Spawning in this species is total but intermittent. The number of eggs spawned by a mature female usually increases with age. The mean number of eggs per age group of menhaden collected east of the Mississippi River delta is reported as I-21,960, II-68,655, III-122,062. In the fish used in this egg study age groups I, II, and III made up 8, 85 and 4% respectively in the samples.

The slender menhaden larvae less than 20 mm (.78 in) SL acquire adult body form by the time they reach 28-30 mm (1.1-1.2 in) long. Juveniles grow rapidly in nursery areas through most of their first year. Young fish 32 mm (1.25 in) TL in April reached 84 mm (3.3 in) TL in July.

Results of efforts to determine whether distinct stocks of Gulf menhaden occur have led to the conclusion that there is one stock ranging from Florida to Yucatan. Extensive migrations along the shore have not been described. Apparently they winter offshore relatively near summer fishing grounds. Tagging studies have shown that there is little movement between fishing grounds east and west of the Mississippi River delta and that, in general, adults move onshore-offshore with no extensive east-west migration.

Age composition of Gulf menhaden catches has been determined by NMFS since 1963. Most menhaden taken in the fishery are 1 and 2 year old fish and the ratio of I's and II's changes from year to year. Much has been learned about Gulf menhaden dynamics since studies began in the 1950's. This information deals with such problems as population structure and size, life cycles, distribution, movements, and age and size composition of the catches. Because few age groups are taken in the fishery, fluctuations in yearly catches are relatively great.

The Gulf catch, after increasing from 75,000 metric tons in 1948 to 479,000 tons in 1962 fluctuated between 316,000 to 728,000 from 1963 to 1977. Mississippi landings showed similar fluctuations (67,828 metric in 1963 to 138,842 metric tons in 1971).

It has been found that a multiple regression equation using catch and effort data provides a reliable method of estimating catches of Gulf menhaden. The predicted 1978 catch was estimated (February 1978) at 546,000 metric tons with 4 out of 5 chances that it would be between 450,000 and 642,000 tons. However, the 1978 population was exceptional, producing landings of about 819,957 M.T.

There are a number of physical, chemical and biological factors which may effect production of menhaden. Young menhaden have been collected in Gulf estuaries at temperatures ranging 5 to 34.9C (41-95 F) and salinities as low as 0.0‰ and as high as 67‰. Larval menhaden may suffer mass mortalities when water temperature falls below 3 C (37 F) for several days or chills rapidly to 4.5 C (40 F). Mass mortalities of menhaden, apparently due to high salinity (80‰ or greater) have been reported.

Mass mortalities attributed to low concentrations of dissolved oxygen occur regularly in Mississippi.

The Gulf menhaden, like the species previously discussed, depend on suitable estuarine nursery areas for survival and production of a harvestable resource. Reduction in area of the nursery or adverse changes in water quality can be expected to result in losses to the resource. Some alteration to the environment such as controlled introduction of fresh water into the western Sound may be beneficial to these resources. However, loss of marsh land due to other activities is irretrievable.

Menhaden are planktonic feeders throughout life. Different age and size menhaden feed on different components of the planktonic biomass including bacteria, phytoplankters, zooplankters and suspensions.

There are a number of predators on menhaden including birds, fish and Man. It has been reported that spotted seatrout and other species feed on young menhaden in east Bay Texas. Mississippi recreational fishermen sometimes use small menhaden as bait for spotted seatrout and other species when fishing in inshore waters, although a study of 868 spotted seatrout stomachs collected from trout taken from the Biloxi Marsh Area between Lake Borgne and Breton Sound revealed only three menhaden. It has also been reported that long nose gar feed primarily at night on juvenile Gulf menhaden in Mississippi estuaries.

The commercial fishing for menhaden takes relatively few fish other than menhaden. Studies on the species composition of menhaden purse seine catches were first done in 1894 on the Atlantic fishery. Since 1947 there have been five studies published on species composition of the Gulf catch.

A report on 77 purse seine sets completed in Mississippi, Chandeleur and Breton Sounds and 11 sets west of the Mississippi River delta in 1958-59 revealed the following species composition:

1. Speckled Trout	7
2. White trout*	153
3. Red Fish	0
4. Flounder**	0
5. Menhaden	53,700
6. Ground Mullet***	29
7. Croaker	342
8. Mullet*	912
9. Sheepshead****	0
10. Black drum	0

*Includes 2 species

**Five observed in net but none found in samples. Used as food for crew.

***Included in 2 samples.

****Three observed in net but none taken in sample.

Most of the mullet (869) reported in this study were taken from one set in Chandeleur Sound when a school of mullet was identified as menhaden by the spotter aircraft pilot. The observations of total numbers of other fishes in purse seine sets (3.8%) was the highest shown by any of the reports.

Southern kingfish - *Menticirrhus americanus* (Linnaeus)

This fish is known locally as the "ground mullet." Three species of fish (*M. americanus, M. littoralis, M. focaliger*) occur in Mississippi waters and are collectively known as "ground mullet." *M. americanus* is the most commonly found species and will be treated here. The life histories of the other two species are similar, but complete information on all three species is needed.

"Ground mullet" spawn in Mississippi from April through October. Spawning grounds are unknown and evidence has been presented that spawning may occur either in the Gulf or at times in the Sound. Resulting larvae move into the inshore nursery areas where they grow rapidly. They have been reported to reach a modal length by the second year of 170 mm (6.6 in).

Males have been reported to mature at about two years at a size of approximately 195 mm (7.6 in), while females mature at two to three years at a size of approximately 240 mm (9.4 in). No information is available on fecundity.

Without fecundity estimates, mortality rates, and a more thorough accounting of the total population no discussion of population dynamics is possible.

"Ground Mullet" are common throughout the year along the Gulf, and show a preference for moderate to high salinity. Fish (17 to 255 mm/.6 - 10.0 in SL) have been collected in Mississippi at temperatures and salinities ranging 10.0 to 34.9 C (50 - 94.8 F) and 5.0 to 35.5°/₀₀ respectively. Highest catches were reported in salinities of 15.0 to 29.9°/₀₀. In general, the mean length of "ground mullet" increased as salinity increased.

Young fish less than 50.0 mm (2 in) SL in Mississippi were generally taken in shallow water with sand grading to soft mud bottom type. Fish 50.0 mm (2 in) to 150.0 mm (5.9 in) SL were widely distributed throughout the estuary, being taken in shallow beach areas, navigational channels in Mississippi Sound, bays and both north and south of the barrier islands. Fish between 151.0 mm (5.9 in) and 275.0 mm (10.8 in) SL were taken almost exclusively in the vicinity of the barrier islands.

The habitat appears to be in good condition at this time. As with the species previously discussed all estuarine dependent species may be affected by changes in the estuarine habitat.

The species is primarily a bottom feeder. They are reported to feed on fish and shrimp. Eighty-five percent of the stomachs examined in one study contained crustaceans and 15 percent contained fish.

The southern kingfish (ground mullet) is common from Chesapeake Bay to Fort Pierce, Florida on the Atlantic coast and in the Gulf of Mexico from Cape Sable, Florida to Campeche, Mexico.

In temperate areas they generally move offshore to deeper water in cold weather. They are common throughout the year along the Gulf coast, being least abundant inshore during winter. In a study of Biloxi Bay recreational fishing these fish were caught most frequently in the summer and early fall and disappeared completely from the Bay fishing in the winter.

A number of parasites and diseases are known to occur on the southern kingfish but there is no information on the effects of the organism on survival and growth of the fish. None are known to affect human health.

Atlantic croaker - *Micropogon undulatus*

The croaker life cycle follows the general pattern of estuarine dependent species as previously discussed. Actual spawning of wild croaker has not been observed. Based on observation of the immigration of croaker as determined by the appearance of post larvae in the inshore nursery grounds it can be concluded that spawning occurs each year generally between September and April. The peak spawning month varies from year to year, but usually is found to be November or December. Croaker are believed to spawn in the open Gulf waters in close proximity to estuarine nursery grounds.

Whether the movement of croaker larvae from their hatching area to estuaries represents passive drifting, active swimming or a combination of the two is not known. It is known that post larvae (under 15.0 mm/.6 in SL) croaker enter Mississippi estuaries where they transform into juveniles and reside for several months before returning to the Gulf. Some croaker are found in Mississippi waters in all months but most of them move to Gulf waters during the winter.

It has been reported that croaker mature at one or two years of age. It is reported that some croaker reach sexual maturity in Mississippi at the end of the first year at 109 to 187 mm (4.3-7.3 in) in length and all are mature by the end of the second year. It has been reported that a 395 mm (15.5 in) croaker can produce approximately 180,000 eggs and that all eggs in the ovary were of uniform size.

Croaker are generally aged using hard structures, particularly the scales. Croaker at one year of age average 14.13 cm (5.5 in), at two years they average 21.31 cm (8.3 in), at three years they average 27.04 cm (10.6 in), at four years they average 31.74 cm (12.4 in), at five years they average 35.59 cm (14.0

in), and at six years they average 38.64 cm (18.2 in) in length.

Generally it is believed that there is one stock of croaker which ranges across the Gulf. There appears to be a difference in size of croaker on the east and west sides of the Mississippi River Delta with larger fish generally occurring on the east side of the Delta.

Age class structure for croaker stocks in November 1973 and November 1974 show that 0-age fish made up 47.2% and 50% of the total commercial catch by number in 5 and 15 fathoms, respectively. In Mississippi territorial waters it is believed that in excess of 80.0% of the croaker would fall into the 0 and 1-year classes. Indications are that year class II and older fish do occur inshore, but primarily in the recreational fishery. There is no data on which to determine what percentage of the inshore populations these larger fish comprise. From observations at hand these older fish make up a very widely variable portion of the population from year to year.

Much has been learned about the population dynamics since studies began in the 1940's. This information deals with such problems as population structure and size, life cycles, distribution, movements and age and size composition of the catches. Because few age groups are taken in the fishery, fluctuations in yearly catches are relatively great. An increase in the utilization of croaker for food fish in the Gulf and for manufacture of pet food appears to have had an impact on the landings. Mortalities resulting from the by-catch of the shrimp fishery also appear to have a detrimental impact on the croaker.

Croaker have been taken in all salinity ranges in Mississippi waters. Juveniles 25 mm (1 in) TL and smaller as well as fish 230 mm (9.1 in) and larger were collected in all salinity ranges. The highest catches per haul occurred in the 15.0 to 19.9°/$_{oo}$ range with somewhat lower catches at 10.0 to 14.9°/$_{oo}$. Temperature at time of capture ranged 5.0 to 34.9 C (41-98.8 F).

At this time it appears that the croaker habitat is in good condition. As with the other estuarine species previously discussed alteration to the inshore nursery areas may impact the croaker population.

Croaker from different localities feed on the same general food items, but often in different proportions and on different components. In general, croaker feed on crustaceans, polychaetes, pelecypods, fish detritus and miscellaneous invertebrates and plants.

Small bottom inhabiting animals comprise the chief food of the 25-50 mm croaker. These forms include both bottom-surface animals (harpacticoid copepods, amphipods, isopods, ostracods, minute snails, foraminiferans, and an occasional coleopterus), as well as certain forms which tend to burrow (chironomid larvae and small clams with attached mussels). Some of these animals were present to a very limited extent in the smallest croakers, but reached a peak of abundance in the 25-50 mm (1-2 in) size class and are present in reduced volume throughout all the larger size groups.

In croaker 75-100 mm (3.0-4.0 in) detritus and undetermined organic material made up over 66% of the food volume.

The adult croaker feed on all those items previously discussed. The percentages of these food items change with the large fish. Fish and larger invertebrates account for a larger portion of those food items consumed. The croaker range down the western Atlantic coast from Cape Cod, Massachusetts to Florida, then across the northern Gulf down to Campeche Bay, Mexico.

In Mississippi young-of-year-fish were most abundant over soft substrates. Larger croaker in coastal bays and the Sound proper were most numerous in navigation channels characterized by mud bottoms. Croaker collected north and south of the barrier islands were taken over variable bottom types. Bottom sediments south of the islands were primarily fine to medium sand grading to sandy mud. Croaker were most abundant in these areas from June through November.

The croaker is most abundant offshore of Mississippi from September to May each year. At 9 m (29.5 ft) they are most abundant in fall and summer, at 18-36 m (59.0-118.1 ft) they are most abundant in fall and winter and at 54 m (177.1 ft) they are most abundant in spring and summer.

Croaker migrate offshore to spawn in the fall. The migration generally starts in summer and peaks with decreasing temperatures in the early fall.

The sampling catch-per-unit-effort of croaker appears to be a direct reflection of its seasonal abundance. In Mississippi the catch-per-unit-effort for croaker decreased from June through September and remained low through March.

Croaker less than 75mm (3 in) probably are the most abundant size in Mississippi waters and are most likely preyed on by any number of other fish although no reference to croaker as a food item was found. Larger croaker have been reported to prey on fish and crustaceans, but there is no information on the magnitude of this predation.

To date over 90 parasites and/or diseases have been identified. Efforts are underway to determine the effects on survival and growth of these parasites and diseases on the croaker. Several of the nematode larvae which have been identified from the croaker

would present a human health problem only if the croaker was eaten raw. The cestode mentioned above as being responsible for "wormy trout" is also found in the croaker and does not present a human health problem.

Striped mullet - *Mugil cephalus* (Linneaus)

Spawning of mullet is protracted along the Gulf of Mexico beginning in early winter and continuing into spring. Mullet under 30.0 mm (1.2 in) TL have been taken in Mississippi inshore waters from November through May. Actual spawning of mullet has been observed to occur 60-80 km (40-50 miles) southeast of the Mississippi River Delta. It has been suggested that spawning begins closer to the barrier islands until water temperatures begin to fall. The adults then move farther offshore.

Fecundity has been estimated at 0.76-1.53 million eggs depending on location and size of fish. Eggs have been reported to be either floating or sinking depending on salinity and water movement. Unfertilized eggs are nonspherical with a diameter of ca. 0.57 mm (.02 in). After fertilization the eggs are spherical, non adhesive and transparent. The egg diameter ranges from 0.60 to 1.08 mm (.02-.04 in) and the oil globule diameter ranges from 0.26 to 0.4 mm (.010-.016 in).

At hatching the mullet range in size from 2.2 to 3.6 mm (.08-.14 in) total length (TL). They remain in the larval stage ca. 20 to 24 days at the end of which they have attained a total length of ca. 11 mm (.43 in) TL. Young fish enter inshore nursery grounds in Mississippi at a size of about 20.0 mm (.8 in) SL. The young fish remain close to the shoreline, traveling in small schools.

By the end of the first year they have attained an average length of 111.2 mm (4.4 in) SL. By the end of the second year they have attained an average length of 225 mm (8.8 in) and all are mature. Males at first maturity generally average 200.0 mm (7.8 in) TL and females at first maturity average 250.0 mm (9.8 in) TL. Fish three years old average 352.0 mm (13.8 in) TL.

Year classes appear to be distinct and can be separated using a length-frequency diagram.

Much is known about mullet, but there is little or no information on population dynamics such as population size and structure, distribution, movements and mortality rates in the northern Gulf therefore a discussion of population dynamics is impossible.

Mullet are euryhaline and are known to occur in salinities from 0-75°/$_{oo}$. They have been taken in Mississippi waters in salinities from 0.0-35.5°/$_{oo}$. Fish 26-44 mm (1.0-1.3 in) SL were most frequently caught in the salinity interval (0.0-14.9°/$_{oo}$) when water temperatures were 5.0-9.9 C (41-49.8 F). Juveniles [30-80 mm (1.1-3.1 in) SL] showed a preference for lower salinities and warmer water. The majority of the fish were taken at salinities from 0.0-10.0°/$_{oo}$ when temperatures ranged 25.0-30.0 C (77.0-86.0F). Fish 80-110 mm (3.1-4.3 in) SL were abundant at salinities 0.0-5.0 and 15.0 to 20.0°/$_{oo}$ and were taken at temperatures 7.0-30.0 C (44.6-86F) with the highest catches taken over the temperature range 7.0-20.0 C (44.5-68.0 F). No ranges have been established for fish over 110.0 mm SL (4.3 in) in Mississippi waters.

The habitat of the mullet in Mississippi appears to be in good condition at this time, but like other estuarine dependent fish, changes in the inshore nursery may have an impact on the population.

It is generally agreed that the mullet feeds largely upon epiphytic algae, littoral diatoms, and finely divided organic detritus scraped from the surface layer of shallow mud flats or from the surface of rocks and other objects present in such habitat. Remains of larger invertebrates and vascular plants sometimes appear among the ingested detritus, and the presence of planktonic crustacea and surface algae indicates that some plankton straining must take place, especially among the younger individuals.

Mullet (*M. cephalus*) are widely distributed throughout the tropical and subtropical shores of the world where they range world-wide along continents to approximately 42° N and 42° S latitudes.

The mullet spawns in the Gulf off the Mississippi Gulf Coast. Young fish enter the inshore estuarine nursery grounds in Mississippi at the size of about 20.0 mm (.78 in) SL. There young fish remain in the inshore nursery areas for two years where they utilize the entire estuarine area and continue to grow. The fish mature at two years when they are ca. 200 mm SL. The mature fish remain in the estuarine area until late summer and early fall where they congregate in large schools with other adults and move offshore to spawn. After spawning they move back into the estuarine areas where they are then followed by the young-of-the-year.

Because of the world-wide distribution of the mullet and the world-wide interest in the species as a source of food a large amount of attention has been focused on the study of parasites and diseases of these fish. No references were found that would indicate that any of the parasites and diseases constitute a human health problem or that they would pose a problem to the health of wild fish popula-

tion, but there is evidence that some parasites and diseases could pose a threat to the fish under culture conditions.

Sheepshead - *Archosargus probatocephalus* (Walbaum)

The occurence of small sheepshead in Mississippi waters in the spring and early summer would indicate an early spring spawning which possibly extends into summer in this area. Spawning is thought to take place in near offshore gulf waters.

No direct information is available on age and size of maturation, but an almost ripe male of 508 mm (20 in) has been reported. No data is available on fecundity.

After hatching, young fish [17-31 mm (.6-1.2 in)] move into shallow inshore waters in Mississippi in March, April and May. The smallest specimens occured in May. It has been suggested that after attaining a length of 50 mm (2 in) individuals leave the larval habitat of grass beds and marsh areas and establish themselves in the adult habitat: around rocks, pilings, wrecks and bulkheads.

No data were found relative to population dynamics of the sheepshead.

At this time the habitat of the sheepshead in Mississippi appears to be in good condition. Like other estuarine dependent fish alterations to the inshore nursery habitat could impact the population.

Young sheepshead less than 50 mm (2 in) eat mostly gammarid amphipods, copepods, and polychaetes. Above 50 mm (2 in), molluscs and barnacles constitute the major portion of the diet. Above 190 mm (7.4 in) it is now believed that they are herbivorous because of the long digestive tract and the large amount of plant material found in sheepshead stomachs.

The sheepshead ranges from Cape Cod on the Atlantic coast down to Key West, Florida, then westward along the Gulf coast to Texas.

Generally the only migratory pattern exhibited is the offshore movement of the adults during the spawning season and their subsequent return.

Adult sheepshead are in Mississippi year around. They make up a substantial portion of the inshore recreational catch in Mississippi.

There are a number of parasites and diseases which have been identified from sheepshead. No information was found with regard to the effects of these parasites and diseases on survival and growth of sheepshead or their effects on human health.

Black drum - *Pogonias cromis* (Linnaeus)

Black drum are generally believed to reach sexual maturity at the end of the second year when they are approximately 320 mm (12.5 in) long. Little information on fecundity is available but it has been reported that a 111 cm (43.7 in) female had about 6,000,000 eggs. Spawning in Mississippi is believed to occur between February and April each year. Spawning occurs near passes, in the near Gulf waters, and in all bay areas. After hatching the larvae tend to move to the inshore nursery areas.

Black drum reach 140-180 mm (5.5-7.0 in) SL by the end of the first year, 290-330 mm (11.4-12.9 in) SL by the end of the second year and 400-430 mm (15.7-16.9 in) SL by the end of the third year. Beyond that, tag returns indicate a growth rate of about 50 mm (2 in) per year.

No data were found relative to population dynamics.

Black drum are euryhaline and frequently inhabit brackish water or even fresh water. They have been reported taken in salinities as high as 80°/₀₀. In Mississippi they have been taken over a salinity range of 9.0 to 25.6°/₀₀. Larger fish were generally caught in the higher salinity waters.

Wide ranges in temperature are also tolerated. They have been reported over a temperature range of 3-35C (37.4-95 F). They have been taken in Mississippi waters over a range of 12.2-29.9 C (54-85 F).

At this time it appears that the black drum habitat in Mississippi is in good condition. Like the other estuarine species previously discussed, alteration to the inshore habitat may have an impact on black drum populations.

Most of the drum's food is taken from the bottom or from below the bottom and they are opportunistic feeders, but generally they select for molluscs and crustaceans. Predation on oyster reefs sometimes causes serious damage.

Black drum range along the Atlantic and Gulf coast from New York to the Rio Grande River in Texas.

Tagging studies in other areas have shown the black drum to exhibit very little migratory movement. There is a constant movement in search of food and the fish often travel in large schools during these periods.

The black drum was found to be the most important fish in the winter recreational fishery in Biloxi Bay, Mississippi. They are found in Mississippi waters year around.

There are a number of parasites and diseases which have been identified from the black drum. No information was found on effects on survival and growth of wild populations, but several ectoparasites are known to be detrimental to black drum in capti-

vity under culture conditions. There were no parasites or diseases found which constitute a human health problem, although the cestode known as the "spaghetti worm" is frequently found in the larger drum and makes the flesh unattractive for human consumption, though it presents no health hazard.

The Fishery

Catch statistics for the species under consideration in this plan covers the periods: spotted seatrout 1887-1977, sand seatrout 1965-1975, red drum 1887-1977, flounder 1887-1977, menhaden 1939-1977, Southern kingfish 1902-1977, croaker 1902-1977, mullet 1880-1977, sheepshead 1887-1977, and black drum 1887-1977. Over the period of reported landing spotted seatrout have fluctuated from 47,000 to 517,000 pounds annually, sand seatrout have ranged from 27,000 to 311,000 pounds annually, red drum have ranged from 31,000 to 257,000 pounds annually, flounder have ranged from 16,000 to 172,000 pounds annually, Southern kingfish have ranged from 2,000 to 1,325,000 pounds annually, croaker as food fish have ranged from less than 500 pounds to 2,000,000 pounds annually, mullet have ranged from 2,000 to 2,363,000 pounds annually, sheepshead have ranged from 1,000 to 173,000 pounds annually and black drum have ranged from 1,000 to 114,000 pounds annually. Menhaden accounts for the largest volume of finfish landed in Mississippi (99.1%). From 1948 through 1970 Mississippi landed 22.3% of all menhaden landed in the Gulf. From 1963 thru 1975 menhaden landings in Mississippi ranged from 149,535,000 to 308,359,000 pounds annually and averaged 215,129,000 pounds.

Two types of fishing have developed: 1. Non-commercial - composed of a large number of recreational fishermen taking principally, spotted seatrout, sand seatrout, red drum, flounder, Southern kingfish, croaker, mullet, sheepshead and black drum for personal use from shallow bays and bayous and along the barrier islands off the Mississippi coast. Menhaden are not fished by this group. 2. Commercial food - this group is composed of a small group of professional fishermen who supply fresh fish to the local markets and to the export market for fresh fish. This group includes also the menhaden fleet and the industrial ground fish fleet. The ground fish fleet does not fish in waters under Mississippi jurisdiction but is dependent on those estuarine dependent fishes found in Mississippi waters.

The fresh fish and fresh fish export fishery is currently composed of two distinct fishing groups. One is the gill and the trammel net fishery. This group generally fishes from vessels less than 25 feet and use nets 1,000 feet or less in length. The second group is a purse net fishery which has developed in Mississippi only in the last three years. This fishery employs vessels up to 50 feet of wood or fiberglass and utilizes a purse net of approximately 1,000 feet in length and 50 feet in depth with a 2 5 8 inch mesh. This fishery is currently accounting for the largest volume of red drum, black drum, sheepshead, mullet, and spotted seatrout being landed in Mississippi.

Sand seatrout, Southern kingfish, and flounder are generally caught as a by-product of the shrimp trawl fishery and the ground fish trawl fishery.

The menhaden fishery is conducted from carrier vessels that range in length up to 194 feet with a gross tonnage of 644 tons. Fish are caught with

TABLE 6.
Average volume and value of finfish landings in Mississippi, 1963-1975.

	Average Volume of Landings (000 lbs)	Rank	Average Value of Landings ($000)	Rank
Croaker	530	5	69	3
Black Drum	37	11	2	11
Red Drum	78	9	11	9
Flounder	113	8	18	7
Southern kingfish	286	5	20	6
Menhaden	215,128	1	4,357	1
Mullet	487	4	25	5
Spouted Seatrout	231	6	63	4
Sand Seatrout	153	7	12	8
Sheephead	57	10	4	10
Industrial	72,182	2	1,555	2

purse nets which are usually 200 fathoms long, 10 or more fathoms deep and made of 3/4 or 7/8 inch barmesh synthtic twine.

The commercial finfish fleet in Mississippi is small in comparison to the total number of recreational anglers fishing the same waters. With very little data on the recreational fishery and on commercial effort it is impossible to make reliable comparisons of catch and effort of the two fishery groups operating in Mississippi waters.

The average volume and value of landings in Mississippi for the period 1963-1975 are summarized in Table 6 by species. Their ranks are also shown. It may be noted that menhaden, industrial fish and croaker ranked No. 1, No. 2, and No. 3 respectively in average volume and average value of landings. Black drum and sheepshead ranked at the bottom in both volume and value at No. 10 and No. 11 respectively.

There has been considerable variation in the volume and value of landings among the species under consideration and over the time period 1963-1975 for each species. For example, croaker was at the bottom of the list in volume and value in 1968 at 2,600 pounds valued at $140. (These volumes and values are for food fish only and do not include industrial bottom fish which are about 70% croaker). Menhaden was at the top of the list at 250 million pounds valued at $3.8 million. In 1975, menhaden still ranked first in terms of volume and value. However, black drum was at the bottom with 19,900 pounds valued at $1,600. The value per pound showed a different ranking. Menhaden was at the bottom of the list in both 1963 and 1975 at $.02 and $.03 per pound respectively.

The price per pound has been somewhat stable for most species over the period 1963-1975. The greatest relative variation was for menhaden which varied from $.01 to $.05, a 400 percent variation. Next was croaker which ranged from $.05 to $.15, a 200 percent variation. Black drum had the smallest relative variation in price change which ranged from $.12 to $.15, which is 25 percent.