LIVING AQUATIC RESOURCES ACTION AGENDA (2.1) FOR THE GULF OF MEXICO

GULF OF MEXICO PROGRAM

September 1993

EXECUTIVE SUMMARY

The Gulf of Mexico contains ecological and commercial resources matched by few other bodies of water. Yet its blue-green waters disguise the increasing environmental threats that endanger these resources. In recognition of the growing threats, Regions 4 and 6 of the U.S. Environmental Protection Agency (USEPA), which share jurisdiction over the five Gulf Coast States (Alabama, Florida, Louisiana, Mississippi, and Texas), initiated the Gulf of Mexico Program in August 1988. The goal of the Gulf of Mexico Program is to protect, restore, and enhance the coastal and marine waters of the Gulf of Mexico and its coastal natural habitats, to sustain living resources, to protect human health and the food supply, and to ensure the recreational use of Gulf shores, beaches, and waters--in ways consistent with the economic well being of the region.

The Gulf of Mexico Program is a cooperative partnership among federal, state, and local government agencies, as well as with people and groups who use the Gulf of Mexico. During the early stages of Program development, eight priority environmental problems were identified and the following Issue Committees have been established to address each of these problems: Marine Debris, Public Health, Habitat Degradation, Coastal & Shoreline Erosion, Nutrient Enrichment, Toxic Substances & Pesticides, Freshwater Inflow, and Living Aquatic Resources. There are important linkages among these various Issue Committees and the Gulf of Mexico Program works to coordinate and integrate activities among them.

The Living Aquatic Resources Committee was charged with characterizing the status of living aquatic resources in the Gulf of Mexico and determining ways to conserve and restore those resources. The Living Aquatic Resources Committee has been meeting for almost two years--to review information and data collected by citizens and scientists, identify problem areas, discuss actions that can resolve the problems, and evaluate methods for achieving and monitoring results. The culmination of Issue Committee efforts is this Living Aquatic Resources Action Agenda which specifies an initial set of activities needed to conserve and restore the living aquatic resources in the Gulf of Mexico. This Action Agenda is the first generation of an evolving series of Action Agendas that will be developed to meet the future needs of the Gulf of Mexico.

Chapter 1 of the Living Aquatic Resources Action Agenda provides an overview of Gulf of Mexico resources and the threats now facing those resources. In addition, Chapter 1 describes the structure of the Gulf of Mexico Program, including the Action Agenda development process.

Chapter 2 is a brief overview of the living aquatic resources in the Gulf of Mexico.

Chapter 3 describes the legal and institutional framework currently in place in the Gulf of Mexico to address living aquatic resources.

Chapter 4, **The Unfinished Agenda**, contains the goal, objectives, and specific activities established by the Gulf of Mexico Program to address living aquatic resources in the Gulf. The long-term goal established by the Issue Committee is to:

- Conserve and restore species diversity and health of aquatic resources while allowing sustainable development.

Seventy-five action items have been developed to support the goal, and these are grouped under five types of activities and nineteen objectives (see **Index of Living Aquatic Resources Objectives**). The action items included in Chapter 4 have been screened by the Gulf of Mexico Program and represent those activities that are currently the most significant and most achievable. This is a fairly comprehensive, but not exhaustive, list. This document begins an evolving process of Action Agendas in which action items are designated, implemented, and then reassessed as progress in the Gulf is made. In the future, new action items will be developed to meet the changing needs in the Gulf of Mexico.

Action items contained in Chapter 4 are not listed in priority order. Each action item is supported by one or more project descriptions. Some of the projects are already underway but not yet completed. Others are included because they will guide federal, state, and local government agencies and private sector organizations in allocating resources where they are most needed and in justifying future management strategies. This Action Agenda should prompt specific agencies and groups to become involved.

The Gulf of Mexico Program recently developed ten short-term environmental challenges to restore and maintain the environmental and economic health of the Gulf. Within the next five years, through an integrated effort that complements existing local, state, and federal programs, the Program has pledged efforts to obtain the knowledge and resources to:

- Significantly reduce the rate of loss of coastal wetlands.
- Achieve an increase in Gulf Coast seagrass beds.
- Enhance the sustainability of Gulf commercial and recreational fisheries.
- Protect the human health and food supply by reducing input of nutrients, toxic substances, and pathogens to the Gulf.
- Increase Gulf shellfish beds available for safe harvesting by ten percent.
- Ensure that all Gulf beaches are safe for swimming and recreational uses.
- Reduce by at least ten percent the amount of trash on beaches.
- Improve and expand coastal habitats that support migratory birds, fish, and other living resources.
- Expand public education/outreach tailored for each Gulf Coast county or parish.
- Reduce critical coastal and shoreline erosion.

This Living Aquatic Resources Action Agenda supports these five-year environmental challenges.

For the public, this Gulf of Mexico Action Agenda should serve three purposes. First, it should reflect the public will regarding the living aquatic resources of the Gulf of Mexico. Second, it should communicate what actions are needed for conserving and restoring those resources and provide the momentum for initiating these actions. Third, it should provide baseline information from which success can be measured.

This Action Agenda is a living document; therefore, the Gulf of Mexico Living Aquatic Resources Committee intends to periodically revise and update this document.

Index of Living Aquatic Resources Objectives

Monitoring & Assessment

Objective: Characterize the current status of living aquatic resources in the Gulf of Mexico and continue to monitor the status and trends of these resources.

Objective: Survey and monitor impacts to the living aquatic resources of the Gulf of Mexico caused by human access and physical use.

Objective: Assess and monitor the effects of fishing mortality on the health and abundance of living aquatic resources in the Gulf of Mexico.

Objective: Identify, inventory, and monitor impacts to the Gulf of Mexico and its living aquatic resources resulting from human-caused contaminants (*i.e.*, sewage, petroleum products, chemicals, toxic pesticides, marine debris, viruses, and bacteria).

Objective: Survey the potential impacts of aquaculture on living aquatic resources of the Gulf of Mexico.

Objective: Inventory the occurrence and evaluate the reoccurrence potential of unusual mortality events of living aquatic resources in the Gulf of Mexico.

Research

Objective: Conduct research to identify, characterize, and enhance the sustainability of living aquatic resources in the Gulf of Mexico.

Objective: Determine the impacts and effects of human activities on the living aquatic resources in the Gulf of Mexico, including habitat availability, structure, and function.

Objective: Assess and address the potential effects of aquaculture on the living aquatic resources of the Gulf of Mexico.

Objective: Determine the cause/effect relationships of unusual mortality events and their potential ecological effects in the Gulf of Mexico.

Index of Living Aquatic Resources Objectives (continued)

Planning & Standards

Objective: Develop a future quantified "vision" of the status of living aquatic resources in the Gulf of Mexico that supports the concept of a "healthy" Gulf of Mexico.

Objective: Develop consistent criteria, seek uniform management, develop specific strategies, and coordinate Gulfwide activities for the protection of living aquatic resources and ecosystems in the Gulf of Mexico.

Objective: Restore anadromous fish populations that have been impacted by dam construction, channelization, dredging, and other habitat modifications and protect the habitats, rivers, and critical areas important to the life histories of these species in the Gulf of Mexico.

Objective: Develop and implement a response strategy for unusual mortality events in the Gulf of Mexico.

Compliance & Enforcement

Objective: Enhance enforcement capabilities to protect living aquatic resources throughout the Gulf of Mexico.

Public Education & Outreach

Objective: Promote the coordination and advancement of all relevant Gulfwide education programs that address any aspect of living aquatic resources.

Objective: Develop a public education and awareness program for the general public and specific user groups regarding human impacts on the living aquatic resources of the Gulf of Mexico, and promote a conservation ethic.

Objective: Develop a Gulfwide public education and awareness program for other key issues concerning living aquatic resources that are not being effectively addressed.

Objective: Involve an informed public constituency in the support and maintenance of "healthy" Gulf of Mexico ecosystems.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 OVERVIEW OF THE GULF OF MEXICO

The Gulf of Mexico - A Vast & Valuable Resource

Bounded by a shoreline that reaches northwest from Florida along the shores of Alabama, Mississippi, and Louisiana, and then southwest along Texas and Mexico, the Gulf of Mexico is the ninth largest body of water in the world. The Gulf's U.S. coastline measures approximately 2,609 km (1,631 miles)--longer than the Pacific coastline of California, Oregon, and Washington. The Gulf region covers more than 1.6 million km^2 (617,600 mi^2) and contains one of the nation's most extensive barrier-island systems, outlets from 33 major river systems, and 207 estuaries (Buff and Turner, 1987). In addition, the Gulf receives the drainage of the Mississippi River, the largest river in North America and one of the major rivers of the world. A cornerstone of the nation's economy, the Gulf's diverse and productive ecosystem provides a variety of valuable resources and services, including transportation, recreation, fish and shellfish, and petroleum and minerals.

Encompassing over two million hectares (five million acres) (about half of the national total), Gulf of Mexico coastal wetlands serve as essential habitat for a large percentage of the U.S.'s migrating waterfowl (USEPA, 1991). Mudflats, salt marshes, mangrove swamps, and barrier island beaches of the Gulf also provide year-round nesting and feeding grounds for abundant numbers of gulls, terns, and other shorebirds. Five species of endangered whales, including four baleen whales and one toothed whale, are found in Gulf waters. These waters also harbor the endangered American crocodile and five species of endangered or threatened sea turtles (loggerhead, green, leatherback, hawksbill, and Kemp's Ridley). The endangered West Indian (or Florida) manatee inhabits waterways and bays along the Florida peninsula.

In addition, a complex network of channels and wetlands within the Gulf shoreline provides habitat for estuarine-dependent commercial and recreational fisheries. The rich waters yielded approximately 771 million kg (1.7 billion pounds) of fish and shellfish in 1991. Worth more than $641 million at dockside, this harvest represented 19 percent of the total annual domestic harvest of commercial fish (USDOC, 1992c). The Gulf boasts the largest and most valuable shrimp fishery in the U.S. and also contributed 41 percent of the U.S. total oyster production in 1991 (USDOC, 1992c). Other Gulf fisheries include diverse shellfisheries for crabs and spiny lobsters and finfisheries for menhaden, herring, mackerel, tuna, grouper, snapper, drum, and flounder. The entire U.S. Gulf of Mexico fishery yields more finfish, shrimp, and shellfish annually than the South and Mid-Atlantic, Chesapeake, and Great Lakes regions combined.

The Gulf's bountiful waters draw millions of sport fishermen and beach users each year. It is estimated that the Gulf supports more than one-third of the nation's

marine recreational fishing, hosting four million fishermen in 1985 who caught an estimated 42 million fish (USDOC, 1992c). Popular nearshore catches include sea trout (weak fish), cobia, redfish, flounder, grouper, red snapper, mackerel, and tarpon; offshore catches include blue marlin, white marlin, sailfish, swordfish, dolphin, and wahoo. Tourism-related dollars in the Gulf Coast States contribute an estimated $20 billion to the economy each year (USEPA, 1991).

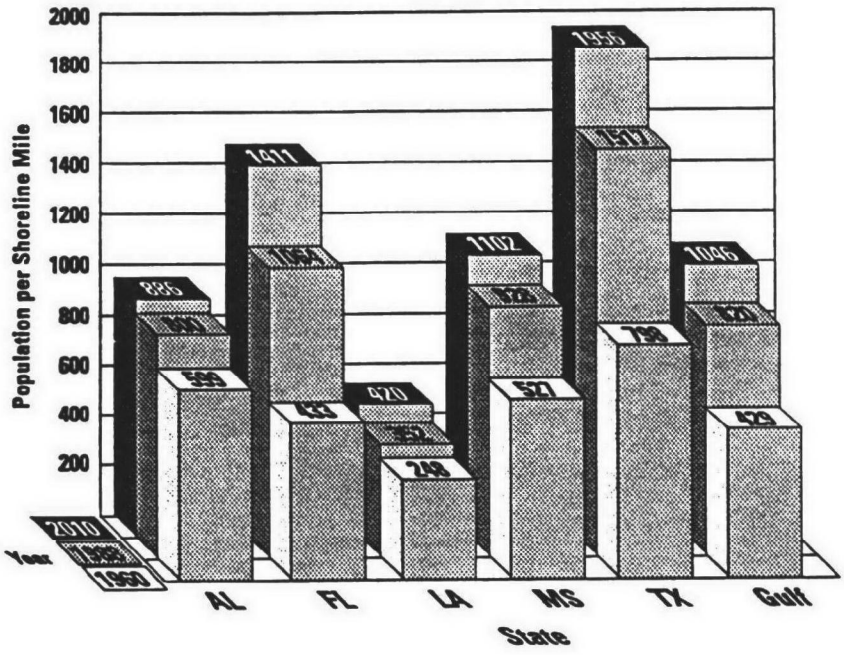
Gulf oil and gas production are equally valuable to the region's economy and are a critical part of the nation's total energy supply. In 1990, more than 1,600 Outer Continental Shelf (OCS) leases were in production, yielding approximately 90 percent of U.S. offshore production. These OCS royalties annually contribute about $3 billion to the Federal Treasury. Thirty-eight percent of all petroleum and 48 percent of all natural gas reserves in the U.S. are estimated to be in the Gulf of Mexico. The industry employs some 30,000 people in the Gulf of Mexico.

Approximately 45 percent of U.S. shipping tonnage passes through Gulf ports, including four of the nation's busiest: Corpus Christi, Houston/Galveston, Tampa, and New Orleans. The second largest marine transport industry in the world is located in the Gulf of Mexico. According to USEPA, vessel trips in and out of American Gulf ports and harbors exceeded an estimated 600,000 trips in 1986. The U.S. Navy is also implementing its Gulf Coast Homeporting Plan, designed to dock at least 25 vessels in Ingelside, TX, Pascagoula, MS, and Mobile, AL.

Millions of people depend on the Gulf of Mexico to earn a living and flock to its shores and waters for entertainment and relaxation. The temperate climate and abundant resources are attracting more and more people. The region currently ranks fourth in total population among the five U.S. coastal regions, accounting for 13 percent of the nation's total coastal population. Although the Gulf region is not as densely settled as others, it is experiencing the second fastest rate of growth; between 1970 and 1980, the population grew by more than 30 percent (USDOC, 1990a). According to the U.S. Department of Commerce, the Gulf's total coastal population is projected to increase by 144 percent between 1960 and 2010, to almost 18 million people. **Figure 1.1** shows the Gulf of Mexico coastal population density or population per shoreline mile projected to the year 2010. Florida's population alone is expected to have skyrocketed by more than 300 percent by the year 2010. The increasing population growth in coastal areas places development pressure on critical fisheries habitat and contributes to water quality problems.

The Gulf's resources and environmental quality are affected not only by the millions living and working in the region, but also by activities occurring throughout much of the nation. Two-thirds of the land area of the contiguous U.S. drains into the Gulf, bringing with it potential impacts on living aquatic resources due to pesticides, fertilizer, toxic substances, and trash.

Figure 1.1 ***Gulf of Mexico Coastal Population per Shoreline Mile***



(Source: USDOC, 1990a)

The Gulf of Mexico - A Resource At Risk

Increasing population pressures mean increased use and demands on Gulf of Mexico resources. Until recently, the Gulf was considered too vast to be affected by pollution and overuse. Recent trends indicate, however, serious long-term environmental damage unless action is initiated today. Potential problems or causes of degradation throughout the Gulf system include the following (USEPA, 1991):

- Fish kills and toxic "red tides," and "brown tides" were an increasing phenomenon in Gulf waters during the 1980s.
- Alabama, Mississippi, Louisiana, and Texas are among those states that discharge the greatest amount of toxic chemicals into coastal waters.

- Diversions and consumptive use for human activities have resulted in significant changes in the quantity and timing of freshwater inflows to the Gulf of Mexico.

- More than half of the shellfish-producing areas along the Gulf Coast are permanently or conditionally closed. These closure areas are growing as a result of increasing human and domestic animal populations along the Gulf Coast (USDOC, 1991b).

- Louisiana is losing valuable coastal wetlands at the rate of approximately 14-66 km^2/year (5-25 mi^2/year) (Dunbar, *et al.*, 1992).

- Almost 1,800 kg/mi (2 tons/mi) of marine trash covered Texas beaches in 1988.

- Up to 9,500 km^2 (4,000 mi^2) of oxygen deficient (hypoxia) bottom waters, known as the "dead zone," have been documented off the Louisiana and Texas coasts (Rabalais, *et al.*, 1991).

- Gulf shorelines are eroding up to 30 m/year (100 ft/year). Few coastal reaches in the Gulf can be characterized as "stable" or "accreting."

The Gulf of Mexico Program - Goals & Structure

Problems plaguing the Gulf cannot be addressed in a piecemeal fashion. These problems and the resources needed to address them are too great. The Gulf of Mexico Program (GMP) was formed to pioneer a broad, geographic focus in order to address major environmental issues in the Gulf before the damage is irreversible or too costly to correct.

The program is part of a cooperative effort with other agencies and organizations in the five Gulf States, as well as with people and groups who use the Gulf. In addition to the U.S. Environmental Protection Agency (USEPA), other participating federal government agencies include: National Aeronautics and Space Administration (NASA), U.S. Army Corps of Engineers (USACE), U.S. Department of Agriculture (USDA), U.S. Department of Commerce (USDOC), U.S. Department of Defense (USDOD), U.S. Department of Energy (USDOE), U.S. Department of the Interior (USDOI), U.S. Department of Transportation (USDOT), U.S. Food & Drug Administration (USFDA), and Agency for Toxic Substances & Disease Registry (ATSDR).

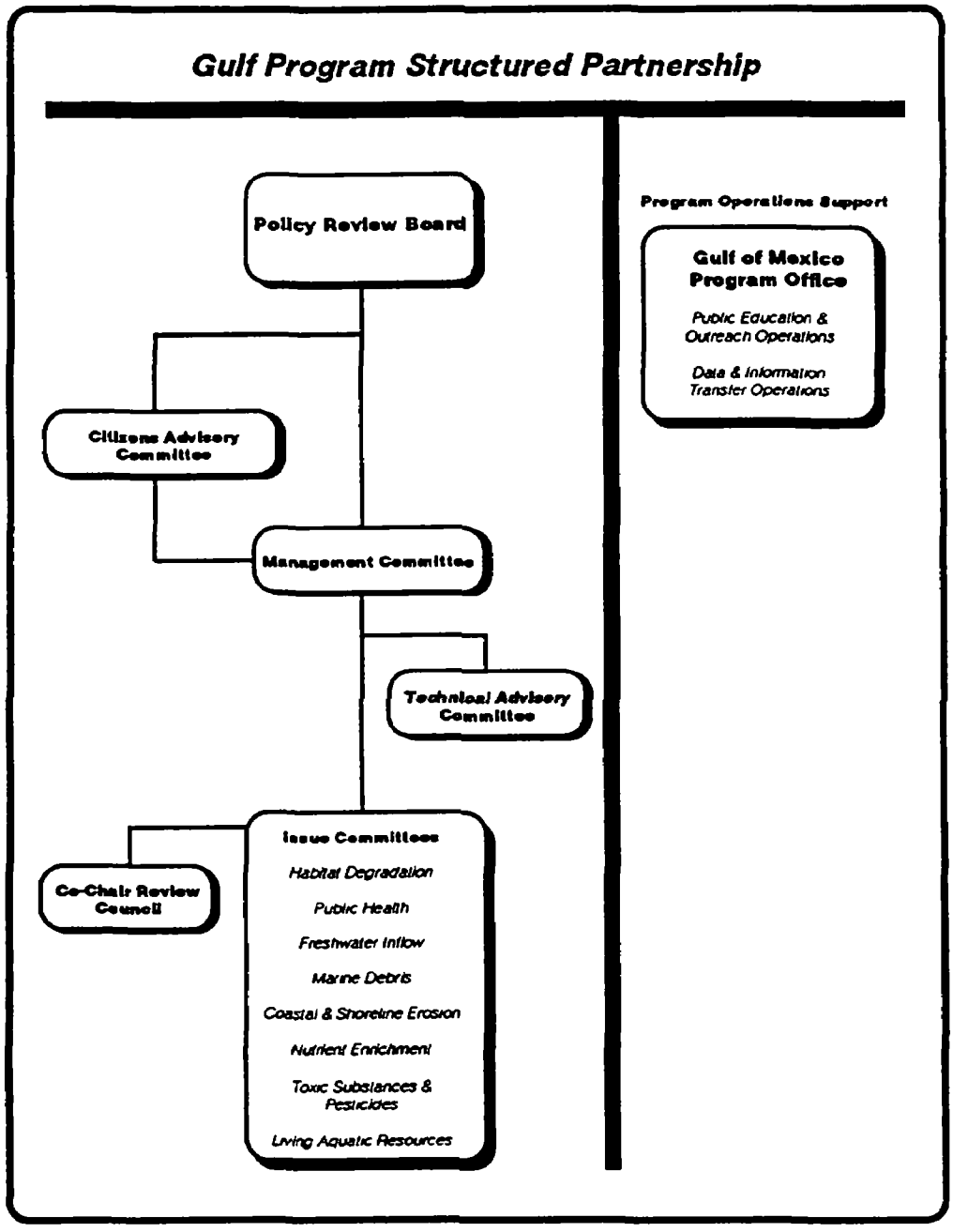
The Gulf of Mexico Program also works in coordination and cooperation with five National Estuary Programs (NEPs) within the Gulf: Tampa Bay, Sarasota Bay, Galveston Bay, Corpus Christi Bay, and the Barataria-Terrebonne Estuarine Complex. The Gulf of Mexico Program supports and builds on certain activities of these programs, bringing a Gulfwide focus and providing a forum for addressing issues of Gulfwide concern.

By building on and enhancing programs already underway, as well as by coordinating new activities, the Gulf of Mexico Program will serve as a catalyst for change. The program's overall goals are to provide:

- A mechanism for addressing complex problems that cross federal, state, and international jurisdictional lines;
- Better coordination among federal, state, and local programs, thus increasing the effectiveness and efficiency of the long-term effort to manage and protect Gulf resources;
- A regional perspective to address research needs, which will result in improved transfer of information and methods for supporting effective management decisions; and
- A forum for affected groups using the Gulf, for public and private educational institutions, and for the general public to participate in the solution process.

The Gulf of Mexico Program is supported by four committees: Policy Review Board (PRB), Management Committee (MC), Citizens Advisory Committee (CAC), and Technical Advisory Committee (TAC) (see **Figure 1.2**). Composed of 20 senior level representatives of state and federal agencies and representatives of the technical and citizens committees, the Policy Review Board guides and reviews overall program activities. The Management Committee guides and manages Gulf of Mexico Program operations and directs the Action Agenda activities of the Issue Committees. The Citizens Advisory Committee is composed of five governor-appointed citizens who represent environmental, fisheries, agricultural, business/industrial, and development/tourism interests in each of the five Gulf Coast States. This committee provides public input and assistance in publicizing the Gulf of Mexico Program's goals and results. Representatives of state and federal agencies, the academic community, and the private and public sectors are members of the Technical Advisory Committee and provide technical support to the Management Committee.

Figure 1.2


Gulf Program Structured Partnership
Policy Review Board
Program Operations Support
Gulf of Mexico Program Office
Public Education & Outreach Operations
Data & Information Transfer Operations
Citizens Advisory Committee
Management Committee
Technical Advisory Committee
Co-Chair Review Council
Issue Committees
Habitat Degradation
Public Health
Freshwater Inflow
Marine Debris
Coastal & Shoreline Erosion
Nutrient Enrichment
Toxic Substances & Pesticides
Living Aquatic Resources

The Gulf of Mexico Program has established the following eight Issue Committees, each co-chaired by one federal and one state representative, to address priority environmental problems:

- **Habitat Degradation** of such areas as coastal wetlands, seagrass beds, and sand dunes;
- **Freshwater Inflow** changes resulting from reservoir construction, diversions for municipal, industrial, and agricultural purposes, and modifications to watersheds with concomitant alteration of runoff patterns;
- **Nutrient Enrichment** resulting from such sources as municipal waste water treatment plants, storm water, industries, and agriculture;
- **Toxic Substances & Pesticides** contamination originating from industrial and agriculturally based sources;
- **Coastal & Shoreline Erosion** caused by natural and human-related activities;
- **Public Health** threats from swimming in and eating seafood products coming from contaminated water;
- **Marine Debris** from land-based and marine recreational and commercial sources; and
- **Living Aquatic Resources**

Two cross-cutting technical operating committees support the public education and information and resource management functions of the eight environmental Issue Committees. These are:

- **Public Education & Outreach Operations**
- **Data & Information Transfer Operations**

The action planning process used by each Gulf of Mexico Program Issue Committee includes the following key activities:

- Definition of environmental issues;
- Characterization of identified problems, including sources, resources, and impacts;
- Establishment of goals and objectives;
- Evaluation/assessment of corrective actions and control measures, including cost/benefit analysis;
- Selection of priority action items;
- Establishment of measures of success;
- Implementation of actions; and
- Evaluation of success and revision of the Action Agenda.

As the Issue Committees progress through each of these activities, ample opportunities are provided for public review and Policy Review Board endorsement is requested at appropriate points. The Gulf of Mexico Program will continuously work to integrate related activities of the eight Issue Committees. Through the consensus of Program participants, a coordinated response will be directed to the successful maintenance and enhancement of resources of the Gulf of Mexico.

The Living Aquatic Resources Committee

The Co-Chairs and membership of the Living Aquatic Resources Committee are as follows:

Co-Chairs:

Dr Herb Kumpf	National Marine Fisheries Service
Dr. Karen Steidinger	Florida Marine Research Institute

Members:

Mr. Philip Bohr	National Marine Fisheries Service
Ms. Nora Deyaun Boudreaux	Texas Shrimp Association
Dr. Thomas Bright	Texas A&M University
Dr. Bradford Brown	National Marine Fisheries Service
Ms. Gail Carmody	U.S. Fish & Wildlife Service
Dr. James Cato	Florida Sea Grant College
Dr. George Crozier	Marine Environmental Sciences Consortium
Dr. Quenton Dokken	Gulf of Mexico Foundation--CAC
Dr. William Evans	Texas A&M University
Dr. Bill Fisher	U.S. Environmental Protection Agency
Mr. Douglas Fruge'	Gulf Coast Fisheries Coordination Office
Mr. Joe Gill	Mississippi Bureau of Marine Resources
Dr. Al Green	Texas Parks & Wildlife Department
Dr. Gary Hendrix	National Park Service
Mr. Joe Herring	Louisiana Department of Wildlife & Fisheries
Dr. Rex Herron	National Marine Fisheries Service
Dr. Richard Hoogland	Gulf of Mexico Fishery Management Council
Mr. Robert Jones	Southeast Fisheries Association
Mr. H.D. Kelly	Soil Conservation Service
Dr. Frederick Kopfler	U.S. Environmental Protection Agency
Mr. John Lambeth	Biloxi Sun Herald
Ms. Heidi Lovett	Center for Marine Conservation
Mr. Ronald Lukens	Gulf States Marine Fisheries Commission
Dr. Kumar Mahadevan	Mote Marine Laboratory
Mr. Bill Mason	U.S. Fish & Wildlife Service
Dr. Thomas McIlwain	Gulf Coast Research Laboratory
Mr. R. Vernon Minton	Alabama Department of Conservation
Dr. John Ogden	Florida Institute of Oceanography
Dr. Steven Plakas	U.S. Food & Drug Administration
Mr. Jim Ratterree	U.S. Environmental Protection Agency--Region 6
Mr. Ralph Rayburn	Texas Parks & Wildlife Department
Dr. Susan Rees	U.S. Army Corps of Engineers
Dr. Bruce Rosendahl	Rosenstiel School of Marine & Atmospheric Science
Dr. Andrew Sansom	Texas Parks & Wildlife Department

Dr. Richard Shaw	Louisiana State University
Dr. Robert Shipp	University of South Alabama
Mr. Larry Simpson	Gulf States Marine Fisheries Commission
Dr. Robert Stewart, Jr.	U.S. Fish & Wildlife Service
Mr. Wayne Swingel	Gulf of Mexico Fisheries Management Council
Dr. Jack Van Lopik	Louisiana State University
Mr. Frederick Werner	U.S. Fish & Wildlife Service
Dr. Pace Wilber	U.S. Army Corps of Engineers
Dr. Jonathan Wilson	Jackson State University
Dr. Alejandro Yanez-Arancibia	Programa Epomex
Dr. Bernard Yokel	Florida Audubon Society

The Living Aquatic Resources Committee developed the following long-term goal for addressing living aquatic resources in the Gulf of Mexico:

- Conserve and restore species diversity and health of aquatic resources while allowing sustainable development.

In developing this Action Agenda, the Living Aquatic Resources Committee has sought input and advice from other technical Issue Committees, as well as from experts from the Gulf of Mexico region. (See **Appendix D: Participants in the Action Agenda Development Process**.)

2 LIVING AQUATIC RESOURCES IN THE GULF OF MEXICO*

***NOTE: The Living Aquatic Resources Committee is the most recently formed Issue Committee of the Gulf of Mexico Program. In the short time since they were established, the Living Aquatic Resources Committee has focused their efforts primarily on the development of specific actions needed to conserve and restore the living aquatic resources of the Gulf of Mexico (see Chapter 4). However, it is the intent of the Committee to do extensive characterization work which will eventually be summarized in Chapter 2 of a future generation of this Action Agenda. The Committee recognizes that the information currently presented in Chapter 2 needs to be expanded and updated, and during the next year a process will be developed to accomplish this task. The existing Chapter 2 is meant to be a very brief overview of the living aquatic resources in the Gulf of Mexico, as well as a summary of issues and concerns.**

Biotic Condition of the Gulf of Mexico

Coastal Resources

Wetlands. Wetland habitat types occurring along the Gulf Coast include fresh, brackish, and saline marshes; forested wetlands; and mangroves. Marshes and mangroves form an interface between marine and terrestrial habitats, while forested wetlands occur inland from marsh areas. Wetland habitats may occupy narrow bands or vast expanses and can consist of sharply delineated zones of different species, monotypic stands of a single species, or mixed plant species communities.

The importance of coastal wetlands to the coastal environment has been well documented. Coastal wetlands are characterized by high organic productivity, high detritus production, and efficient nutrient recycling. Wetlands provide habitat for a great number and wide diversity of invertebrates, fish, reptiles, birds, and mammals. Wetlands are particularly important as nursery grounds for juvenile forms of many important fish species. (See the **Gulf of Mexico Program Habitat Degradation Action Agenda** for additional information on wetlands in the Gulf of Mexico.)

Seagrasses. Submergent seagrasses occupy over 323,760 hectares (800,000 acres) within the estuaries and shallow near-coastal waters of the Gulf (Iverson and Bittaker, 1986). Approximately 95 percent of this acreage is in Florida and Texas, where seagrasses occupy about 20 percent of the bay bottoms (Thayer and Ustach, 1981). Although often considered continuous around the Gulf's entire periphery, a combination of low salinity and high turbidity results in only scattered patches of seagrass communities, mostly in bays, from Alabama to Laguna Madre, TX. In fact, the distribution and species composition of seagrasses in the lower Laguna Madre has changed in recent years because of human impacts; these changes are a major cause for concern.

Seagrasses have many ecological functions and are an important component of the coastal ecosystem. Seagrass beds provide substrate stabilization by causing sediments to drop out of suspension. They provide nursery habitat and shelter for commercially and recreationally important species of fish and shellfish, and attract a diverse and prolific epiphytic biota, serving as sites of attachment for many mollusks and often providing unique habitats for certain species. Seagrasses contribute oxygen and nutrients to the water column and serve as both direct and indirect food sources for many marine species Seagrass meadows provide a region of high production and growth that offers sustenance, high detrital input to the coastal ecosystem, habitat diversity and stability, and refuge for the associated organisms. Seagrasses also function mechanically by dampening wave energy and increasing sedimentation rates and contributing to the maintenance of good water quality. (See the **Gulf of Mexico Program Habitat Degradation Action Agenda** for additional information on seagrasses in the Gulf of Mexico.)

Offshore Resources

Continental Shelf. The benthos has both floral and faunal components, the floral representatives are algae and seagrasses. The abundance of benthic algae is limited by the scarcity of suitable substrates and light penetration. Rezak *et al.* (1983) recorded algae from the submarine banks off Louisiana and Texas. In exceptionally clear waters, benthic algae, especially coralline red algae, are known to grow in water depths to at least 183 m (600 ft).

Benthic fauna include the infauna (animals that live in the substrate, such as burrowing worms and mollusks) and epifauna (animals that live on the substrate, such as mollusks, crustaceans, hydroids, sponges, and echinoderms). Shrimp, crabs, and demersal fish are closely associated with the benthic community. Substrate is the single most important factor in the distribution of benthic fauna (Defenbaugh, 1976), although temperature and salinity are also important in determining the extent of faunal distribution. Other less important factors include illumination, exposure to air, nutrient availability, currents, tides, and wave shock. Defenbaugh (1976) states that depth and/or distance from shore should also be considered as major influences on the benthic faunal distribution. In general, the vast majority of the benthos of the central and western Gulf consists of soft, muddy bottoms dominated by polychaetes. The dominant bottom conditions in the eastern Gulf consist of scattered, patchy, low-relief live bottoms, as well as seagrass beds.

Coral reef communities are exceedingly complex. In general, hermatypic corals require temperatures of 18°-30°C, with the optimum at about 26°C; salinities from 36-40 ppt, with the optimum at 36 ppt; little pollution and nutrient loads; and adequate light (*i.e.*, little turbidity). In the Caribbean they may grow as deep as 80 m (262 ft), while in the Gulf they seem to be limited to a depth of about 50 m (164 ft) (Bright and Jaap, 1976; Rezak *et al.*, 1983). Off the west coast of Florida, tropical reef

development is nonexistent. Ledges and outcropping occur and are a special rocky habitat which support an association of hardy corals and other biota; however, they do not construct three-dimensional reefs (Jaap, 1984).

The Florida Middle Ground is one of the most biologically developed of the Eastern Gulf live bottoms and represents the northernmost extent of coral reefs and their associated assemblages in the Eastern Gulf (Bright and Jaap, 1976; Rezak and Bright, 1981). Probably for this reason, the Middle Ground communities are limited in terms of the number of species present. The Middle Ground outcrops rise essentially from a depth of 35 m (115 ft), with the shallowest portions about 25 m (82 ft) deep. Significantly productive areas comprise about 12,126 hectares (29,963 acres). They are inhabited by hermatypic (reef building) corals and related communities that grow on these ancient limestone outcrops. This area is 140 km (87 nautical miles) west-northwest of Tampa and has been designated as a Habitat Area of Particular Concern (HAPC) by the Gulf of Mexico Fishery Management Council. Within the HAPC, bottom longlines, traps and pots, and bottom trawl are prohibited. The taking of any coral is prohibited except as authorized by permit from the National Marine Fisheries Service.

The Florida Middle Ground supports numerous Caribbean fish, corals, and invertebrates. This is probably due to the intrusion of the Loop Current, short periods of low temperatures, and high organic productivity. A total of 197 species of fish, with largely tropical West Indian affinity, have been reported at the Middle Ground (Rezak and Bright, 1981). The benthos of the Florida Middle Ground is composed of hard and soft corals, sponges, and algae. The hard corals include *Madracis decactis, Porites divaricata, Dichocoenia stellaris,* and *Dichocoenia stokesii.* Octocorals, relatively minor components of other Gulf reefs, are prominent at the Middle Ground. Dominant octocorals include *Muricea elongata, M. laxa, Eunicea calyculata,* and *Plexaura flexuosa.* The biota of the Middle Ground is sensitive to environmental change, as documented by Rezak and Bright (1981).

The Florida Keys comprise an important shallow water, tropical, coral reef ecosystem that is unique on the continental shelf of North America and have been designated as a National Marine Sanctuary. Coral reefs are closely interrelated and interdependent with other marine and terrestrial communities that compose the coastal ecosystem. Energy, chemical constituents, and mobile species move between the reefs and other communities, including mangrove, seagrass, benthic, and hard ground communities. In addition, the coral reefs of the Keys are important to the economy of Florida. Commercial and recreational fishing, as well other uses, such as boating, scuba diving, snorkeling, and educational and natural history activities are large businesses (Jaap and Hallock, 1990).

Continental Slope and Deep Slope. Much less is understood about the deep sea area of the northern Gulf of Mexico than the shelf. Pequegnat (1983) reported observations based on 264 oceanographic stations, between 150 and 3,850 m (492-12,632 ft), in an area including the DeSoto and Alminos Canyons, the Mississippi

Trough and Fan, and the Sigsbee Abyssal Plain. There are some remarkable biotic differences in the deep ecosystem of the Gulf. In fact, the biotic differences have led some scientists to refer to the western Gulf as the "true" Gulf and the eastern Gulf as a divergence of the Atlantic Ocean via the Caribbean Sea (Pequegnat, 1983; LGL Ecological Research Associates, Inc. and Texas A&M University, 1986).

The highest values of surface primary production are found in the upwelling area north of the Yucatan Channel and in the region around the DeSoto Canyon. In the oceanic region, the western Gulf is, in general, more productive than the eastern Gulf. It is generally assumed that, perhaps except for brief periods during major plankton blooms, the zooplankton consume all the phytoplankton produced. In turn, they excrete a high percentage of their food intake as feces that sink to the bottom. Most of the herbivorous zooplankters are copepods, with calanoids the dominant group (Pequegnat, 1983). The topographic and physical oceanographic conditions present at East Breaks in the western Gulf are such that a nutrient-rich upwelling could be expected in the vicinity (USDOI, 1992).

Beneath the euphotic zone and extending to approximately a meter off the bottom is a huge mass of water that, beyond the shelf, is largely devoid of sunlight. This is the aphotic zone where photosynthesis cannot occur and where the processes of food consumption, biological decomposition, and nutrient regeneration take place. The benthic zone is considered to be the bottom sediments and one meter of water contiguous with the bottom. Particulate matter is deposited in the benthic zone, where nutrient storage and regeneration take place in association with the solid and semisolid substrate (Pequegnat, 1983).

The slope is a transitional environment influenced by processes on the shelf and the abyssal Gulf. This transition applies both to the pelagic and the benthic realm. The general conclusions that may be reached are as follows: 1) the shelf phyto- and zooplankton are more abundant, more productive, and seasonally more variable than the deep Gulf plankton; 2) slope-associated plankton are intermediate in nature but more closely correspond to the deep Gulf zone than the shelf zone; and 3) the three areas (shelf, slope, and deep Gulf) are each characterized by some specific planktonic species. Some east-west differences have been noted, especially among the diatom species. These species have been used to indicate areas of the Gulf of Mexico that are influenced by the Mississippi River outflow and those that are not (Pequegnat, 1983). The 450 m (1,476 ft) isobath defines the area where the truly deep sea fauna are found. These benthic fauna are generally restricted to these depths and are not found elsewhere.

Live Bottoms. Live bottoms are regions of high productivity characterized by a firm substrate with high diversity or density of epibenthic biota. These communities are scattered across the west Florida shelf in the shallow waters and within restricted regions of the central Gulf. Depth zonation is apparent in the dominant communities. The density of the epibenthic biotic communities varies from diffuse to 100 percent coverage of the bottom, largely depending on bottom type, current

regimes, suspended sediments, habitat availability, as well as anthropogenic and meteorological perturbations. Sessile epibenthic biota include seagrasses, algae, sponges, anemones, encrusting bryozoans, and associated communities. Live bottoms also include biological assemblages consisting of sea fans, sea whips, hydroids, ascidians, or corals living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; as well as areas whose surface attracts and provides habitat for turtles, fishes, seagrasses, algae, and other fauna. The faunal assemblages of the eastern Gulf are markedly different from those of the central Gulf. The difference is partially attributed to the calcareous sediments found east of DeSoto Canyon as opposed to the terrigenous muds and sands of the central and western Gulf and the influence of the upwelling associated with the Loop Current.

In the northeastern portion of the central Gulf of Mexico, between 67 and 110 m (220 and 361 ft) of depth, there is a region of topographic relief known as the "pinnacle trend." The pinnacles appear to be carbonate reef structures in an intermediate stage between growth and fossilization (Ludwick and Walton, 1957). The region contains a variety of features from low to major pinnacles, as well as ridges, scarps, and relict patch reefs. The pinnacles provide a surprising amount of surface area for the growth of sessile invertebrates and attract large numbers of fish.

Human impact in these environments appears to be minimal at present (Brooks *et al.*, 1989). Discarded debris is present at many sites, but is not abundant. Fishing pressure on these features may reduce the population of the larger, commercially and recreationally important species, and may explain the abundance of smaller individuals of unprofitable species (Brooks *et al.*, 1989).

With the exception of the region defined as the pinnacle trend, the substrate in waters shallower than 67 m (220 ft) of the central Gulf is a mixture of mud and/or sand. These areas are not conducive to "live bottom" community growth since a hard substrate is needed for epifaunal attachment. As the substrate grades to carbonate sand in the eastern Gulf, the potential for "live bottoms" increases. The southwest Florida shelf, in water depths between 10 m (33 ft) and 200 m (656 ft), supports several biological assemblages that are associated with particular substrates and have strong depth affinities. The sediments and underlying rock are almost entirely carbonate, reflecting the fact that the west Florida shelf has been cut off from the terrigenous sediment load of the Mississippi River for over 150 million years (Ginsburg and James, 1974). The sand veneer over bedrock is thin, particularly near shore (where many patch reefs are seen) and over ancient, partially buried reef features on the middle shelf (Pulley Ridge) and outer shelf (Howell Hook). The climate is favorable for tropical species, with near-bottom temperatures at or above 18° C most of the time (although occasional winter cold fronts have been known to kill reef fishes and invertebrates in shallow water). The availability of hard substrate, the favorable climate, and the proximity to sources of colonizing reef biota

help to explain the presence of a diverse sessile epifauna, including many species of corals and sponges commonly found on reefs in the Florida Keys and the Caribbean (CSA, 1990).

Deep Water Benthic Communities. Chemosynthetic clams, mussels, and tube worms have been discovered in the deep waters of the Gulf (Corliss *et al.*, 1979). These cold water communities are associated with seismic wipe-out zones and hydrocarbon seep areas between water depths of 400 m (1,312 ft) and 1,000 m (3,281 ft) (Kennicutt and Gallaway, 1985; Brooks *et al.*, 1986). The seep communities are characterized by white bacterial mats; large dense beds of tube worms, clams, and mussels; numerous small gastropods; and galatheid crabs (Kennicutt and Gallaway, 1985; LGL Ecological Research Associates, Inc. and Texas A&M University, 1986).

Topographic Features. The shelf and shelf edge of the central and western Gulf are characterized by a variety of topographic features. The habitat created by the topographic features is important in several respects: 1) they support hard bottom communities of high biomass and high diversity and an abundance of plant and animal species; 2) they support, either through shelter, food, or both, large numbers of commercially and recreationally important fishes; 3) they are unique to the extent that they are small, isolated areas of such communities in vast areas of much lower diversity; 4) they provide a relatively pristine area suitable for scientific research (especially in the East and West Flower Garden Banks); and 5) they have an aesthetically attractive intrinsic value (USDOI, 1992).

The benthic organisms inhabiting these topographic features are temperature and light limited. The 16°C isotherm is stressful for most coral and is considered the lower limit for coral growth (Rezak *et al.*, 1983). Elevated temperatures can also cause thermal stress. Where light is limited, coral growth is inhibited. Therefore, coral growth is limited by water depth. Because the coral communities must be close enough to the surface of the water for adequate light penetration and yet removed from the seafloor to escape the effects of the nepheloid layer, the topographic features (or banks), in some cases, present the proper conditions for coral growth.

Terrestrial and Marine Mammals

Marine Mammals. Twenty-nine species of cetaceans, one sirenian, and one exotic pinniped (California sea lion) have been sighted in the northern Gulf of Mexico (see **Table 2.1**). Cetaceans are divided into two major suborders: Mysticeti (baleen whales) and Odontoceti (toothed whales and dolphins). The only member of the Order Sirenia found in the northern Gulf is the Florida manatee, which is common throughout coastal and inshore waters south of the Suwannee River in Florida. California sea lions exist in the northern Gulf of Mexico as feral individuals that were probably released or escaped from aquaria, animal shows, and marine parks (USDOI, 1992).

Seven species of baleen whales have been reported in the Gulf of Mexico. These include the northern right whale and six species of balaenopterid whales (blue, fin, sei, Bryde's, minke, and humpback). Sightings and strandings of these species in this area are uncommon, though historical sightings and stranding census data suggest that they more often frequent the north-central Gulf region in comparison to other areas of the Gulf (USDOI, 1992).

Twenty-two species of toothed whales and dolphins have been reported in the Gulf of Mexico. These include the great sperm whale; pygmy and dwarf sperm whales; four species of beaked whales (North Sea, Blainville's, Antillian, and goose); killer whale; false and pygmy killer whale; short-finned pilot whale; grampus (Risso's dolphin); melon-headed whale; and nine other species of delphinid dolphins (Atlantic bottlenose, saddleback, rough toothed, striped, pantropical spotted, short-snouted spinner, Atlantic spotted, long-snouted spinner, and Fraser's). Many of these species are distributed in warm temperate to tropical waters throughout the world (Mullin *et al.*, 1991).

• Nonendangered and Nonthreatened Species -- Baleen whales from the Gulf of Mexico that are not listed as endangered are the Bryde's whale and the minke whale. The Bryde's whale is the second smallest of the balaenopterid whales commonly called rorquals, a Norse term meaning "red whale," which refers to the pinkish tint of its characteristic throat pleats that expand during feeding. Bryde's whales are not noted for lengthy migrations and tend to remain within tropical to temperate waters. This species feeds on small pelagic fishes (such as herring, mackerel, and pilchard) and cephalopods (Cummings, 1985). It is believed that a small, resident population of Bryde's whales may occur in the Caribbean Sea or Gulf of Mexico (Schmidly, 1981). The minke whale is the smallest of the rorquals and is cosmopolitan in distribution. It is widespread and seasonally abundant in the North Atlantic Ocean, migrating southward during the winter months to the Florida Keys, the Gulf of Mexico, and the Caribbean Sea. Minke whales feed on zooplankton and fish (Stewart and Leatherwood, 1985).

With one exception (sperm whale), none of the toothed whales and dolphins from the Gulf are listed as endangered or threatened. Dwarf and pygmy sperm whales are typically found in deeper waters (continental shelf edge and beyond) and congregate in small average herd sizes (2-10 individuals). Temporal distribution within the Gulf has been variable (Mullin *et al.*, 1991). Their diet includes squid, benthic fish, and crabs (Caldwell and Caldwell, 1989). Beaked whales (family Ziphiidae) from the Gulf include Cuvier's beaked whale and three members of the genus *Mesoplodon* (North Sea beaked whale, Blainville's beaked whale, and Antillian beaked whale). Taxonomy and life history data on these species are extremely limited. Observations of beaked whales are in most cases small (1-2 individuals), and the typical behavioral response to survey aircraft and ships is evasion (Mullin *et al.*, 1991). An analysis of stomach contents from captured and stranded individuals suggest that they are deep-diving animals, feeding predominately on mesopelagic fish and squid or deep water benthic invertebrates (Heynig, 1989; Mead, 1989).

Table 2.1 *Marine Mammals of the Gulf of Mexico*

Order Cetacea		
Suborder Mysticeti (baleen whales)		
Family Balaenidae		
Eubalaena glacialis	northern right whale	R*
Family Balaenopteridae		
Balaenoptera musculus	blue whale	R*
Balaenoptera physalus	fin whale	R*
Balaenoptera borealis	sei whale	R*
Balaenoptera edeni	Bryde's whale	R
Balaenoptera acutorostrata	minke whale	R
Megaptera novaeangliae	humpback whale	R*
Suborder Odontoceti (toothed whales)		
Family Physeteridae		
Physeter macrocephalus	great sperm whale	C*
Kogia breviceps	pygmy sperm whale	C
Kogia simsus	dwarf sperm whale	U
Family Ziphiidae		
Mesoplodon bidens	North Sea beaked whale	E
Mesoplodon densirostris	Blainville's beaked whale	R
Mesoplodon europaeus	Antillean beaked whale	U
Ziphius cavirostris	goose beaked whale	U
Family Delphinidae		
Orcinus orca	killer whale	R
Pseudorca crassidens	false killer whale	U
Feresa attenuata	pygmy killer whale	U
Globicephala macrorhynchus	short-finned pilot whale	C
Grampus griseus	grampus/Risso's dolphin	U
Peponocephala electra	melon-headed whale	R
Tursiops truncatus	Atlantic bottlenose dolphin	C
Delphinus delphis	saddleback dolphin	R
Steno bredanensis	rough toothed dolphin	R
Stenella coeruleoalba	striped dolphin	C
Stenella attenuata	pantropical spotted dolphin	R
Stenella clymene	short-snouted spinner dolphin	U
Stenella frontalis	Atlantic spotted dolphin	C
Stenella longirostris	long-snouted spinner dolphin	U
Lagenodelphis hosei	Fraser's dolphin	R
Order Carnivora		
Suborder Pinnipedia (seals, sea lions)		
Family Otariidae		
Zalophus californianus	California sea lion	I,R
Family Phocidae		
Monachus tropicalis	Caribbean (West Indian) monk seal	Ex
Order Sirenia		
Family Trichechidae		
Trichechus manatus	West Indian manatee	C*

C = common, U = uncommon, R = rare, E = extralimital record, I = introduced, Ex = extinct, * = endangered

(Source: USDOI, 1992)

The family Delphinidae is taxonomically broad and includes all remaining species of nonendangered whales and dolphins found in the Gulf. Most of the constituents of the family inhabit deeper waters of the Gulf, except the bottlenose dolphins, and their specific distributions appear to be a function of preferred depth range. Bottlenose dolphins are the most common delphinid on the continental shelf and nearshore waters of the Gulf. Atlantic spotted dolphins frequent mid-shelf to outer-shelf waters with some degree of overlap with bottlenose dolphins. Grampus are also frequently sighted along the shelf edge. All other delphinids appear to prefer deeper slope waters and feed on fish and/or squid, depending upon the species (Mullin *et al.*, 1991). Recent surveys have led to the discovery of at least one rather large herd (approximately 200 individuals) of Fraser's dolphins (previously only known to the Gulf via a single stranding on the Florida Keys) (USDOI, 1992).

• Endangered & Threatened Species -- Six species of baleen whales (northern right, blue, fin, sei, minke, and humpback), one species of toothed whales (sperm), and the West Indian manatee, all found within the Gulf of Mexico, are currently listed as endangered species under the provisions of the U.S. Endangered Species Act; all are uncommon to rare in the Gulf except for the sperm whale.

The northern right whale is a robust, medium-sized whale. As a result of extensive hunting pressure, it remains the rarest of the world's large whales; current populations within the North Atlantic seasonally migrate around five discrete areas along the eastern seaboard of the U.S. Historical records of northern right whales in the Gulf of Mexico consist of a single stranding record in Texas in 1974 and a sighting of two individuals off the western coast of Florida (1963) (Moore and Clark, 1963; Schmidly, 1981). Right whales feed by systematically skimming through surface and subsurface concentrations of zooplankton (Watkins and Schevill, 1976).

The blue whale is the largest of the whales and is cosmopolitan in distribution, migrating poleward to feeding grounds in spring and summer after wintering in subtropical and tropical waters (Yochem and Leatherwood, 1985). Records of the blue whale in the Gulf consist of two strandings on the Texas coast (1924 and 1940), and it is believed that the entire surviving population in the North Atlantic consists of only a few hundred individuals (Leatherwood and Reeves, 1983). The blue whale feeds almost exclusively on zooplankton via a combination of gulping and lunge-feeding in areas of heavy prey concentration (Yochem and Leatherwood, 1985).

The fin whale is the second largest rorqual in size and is also cosmopolitan in distribution. It is thought that fin whales segregate into independent stocks in each hemisphere and that there may be a small population which inhabits the Gulf of Mexico or Caribbean Sea (Schmidly, 1981). Fin whales feed on zooplankton, cephalopods, and fish, generally via surface and subsurface lunge-feeding (Gambell, 1985a). Sightings in the Gulf have typically been in deeper waters, more commonly in the north-central area (Mullin *et al.*, 1991).

Sei whales are medium-sized rorquals that are widely distributed in all oceans. They migrate between temperate waters and higher latitudes, though they do not go so far towards polar waters as do some other rorquals. Sei whales feed primarily on plankton via skimming, though they do consume small schooling fish in some areas via lunge-feeding (Gambell, 1985b). Two sei whales were sighted off the Mississippi River Delta in 1956, and off Gulfport, MS, in 1973 (Mullin *et al.*, 1991). No sei whales were observed in the northern Gulf during 1980-1981 aerial surveys (Fritts *et al.*, 1983). However, valid sighting and stranding records from the Gulf of Mexico, Caribbean Sea, and off eastern Florida suggest that there may be a resident population in the Gulf (Mead, 1977).

The humpback whale, though a member of the family Balaenopteridae, is distinctively different in appearance from the true rorquals. Humpbacks inhabit all oceans and seasonally migrate from summer feeding grounds in higher latitudes to winter ranges over shallow tropical banks where they calve and do not feed. Humpbacks feed on fish and zooplankton, which typically aggregate into dense or large patches. They capture prey using a diverse and oftentimes elaborate array of feeding techniques, either singly or within groups (Winn and Reichley, 1985). Sightings in the Gulf of Mexico have been sporadic and include the central Gulf, the eastern Gulf off the coast of Florida, and most recently Galveston Bay, TX (Schmidly, 1981).

Sperm whales are the only toothed whales listed as an endangered species. They have a cosmopolitan distribution within deep-sea areas and form social aggregations consisting of mature females, juveniles, and calves. Male sperm whales form separate bachelor herds of varying size or, in the case of large males, remain solitary. As a group they seem to prefer certain areas within each major ocean basin, which historically have been termed "grounds" (Rice, 1989). Large mesopelagic squid are the primary diet of sperm whales, though other cephalopods, demersal fishes, and occasionally benthic invertebrates are consumed (Rice 1989). Sperm whales are the most abundant large whale in the Gulf and have been sighted on most surveys conducted in deeper waters (Fritts *et al.*, 1983; USDOC, 1988; Mullin *et al.*, 1991). Congregations of sperm whales are commonly seen off the shelf edge in the vicinity of the Mississippi River Delta (Mullin *et al.*, 1991). There are, as yet, no data available that suggest seasonal movements of sperm whales in the Gulf of Mexico (Schmidly, 1981).

The West Indian manatee is an aquatic herbivore and one of four living species of the order Sirenia. It inhabits low-energy coastal areas throughout the northern Gulf of Mexico; however, it is uncommon west of the Suwannee River, FL. The cool water of the northern Gulf and the swift currents in the Straits of Florida have acted as a geographic barrier, resulting in Antillean and Florida subspecies. The Antillean population occurs infrequently in the central and western Gulf due to the species' physiological requirements for warm water. Only 11 manatees were sighted in the western and central Gulf between 1975 and 1990 (USDOI, 1990). In two of the strandings, the animals were found dead of starvation and cold stress. The two

sightings in Texas are thought to be of the Antillean population coming from Mexico. The others, seven in Louisiana and two in Mississippi, are thought to be from the Florida population (Beeler and O'Shea, 1988). The Florida population is estimated to be greater than 1800 individuals (Ackerman, pers comm., 1992). For most of the year, they are dispersed throughout south and central Florida, often correlated with the distribution of seagrasses and vascular freshwater aquatic vegetation. During the winter, typically between November and March, manatees seek warm water by southern migration or by congregating in warm springs and industrial outfalls (USDOI, 1990).

Alabama, Choctawhatchee & Perdido Key Beach Mice. The Alabama, Choctawhatchee, and Perdido Key beach mice, subspecies of the field mouse, occupy restricted habitats in the mature coastal dunes of Florida and Alabama. Their population has declined as a result of tropical storms and the loss of habitat from coastal development. The Perdido Key beach mouse currently is found on the western portion of Perdido Key, including Gulf State Park, and on the eastern portion of the Key at Gulf Islands National Seashore. The Choctawhatchee beach mouse is found on two limited areas consisting of approximately 7.9 km (4.9 mi) of beach at Topsail Hill, Walton County, FL, and Shell Island, FL. The Choctawhatchee beach mouse has also been re-established on the Grayton Beach State Recreation Area. The Alabama beach mouse is restricted to only 1.5 km (0.9 mi) of beach habitat at the western end of Perdido Key within the Bon Secour National Wildlife Refuge. Portions of these areas have been designated critical habitat. The beach mice feed nocturnally on the lee side of the dunes and remain in burrows during the day. Seeds are the major item of their diet (USDOI, 1987).

Marine Turtles

The green turtle (*Chelonia mydas*) population in the Gulf once supported a commercial harvest in Texas and Florida, but the population has not completely recovered since the collapse of the fishery around the turn of the century. Reports of nesting in the northern Gulf are isolated and infrequent, with the exception of documented nesting on Santa Rosa Island, Okaloosa County, FL, since 1988. The closest nesting aggregations are on the east coast of Florida and the Yucatan Peninsula. Green turtles prefer depths of less than 20 m (66 ft), where seagrasses and algae are plentiful (NRC, 1990).

Leatherbacks (*Dermochelys coriacea*), the most oceanic of the marine turtles, occasionally enter shallow waters. Their nesting is concentrated on coarse-grain beaches in tropical latitudes (Ogren *et al.*, 1989), but there are rare occurrences in the Panhandle. The nearest location with regular nesting by this species is central eastern Florida, where 100-200 nests are deposited annually (Florida Department of Environmental Protection, Statewide Nesting Survey Data Base).

The hawksbill (*Eretmochelys imbricata*) is the least commonly reported marine turtle in the Gulf. Texas is the only Gulf State where stranded turtles are regularly reported (Ogren *et al.*, 1989) and these tend to be either hatchlings or yearlings. Northerly currents may carry them from Mexico, or their nesting range may be expanding northward into Texas. They are more frequent in the tropical Atlantic, Gulf of Mexico, and Caribbean. Hawksbills prefer reefs and waters where marine invertebrates are abundant.

The Kemp's ridley sea turtle (*Lepidochelys kempi*) is the most imperiled of the world's marine turtles. The population of nesting females has dwindled from an estimated 47,000 in 1947, to less than 1,000 today (NRC, 1990). There are an estimated 800 nests per year (NRC, 1990), primarily on a 17 km (10.6 mi) stretch of beach in Rancho Nuevo, Vera Cruz, Mexico (Thompson, 1988). Nesting occurs infrequently in the U.S. (Thompson, 1988). Natural nesting is supplemented by a NMFS headstart rearing program at the Galveston Laboratory in Texas. Hatchlings appear to disperse offshore to seek refuge in sargassum mats (Collard and Ogren, 1989). Female Kemp's ridleys appear to inhabit nearshore areas, and congregations of Kemp's have been recorded off the mouth of the Mississippi River (Byles, 1989). Although most Kemp's ridleys inhabit the Gulf, they range along the Atlantic Coast to Massachusetts. However, there is speculation that young turtles swept out of the Gulf of Mexico are lost to the population (NRC, 1990).

The loggerhead sea turtle (*Caretta caretta*) occurs worldwide in depths ranging from estuaries to the continental shelf. It has been reported throughout the Atlantic from Newfoundland to Argentina (NRC, 1990). Nesting also occurs worldwide. The largest nesting concentration in the U.S. is on the southeast Florida coast from Volusia to Broward counties (Conley and Hoffman, 1987). In the Gulf of Mexico, recent surveys indicate that the Florida Panhandle accounts for approximately one-third of the nesting on the Florida Gulf Coast. In the central Gulf, loggerhead nesting has been reported on Gulf Shores and Dauphin Island, AL; Ship Island, MS; and the Chandeleur Islands, LA. Nesting in Texas occurs primarily on North and South Padre Islands, although occurrences are recorded throughout coastal Texas. Hildebrand (1982) noted that banks off the central Louisiana coast and near the Mississippi Delta are also important marine turtle feeding areas. Hatchlings appear to have a pelagic phase followed by a movement inshore and associated benthic, omnivorous feeding (Nelson, 1988). Adults are frequently found in association with concentrations of portunid crabs. The Archie Carr National Wildlife Refuge in Brevard and Indian River counties, FL, on the east coast of Florida, hosts the largest concentration of nesting loggerheads and green sea turtles in the U.S. and is the second most important nesting beach for loggerheads in the world.

Coastal & Marine Birds

Nonendangered and Nonthreatened Species. Migrant and non-migrant coastal and marine birds populate the beaches and wetlands of the northern Gulf of Mexico. This broad category consists of three main groups: waterfowl, wading birds, and marine birds. Feeding habitats include the waters and coastal shores of the open Gulf, bays and estuaries, brackish and freshwater wetlands, as well as coastal farmlands and landfills.

Waterfowl consist mainly of ducks and geese. The majority of waterfowl found in the northern Gulf of Mexico's coastal wetlands are over-wintering migrants. The major waterfowl habitats are brackish and freshwater marshes, but species of resident waterfowl inhabit swamp forests and marshes in all central and western Gulf States (Portnoy, 1977; Chapp *et al.*, 1982a and b). Some species feed and congregate in open waters, often clustered in dense rafts. These most commonly include members of the Pochards (canvasback, redhead, and scaups), sea ducks (bufflehead, goldeneyes, and mergansers), and the ruddy duck (Madge and Burn, 1988). Waterfowl journey to Gulf feeding grounds using specific flight corridors that run the length of the continental U.S. and terminate in distinct localities along the Gulf Coast. Some waterfowl exhibit a limited degree of coastal movement within their terminal locality (Bellrose, 1968).

Wading birds of the coastal Gulf of Mexico consist of herons, egrets and bitterns, storks and cranes, and ibis and spoonbills. They occupy a very diverse array of feeding habitats, and thus demonstrate similarly diverse feeding strategies based on species morphology and physiological adaptation in relation to the availability of prey (Kushlan, 1978). The most abundant species are tricolored herons, snowy egrets, and cattle egrets (Fritts *et al.*, 1983). Texas reported approximately 200,000 wading birds (12 species) at 287 colony sites in its 1988 colonial waterbird census (Texas Parks & Wildlife Department, 1989). Resident wading bird populations are augmented during the winter by migrants from as far away as Canada. The Mississippi Delta divides migrating birds into distinct east-west groups in the Gulf. Migrating adults of each group terminate and remain in distinct localities along the Gulf Coast, while juveniles usually continue migration outside the country. Migration by eastern Gulf juveniles begins in southern Florida and terminates in the Caribbean or on the Yucatan Peninsula. Juvenile migration in the western Gulf begins and continues southwestward along the Gulf coast, terminating in Mexico and Central America (Byrd, 1978; Ogden, 1978; Ryder, 1978). Although their range extends to barrier islands, very few wading birds are seen offshore in the Gulf.

Marine birds include both seabirds and shorebirds. Seabirds are defined as those species whose normal habitat and food source are the sea, whether they be coastal, offshore, or pelagic. Within the Gulf of Mexico, this group is composed primarily of gulls and terns, yet also includes some petrels and shearwaters, storm-petrels, tropicbirds, pelicans, gannets and boobies, cormorants, frigatebirds, phalaropes, skuas (jaegers), skimmers, loons, and grebes (Harrison, 1983). Some of these species

are entirely pelagic, (*i.e.*, both feed and roost offshore, though the majority of seabirds return to shore to roost). Seabirds exploit a wide variety of feeding habitat, and their distribution within marine and coastal ecosystems relates to the distribution of productivity and biomass within these ecosystems (Hunt and Schneider, 1987). Shorebirds are closely associated with coastal and nearshore habitats. Many species are highly migratory and seasonally congregate along select coastal areas, often in great numbers. Within the Gulf of Mexico, this group consists of some oystercatchers; stilts and avocets; plovers; and sandpipers, snipes, and allies (Hayman *et al.*, 1986).

In its 1988 colonial water bird census, Texas reported approximately 300,000 marine birds, of which approximately 115,000 were terns and 137,000 were gulls (Texas Parks & Wildlife Department, 1989). Migrants from as far away as the North American Arctic Circle augment resident seabird and shorebird populations during the winter. Some species over-winter in discrete localities within a single planning area of the Gulf of Mexico region, while other species are split into distinct groups east or west of the Mississippi Delta. Some species of marine birds may continue migration. Those few species in the central Gulf that do, migrate nonstop at high altitudes from the Mississippi Delta to the Yucatan Peninsula and/or northern Central America. Those in the western Gulf continue southwestward along the Gulf Coast to Mexico and Central America, and those in the eastern Gulf to the Caribbean. Those that remain on the Gulf Coast exhibit a limited degree of coastal movement within their terminal locality (Clapp, 1982a and b; Fritts *et al.*, 1983).

Those birds most susceptible to oiling either raft at sea, such as gulls and terns, or dive when disturbed, such as cormorants and boobies. The death of coastal area birds caused by OCS-related oil and gas activities makes a strong visual impact that heightens publicity (Chapp *et al.*, 1982a; NRC, 1985).

Endangered and Threatened Species. The piping plover is endangered in the Great Lakes watershed and threatened elsewhere. Market hunting decimated its historic populations, which have remained depressed because of losses to beach and nesting habitat. Habitat loss is primarily the result of damming, channelization, beach armoring, and shoreline development (USDOI, 1988a). The plover has three distinct breeding populations: Atlantic Coast, Great Plains, and Great Lakes. Only the Great Lakes and Great Plains populations migrate south in the fall to winter on the Gulf Coast, in Mexico, and in the Caribbean. The Great Lakes population, consisting of 17 pairs, is the most depleted; the Great Plains population has 1,258-1,326 pairs (Nicholls, 1990). On the Gulf Coast, Texas and Louisiana have the largest numbers and highest wintering densities. There, the plover prefers intertidal flats and beaches for its habitat. The birds are thought to roost on secluded beaches just above the wrack line. Piping plovers are susceptible to contact with spilled oil because of their preference for feeding in intertidal areas; a susceptibility documented in Texas.

The whooping crane population (130 individuals) winters along the Texas coast from November to April, occupying the coastal marshes of Aransas, Calhoun, and Matagorda counties. Portions of these counties and all of the Aransas National Wildlife Refuge have been designated as critical habitat for the whooping crane. The birds feed on blue crabs and clams in tidal flats (USDOI, 1986). The conversion of wetlands and prairie to agriculture, and other encroachments by man, have the greatest impact on the whooping crane. A rapid recovery of the population is unlikely because of delayed sexual maturity and small clutch sizes. Mortality from inclement weather, predation, fire, and collisions with powerlines and aircraft also inhibits the birds' recovery.

The Arctic peregrine falcon is a subspecies of the peregrine falcon, which breeds in the North American tundra. A portion of the population migrates along the Central, Mississippi, and Eastern flyways to winter on the U.S. and Mexican Gulf coasts. The birds concentrate along beaches and barrier islands. Their population decline has been attributed to reproductive failure resulting from the ingestion of prey containing chlorinated hydrocarbons.

Bald eagles are found throughout the Gulf States. Bald eagles actively nest in upland and wetland areas 48-80 km (30-50 mi) from the coast throughout the Gulf. Bald eagles inhabit areas near water although they rarely nest on the coast. They prey on birds, fish, and small mammals. Nesting occurs in September followed by egg laying from October to December. Their population decline is primarily the result of habitat alteration and reproductive failure from the ingestion of prey containing chlorinated hydrocarbons. Historically, two nestings have occurred along the Mississippi coast. In Florida, coastal nesting occurs at St. Vincent, St. Marks, and Lower Suwannee National Wildlife Refuges, and south to Hondo Bay.

Brown pelicans have been removed from the federal endangered species list in Alabama and Florida but remain listed as endangered in Mississippi, Louisiana, and Texas. Their decline is primarily the result of hatching failure caused by ingestion of fish containing pesticides. Nesting occurs in colonies on coastal islands. Six brown pelican rookeries have been documented in Louisiana: on Queen Bess, North, Last, Calumet-Timbalier, and Grand Gosier Islands, and at South Pass (Martin, 1990). There is also a small rookery on Pelican Island in Nueces County, Texas. Unsuccessful nesting has occurred on Sunset Island in Matagorda Bay, and 40 hatchlings have been reintroduced to San Bernard National Wildlife Refuge (USDOI, 1989). Brown pelicans inhabit the coast, rarely venturing into freshwater or flying more than 32 km (20 mi) offshore. They feed by plunge-diving to catch fish near the surface.

The endangered Eskimo curlew is one of the rarest native North American birds in the wild. Only 18 birds were reported between 1983-1987. Most sightings occur in coastal Texas, the largest being 23 birds by Atkinson Island, Galveston Bay, in 1981 (USDOI, 1990). This is the largest number reported in over 80 years. The birds migrate through and concentrate in the Gulf Coast marshes during the spring on

their way from southern South America to Canada. Eskimo curlews feed on invertebrates and crowberries in their northern range and are assumed to have similar habits along the Gulf Coast. The drastic population decline, which was first reported in the late 1800s, appears due to overharvest, habitat loss, and short-term climatic changes (USDOI, 1990).

Fishery Resources

Nonendangered & Nonthreatened Species. The Gulf of Mexico supports a great diversity of fish resources that are dependent on various ecological factors, such as salinity, primary productivity, bottom type, etc. These factors differ widely across the Gulf of Mexico and between the inshore and offshore waters. Specific fish species are associated with the various environments and are not randomly distributed.

High densities of fish resources are associated with particular habitat types (*e.g.*, east Mississippi Delta, Florida Big Bend seagrass beds, Florida Middle Ground, mid-outer shelf, and DeSoto Canyon). Approximately 46 percent of the southeastern U.S. wetlands and estuaries important to fish resources are located within the Gulf of Mexico (Mager and Ruebsamen, 1988). Consequently, estuarine-dependent species, both finfish and shellfish, dominate the fisheries.

The life history of many of the recreationally and commercially important estuarine-dependent species involves spawning on the continental shelf; transporting eggs, larvae, or juveniles to the estuarine nursery grounds; growing and maturing in the estuary; and migrating back to the shelf for spawning. After spawning, the adult individuals generally remain on the continental shelf. Movement of adult estuary-dependent species is essentially onshore-offshore with no extensive east-west or west-east migration. Estuary-related species of importance include menhaden, shrimp, oyster, crab, black drum, spot, Atlantic croaker, red drum, spotted seatrout, other sciaenids, southern flounder, Gulf flounder, striped mullet, and white mullet. Major estuarine communities are found from east Texas through Louisiana, Mississippi, Alabama, and northwestern Florida. Estuaries of the Gulf of Mexico export considerable quantities of organic material, thereby enriching the adjacent continental shelf areas (Darnell and Soniat, 1979).

Darnell *et al.* (1983) and Darnell and Kleypas (1987) found that the density distribution of fish resources in the Gulf was highest nearshore off the central coast. For all seasons the greatest abundance occurred between Galveston Bay and the Mississippi River. Fish resources are generally less abundant in the far western and eastern Gulf of Mexico, though areas of relatively high abundance may be found. The high salinity bays of the western Gulf contain no distinctive species, only a greatly reduced component of the general estuary community found in lower salinities (Darnell *et al.*, 1983). High salinity bays and sounds in the eastern Gulf contain invertebrate species which prefer shell, coral sand, and coral silt bottoms; these include pink shrimp, rock shrimp, and stone crab (Darnell and Kleypas, 1987).

Populations in the inshore shelf zone [7-14 m (23-46 ft)] are dominated seasonally by Atlantic croaker, spot, drum, silver seatrout, southern kingfish, and Atlantic threadfin (USDOC, 1992a). Populations in the middle shelf zone [27-46 m (89-151 ft)] include sciaenids, but are dominated by longspine porgies (USDOC, 1992a). The blackfin searobin, Mexico searobin, and shoal flounder are dominant on the outer shelf zone [64-110 m (210-361 ft)] (USDOC, 1992a).

Natural reefs and banks, located mainly between the middle and outer shelf zones, support large numbers of grouper, snapper, gag, scamp, and seabass. Reef fish occur on the continental shelf wherever hard/live bottoms with rocks, holes, or crevices are available (USDOC, 1986). In the western and central Gulf, natural reefs are scattered along the 200 m (656 ft) isobath. Numerous offshore petroleum platforms, believed to act as artificial reefs, augment the hard substrate of natural reefs in this area (Linton, 1988). In the eastern Gulf, prominent reef complexes such as the Florida Middle Ground provide reef fish habitat (USDOC, 1986).

Hard substrates with some vertical relief act as important landmarks for pelagic species. Coastal pelagics such as mackerels, cobia, bluefish, amberjack, and dolphin move seasonally within the Gulf of Mexico. Prime nursery areas are probably the shallow portion of the continental shelf at high nutrient areas near river plumes (Grimes, 1988).

Oceanic species such as yellowfin and bluefin tuna are mainly found beyond the continental shelf during winter and spring, but after spawning they move through the Florida Straits into the Atlantic Ocean. Billfishes (black marlin, white marlin, sailfish, and swordfish) spawn in the northeastern Gulf, mostly in areas beyond the continental shelf (State of Florida, Marine Fisheries Commission, 1988).

Fishing operations, as well as phenomena, such as weather, hypoxia, and red tides, contribute to reduced standing populations. Fishing techniques, such as trawling, gill netting, purse seining, or hook and line, when practiced non-selectively, may reduce the stocks of the desired target species, as well as substantially affect fish resources other than the target species. In addition, hurricanes may affect fish resources by destroying oyster reefs, damaging gear and shore facilities, and changing physical characteristics of inshore and offshore ecosystems.

The degradation of inshore water quality and loss of Gulf wetlands as nursery areas are considered significant threats to fish resources in the Gulf of Mexico (Christmas *et al.*, 1988). Loss of wetland nursery areas in the north-central Gulf is believed to be primarily the result of channelization, river control, coastal development, and subsidence of wetlands (Turner and Cahoon, 1987). Loss of wetland nursery areas in the far western and eastern Gulf is believed to result primarily from urbanization and poor water management practices (Texas Parks and Wildlife, 1989; USEPA, 1989).

• Finfish -- Finfish resources are linked both directly and indirectly to the vast estuaries that ring the Gulf of Mexico. A species is directly dependent on estuaries when it relies on low salinity brackish wetlands for most of its life history, such as during the maturation and development of larvae and juveniles. Even the offshore demersal species are indirectly related to the estuaries because the estuaries influence the productivity and food availability on the continental shelf (Darnell and Soniat, 1979; Darnell, 1988).

Gulf menhaden spawn near the water surface in a localized area of the middle continental shelf proximate to the Mississippi River Delta from fall to spring (mid-October through March). Planktonic larvae are transported via currents to estuary nursery areas. Larvae enter estuaries when 3-5 weeks old. After the larvae grow and transform into juveniles in the shallow portions of the estuary, they move to open and deeper estuarine waters. Juvenile and adult Gulf menhaden inhabit estuaries throughout the year (Christmas *et al.*, 1982). Some first year juveniles may over-winter in estuaries; however, most Gulf menhaden move from estuaries into offshore marine waters during the late fall and winter. There is evidence that older fish move toward the Mississippi River Delta (Shaw *et al.*, 1985; Vaughan *et al.*, 1988). Sexual maturation is completed after two growing seasons.

Schooling is apparently an inborn behavioral characteristic of menhaden, beginning at the late larval stage and continuing throughout the remainder of life. Their occurrence in dense schools, generally by individuals of fairly uniform size, is an outstanding characteristic that facilitates mass harvesting. The seasonal appearance of large schools of menhaden in the inshore Gulf waters from April to November dictates menhaden fishery operations (Nelson and Ahrenholz, 1986).

Larval menhaden feed on pelagic zooplankton in marine and estuarine waters. Within the estuary, the mouthparts of the larvae transform, and juvenile and adult Gulf menhaden become filter-feeding omnivores that primarily consume phytoplankton, but also ingest zooplankton, detritus, and bacteria. As filter-feeders, menhaden form a basal link in estuarine and marine food webs and, in turn, are prey for many species of larger fish (Vaughan *et al.*, 1988).

Throughout the Gulf, sciaenids have a protracted spawning season over the spring and summer or fall and winter. The inception of spawning is variable and dependent on rising or falling water temperatures. Preferred spawning habitat varies according to species. Large schools of spawning red drum congregate around major passes in relatively shallow water during late summer and fall. Croaker prefer deeper, high salinity waters for spawning. Planktonic larvae develop in nearshore areas, and, with the help of prevailing currents, actively seek protected areas of estuaries and inshore bays with slightly muddy bottoms (USDOI, 1992). Sciaenids move to deeper waters of bays during their first year. After the first year, there is gradual movement of sciaenids into the Gulf during cold weather and a pronounced movement back into bays and estuaries during the warmer months. Sexual maturation in croaker occurs after five years and continues for up to 15 years.

Sciaenids are opportunistic carnivores whose food habits change with size (USDOI, 1992). Larval sciaenids feed selectively on pelagic zooplankton, especially copepods. Juveniles feed upon invertebrates, changing to a more piscivorous diet as they mature (Perret *et al.*, 1980; Sutter and McIlwain, 1987; USDOC, 1986).

Approximately 90 percent of finfish in the Gulf of Mexico are directly dependent on estuaries during some stage of their life history. Demersal species are associated with live bottoms, reef complexes, hard bottom banks, patch reefs, shell banks, flat mud bottoms, and flat sand bottoms. Pelagic species are associated with high salinity open water beyond the direct influence of coastal systems.

Most snappers are non-estuarine-dependent demersal fish associated with natural reefs, hard bottoms, and artificial reefs of the mid-outer continental shelf. Called reef fish, snappers remain close to underwater structures. Snappers spawn offshore in groups over unobstructed bottoms adjacent to reef areas. Juvenile snapper form loose aggregations, while adults form schools during the day and disperse at night. There is a tendency for larger, older snappers to occur in deeper water than juveniles. Seasonal spawning patterns vary among snapper species, but generally, once they attain sexual maturity, they have a protracted spawning period with seasonal peaks. There is a decline in spawning activity among snappers during the winter. Snappers feed along the bottom on fishes and benthic organisms such as tunicates, crustaceans, and mollusks. Juveniles feed on zooplankton, small fish, crustaceans, and mollusks (Bortone and Williams, 1986; USDOC, 1986).

Coastal pelagics are open water fish widely distributed throughout the Gulf of Mexico. Pelagic species such as king and Spanish mackerel move seasonally in response to water temperature and oceanographic conditions. Mackerel are found from the shore to 200 m (656 ft) depths. Spanish mackerel frequent the coastal areas while king mackerel stay farther offshore. King mackerel move from the eastern to the north-central and western Gulf in the spring. During cooler fall seasons, they move back into the warmer waters of the southeastern Gulf. A contingent of large, solitary adult king mackerel can be found in a localized area of the north-central Gulf during part of the winter. Spanish mackerel are spread over the northern Gulf during the summer and are mainly found in southeastern coastal areas in the fall and winter. Mackerel spawn offshore over the continental shelf during the spring and summer. Spawning may occur more than once per season. Juvenile mackerel utilize nearshore areas as nurseries. Mackerel feed throughout the water column on other fishes, especially herrings, and on shrimp and squid. Mainly a schooling fish at smaller sizes, larger king mackerel occur in small groups or singly (Godcharles and Murphy, 1986; USDOC, 1986).

Anadromous fishes are species that spend a portion of their life in marine waters, but ascend rivers for spawning. Fish species in the Gulf of Mexico considered anadromous include the following: striped bass, *Morone saxatilis*; Gulf of Mexico sturgeon, *Acipenser oxyrinchus desotoi*; and Alabama shad, *Alosa alabamae* (GSMFC, 1991; Hoese and Moore, 1977). Striped bass, Gulf sturgeon, and Alabama

shad are currently considered to be in various stages of population decline resulting from various factors: overfishing; habitat alterations, including channelization and damming of rivers; water quality deterioration; and contaminants (GSMFC, 1991). Striped bass were harvested both commercially and recreationally prior to their decline, and a limited sport fishery still exists (Nicholson, 1986). Striped bass populations have been augmented by annual stocking of fry and juveniles in selected Gulf rivers since the late 1960s, and such stocking is believed to be a major factor in preventing the complete elimination of the species from most of these river systems (Nicholson, 1986). Commercial fisheries existed for Gulf sturgeon in the late 19th and early 20th centuries, but all five Gulf States now prohibit take of this species, and it was listed as threatened under the Endangered Species Act in 1991.

• Shellfish -- To a great degree, conditions in estuaries determine the status of shellfish resources of the Gulf of Mexico. Life history strategies are influenced by tides, lunar cycles, maturation state, and estuarine temperature changes. Very few individuals live more than a year, and the majority are less than six months old when they enter the extensive inshore and nearshore fisheries. Year-to-year variations in shellfish populations are frequently as high as 100 percent and are most often a result of extremes in salinity and temperature during the period of larval development. Shellfish resources in the Gulf range from those located only in brackish wetlands to those found mainly in saltmarsh and inshore coastal areas. Life history strategies reflect estuary relationships, ranging from total dependence on primary productivity to opportunistic dependence on benthic organisms. Gulf shellfish resources are an important link in the estuary food chain between benthic and pelagic organisms (Darnell *et al.*, 1983; Darnell and Kleypas, 1987; Turner and Brody, 1983).

A total of nine species of penaeid shrimp utilize the coastal and estuarine areas in the Gulf of Mexico. Brown, white, and pink shrimp are the most economically important species. Pink shrimp have an almost continuous distribution throughout the Gulf but are most numerous on the shell, coral sand, and coral silt bottoms off southern Florida. Brown and white shrimp occur in both marine and estuarine habitats and have similar reproductive strategies. Adult shrimp spawn offshore in high salinity waters. After several molts, the larvae enter estuarine waters. Wetlands within the estuary offer both a concentrated food source and a refuge from predators. After growing into juveniles, the shrimp larvae leave the saltmarsh to move offshore where they grow to adulthood. Life history factors, such as the timing of immigration and emigration, spatial use of a food rich habitat, and physiological and evolutionary adaptations to tides, temperature, and salinity differ between the two species (Muncy, 1984; Turner and Brody, 1983; USDOC, 1986).

Pink shrimp occur throughout the Gulf. On the northwestern Gulf shelf, they are widespread but generally of very low density; however, in the eastern Gulf, densities may be quite high. Here the primary nursery is the lower Everglades and mangrove swamps, although seagrass meadows are also used to some extent. Young adults

abandon nursery areas in summer, fall, and early winter, and take up residence on the middle or outer continental shelf. The life history of the pink shrimp indicates the importance of specific nursery areas and the use of multiple habitats by a species (Darnell, 1992).

Although the brown shrimp is an estuary-dependent species, the young prefer higher salinity areas of estuaries. This species is more abundant off Texas than off Louisiana. Among estuary-dependent species, the brown shrimp is somewhat unusual in that adults over-winter in warmer waters of the middle and outer shelf rather than the inner shelf. Although the species is abundant all along the northwestern Gulf Coast, in the spring at least, its areas of greatest density appear to be concentrated off the mouths of individual estuaries (Darnell, 1992).

White shrimp spawn from spring to fall. Spawning activity is probably correlated with a rapid change in bottom temperature. Recruitment of postlarval white shrimp occurs from early summer to fall. Some young white shrimp move from estuaries to nearshore marine waters during late fall to over-winter and then move back to estuaries in early spring when the water temperatures rise. In nursery grounds, juvenile white shrimp move further up water courses than brown shrimp. White shrimp leave Gulf embayments as waters cool from fall through early winter (Muncy, 1984).

Both brown and white shrimp are omnivorous. Larvae feed in the water column on both phyto- and zooplankton. After moving into estuarine nursery areas, postlarvae become demersal and feed at the vegetation-water interface. Developing larvae ingest the top layer of sediment, which contains primarily marsh plant detritus, algae, and microorganisms. When shrimp move to deeper embayments, they become more predaceous (USDOC, 1986).

One species of portunid crab (blue crab) utilizes the coastal and estuarine areas in the Gulf of Mexico and comprises a substantial fishery. Blue crabs occur on a variety of bottom types in fresh, estuarine, and shallow offshore waters. Spawning occurs from March to November in the northern Gulf and year-round in the warmer waters of the southern Gulf. Larval blue crabs occur throughout the water column. Movement during the larval stages is governed by tidal action and coastal currents. Female blue crabs move into areas of lower salinity to mate, then to higher salinities to spawn. Mature crabs usually remain in the same estuary until, after mating, males move into lower salinities and females move into the Gulf. During cold periods, blue crabs move into deeper water or burrow into bottom sediments. A benthic omnivore with a high degree of variability in food habits, the blue crab feeds on annelids, mollusks, crustaceans, other benthic invertebrates, fishes, carrion, and some detritus (Steele and Perry, 1990).

Vast intertidal reefs constructed by sedentary oysters are prominent biologically and physically in estuaries of the Gulf of Mexico. Finfishes, crabs, and shrimp are among the animals that use the submerged intertidal reefs for refuge and also as a food

source, foraging on the many reef-dwelling species. Reefs, as they become established, modify tidal currents and this, in turn, affects sedimentary patterns. Further, the reefs contribute to the stability of bordering marsh (Kilgen and Dugas, 1989).

Oysters spawn from late spring through summer and fall in the Gulf of Mexico. A rapid change in water temperature triggers mass spawning over localized areas of reefs. Oysters may spawn several times during a season. Oyster larvae are transported throughout estuarine systems by tidal action. After several weeks, free-swimming larvae attach in clusters to shell reefs, firm mud/shell bottoms, and other hard substrates. Oysters filter-feed principally on small unicellular algae and incidentally on suspended detrital particles (Burrell, 1986).

Threatened Species. The Gulf sturgeon was listed as a threatened species for protection under the Endangered Species Act on September 30, 1991. The Gulf sturgeon (*Acipenser oxyrinchus desotoi*) is a subspecies of the Atlantic sturgeon. Historically, the Gulf sturgeon occurred in most major river systems, from the Mississippi River to the Suwannee River, and in marine waters of the central and eastern Gulf of Mexico south to Florida Bay (Wooley and Crateau, 1985). Food-habit studies suggest that the Gulf sturgeon feeds on benthic invertebrates over sand, hard bottom, and seagrass substrates in the marine environment. Fish up to three years of age inhabit their river of origin or estuary year-round. Older fish move offshore in the cooler months and return to rivers during the warmer months. While in the rivers, the adults cease feeding and spend most of their time in deep holes or deeper areas within the rivers (Wooley and Crateau, 1985; Odenkirk *et al.* 1985). Spawning occurs in freshwater and is thought to occur in swift water over rocky or coarse substrates. Although adults migrate to freshwater every year, they do not always spawn (Wooley *et al.* 1982; Foster *et al.* 1988; USDOI, 1988b; and Huff, 1975). The decline of the Gulf sturgeon is due to overfishing and habitat destruction, primarily the damming of coastal rivers and the degradation of water quality (McDowall, 1988).

Unusual Mortality Events

Throughout the Gulf of Mexico, single species of plants and animals are known to die in unusually large numbers within a relatively short period of time. Reported mass mortalities have occurred with fish, dolphins, turtles, bivalves (such as oysters, clams, and scallops), seagrasses, and other submerged aquatic vegetation. Large scale losses of less visible organisms, such as zooplankton, phytoplankton, and benthic invertebrates, may also occur but the events are rarely recorded. Mass mortalities are extremely important ecological indicators because they can reflect the acute impacts of pollutants or natural stressors, the cumulative effects of multiple stressors, increased susceptibility to disease, or any other change in habitat resulting in ecological imbalance. Moreover, the loss of these organisms may further imbalance the ecosystem by affecting other species in the community, such as their predators and prey. The loss of large numbers of individuals from a single species may significantly reduce reproduction and recruitment, ultimately creating population impacts far beyond the countable mortalities.

Marine Mammals

During the decade from 1977 to 1987, the Southeast Marine Mammal Stranding Network (SEUS) logged 2,381 stranding and sighting records (Prunier, 1992). These events included strandings of five species of baleen whales and at least 23 species of odontocetes (toothed whales, dolphins, and porpoises). The two most commonly reported species stranded were the bottlenose dolphin and the pygmy sperm whales, with 1,472 and 224 records, respectively. Twenty-one mass strandings were reported. They included the short-finned pilot whale (four stranding events); short-snouted spinner dolphin (three); Risso's dolphin (three); pygmy killer whale (three); false killer whale (two); rough toothed dolphin (two); spotted dolphin (one); striped dolphin (one); sperm whale (one); and Fraser's dolphin (three). Of the 21 mass strandings, 17 occurred in Florida, two in Louisiana, and one in Texas.

A pod of at least 33 short-finned pilot whales stranded on Marco Island on the southwest coast of Florida on July 23, 1986. On August 9, 1986, the apparent remnants of the pod were found stranded near Key West. All of the individuals sampled from the incidents showed physical, clinical, pathological, or histological evidence of illness.

An unusual stranding of 26 bottlenose dolphins occurred along the Texas Gulf Coast in January 1990 (Miller, 1992). There are no previous reports of this number of strandings in a relatively small area in a single day (Miller, 1992). The major contributing factor to the dolphin mortality was the December 1989 freeze, in which temperatures stayed near freezing for about four days, and which resulted in the devastation of the dolphins' most likely major food source, the striped mullet (Miller, 1992).

An increase in the normal bottlenose dolphin stranding rate occurred in a localized portion of the central Texas coast in March and April, 1992, which was 4-10 times the historical mean stranding rate (NMFS Miami & Charleston Laboratories, 1993). This followed the earlier Gulf of Mexico bottlenose dolphin stranding in 1990, which was 2-3 times the 1986-89 rate for those months. In contrast to the 1990 stranding event, however, the 1992 strandings were localized and concentrated in a few bay areas inside the barrier islands (not along the Gulf coast). All size classes were represented.

The NMFS Miami Laboratory initiated an extensive investigation into the 1992 Texas bottlenose dolphin strandings. Although a causal relationship between contaminant levels and dolphin mortalities has not been established, the detection of a pesticide and a herbicide in some of the water samples has focused attention on the potential role of nonpoint source agricultural pesticide runoff into Texas bays (NMFS Miami & Charleston Laboratories, 1993).

The reported strandings have significantly increased along the Texas coast (Parrish, 1990). In the first three months of 1990, 131 strandings were confirmed in Texas, compared to a total of 114 strandings for the previous 12 months of 1989. Texas appears to be the hardest hit by dolphin loss, but Alabama and Florida are also reporting increased or unusual stranding events (Parrish, 1990).

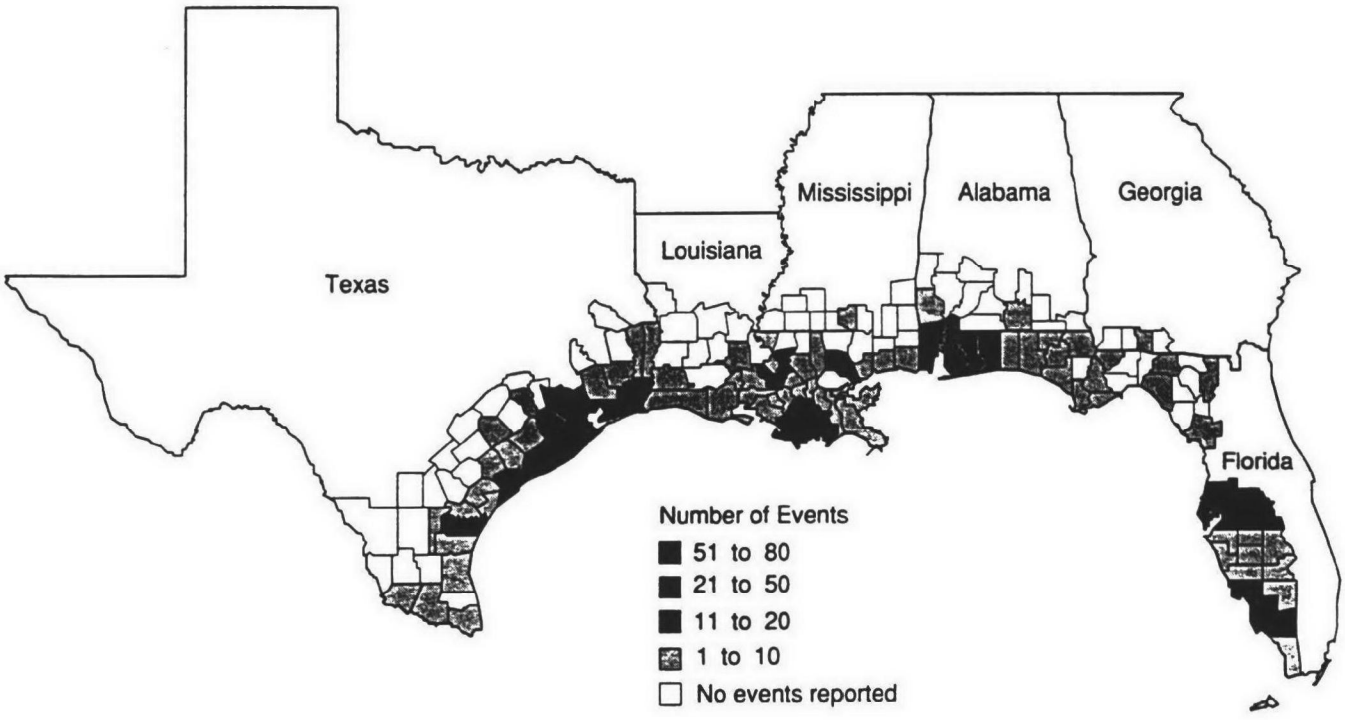
Fish Kills

The NOAA report, "Fish Kills in Coastal Waters, 1980-1989," (Lowe *et al.*, 1991) summarizes results of efforts across the U.S. to identify, report, and assess the causes of fish kills in coastal rivers, streams, and estuarine waters between 1980 and 1989. The location, extent, severity, timing, and cause of over 3,600 nationwide fish kill events were documented.

Fish kill events were reported in 99 of the 160 counties within the Gulf of Mexico coastal region (See **Figure 2.1**). The Gulf of Mexico coastal region had the third highest number of reported events (828) and the highest number of fish killed (188,161,000) (compared to the North Atlantic, Middle Atlantic, South Atlantic, and Pacific coastal regions). Texas accounted for over half of the fish kill events reported in the region (355), followed by Florida (250); Louisiana (172); Alabama (44); and Mississippi (seven).

Texas also had the highest number of fish killed in the region, with approximately 159 million or 85 percent of all reported fish killed between 1980 and 1989. Twenty-one events in Texas, each involved the death of over one million fish. Eight of these occurred in Galveston County and five in Chambers County.

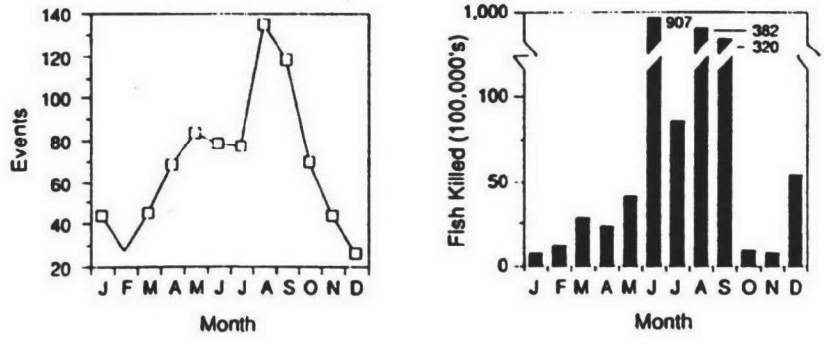
Figure 2.1 ***Reported Fish Kill Events by County, 1980-1989***



(Source: Lowe *et al.*, 1991)

Trends. The number of events reported from 1980 to 1989 does not show any trend. However, an apparent seasonal pattern exists in the region. Most events were reported during May, August, and September (see **Figure 2.2**). However, the greatest numbers of fish killed were reported in June, August, and September (see **Figure 2.2**). This seasonal pattern exists across the U.S., with the majority of kills occurring during the summer months.

Figure 2.2 ***Number of Events & Fish Killed by Month, 1980-1989***

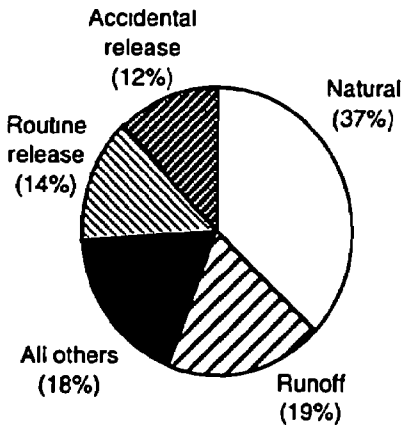


(Source: Lowe *et al.*, 1991)

Sources & Causes. A number of factors may account for the relatively high number of events and fish killed in the Gulf of Mexico. This region has the highest percentage of agricultural land, application of fertilizers and pesticides, industrial point sources, and municipal wastewater treatment plants among regions (USDOC, 1990b). Estuaries in this region have an average depth of eight feet, the shallowest among regions, which restricts their ability to assimilate the loadings of pollutants mentioned above (USDOC, 1990b). These factors, in addition to the hot/humid climate, contribute to waterbodies that are frequently nutrient-enriched and thermally stressed. The result is frequent low dissolved oxygen levels, particularly in the summer, that can lead to fish kills.

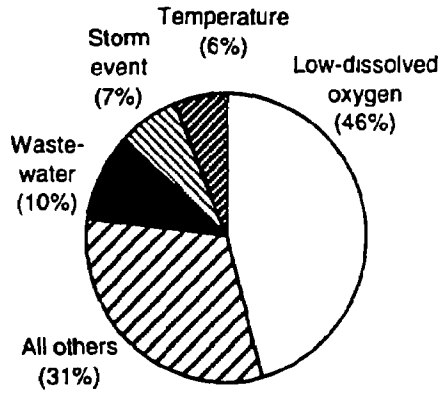
Naturally occurring events dominate the region, with the top two direct causes reported as low dissolved oxygen levels and wastewater (see **Figures 2.3** and **2.4**). In addition, a significant impact is caused by runoff from storm events in urban areas and/or by routine and accidental releases from industrial land uses (see **Figure 2.5**). These events reflect kills related to impacts from human activities.

Figure 2.3 ***Number of Fish Kill Events by Type of Incident****



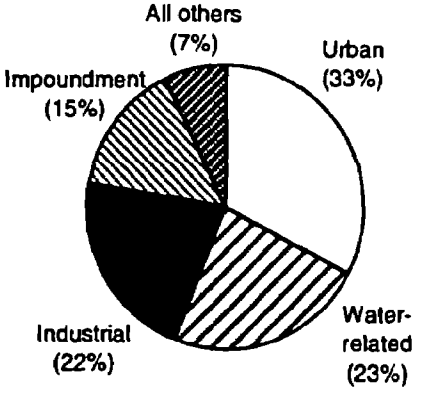
***Does not include information from unspecified events.**
(Source: Lowe *et al.*, 1991)

Figure 2.4 ***Number of Fish Kill Events by Direct Cause****



***Does not include information from unspecified events.**
(Source: Lowe *et al.*, 1991)

Figure 2.5 ***Number of Fish Kill Events by Land Use Cause****



***Does not include information from unspecified events.**
(Source: Lowe *et al.*, 1991)

Alabama. In Alabama, 40 of the 44 reported events indicated the direct cause of the kill. Low dissolved oxygen was the direct cause in 23 of the 40 events. Sixteen of the 44 reported events indicated a land use cause of the kill. Urban land use was the land use cause in ten of the 16 events. In only 16 of the 44 reported events was a direct cause linked with a specific land use cause.

Florida. In Florida, 219 of the 250 reported events indicated the direct cause of the kill. Low dissolved oxygen was the direct cause reported in 116 of the 219 events. Of the 250 reported events, 109 indicated a land use cause of the kill. Urban land use was the land use cause in 56 of the 109 events. In only 106 of the 250 events was a land use cause reported along with a direct cause.

Louisiana. In Louisiana, 146 of the 172 reported events indicated the direct cause of the kill. Low dissolved oxygen was the direct cause in 63 of the 146 events. Of the 172 reported events, 108 indicated a land use cause of the kill. Impoundments were the land use cause in 36 of the 108 events. A direct cause was associated with a specific land use cause in 107 of the 172 reported events.

Mississippi. In Mississippi, six of the seven reported events indicated the direct cause of the kill. A change in salinity was the direct cause in three of the six events. Five of the seven reported events indicated a land use cause of the kill. Water-related land use was the land use cause identified in all five of the events. In five of the seven events was a land use cause reported along with a direct cause.

Texas. In Texas, 291 of the 355 reported events indicated the direct cause of the kill. Low dissolved oxygen was the direct cause reported in 119 of the 291 events. Of the 355 reported events, 208 indicated a land use cause of the kill. Water-related land use was the land use cause in 67 of the 208 events. A direct cause was associated with a specific land use cause in 201 of the 355 reported events.

Hotspots & Recurring Kills. Two counties in Texas reported the highest number of fish kill events for the Gulf of Mexico region: Galveston County (72) and Harris County (66). Galveston County had the highest number of fish killed (almost 106 million) of all of the counties in the entire study area. Half of these kills were attributed to low dissolved oxygen levels that were not associated with a land use cause.

Galveston Bay was the waterbody for which the most events (28) were reported in the region. Large portions of Brazoria, Chambers, Galveston, Harris, and Liberty counties are in the Galveston Bay estuarine drainage area. Taken together, these counties contain the highest concentration of point sources in the U.S.'s coastal area. Fifteen percent of all industrial point sources and municipal wastewater treatment plants in the study area are located in the Galveston Bay watershed. Seventeen of the 28 kills in the Galveston Bay area were related to low dissolved oxygen and temperature. Five of the 17 events were caused by releases of cooling water from power plants.

The only other area in the region where a large number of kills was reported was Collier County in Florida, with 49 events between 1980 and 1989. Most of these kills were due to low dissolved oxygen and/or excessive nutrient loadings.

Impacts of Fishing on the Ecosystem

According to the National Marine Fisheries Service report, "Status of Fishery Resources off the Southeastern United States for 1991," marine fisheries in the southeastern U.S. continue a downward slide (USDOC, 1992b). This report documents a decline in the yield of both recreational and commercial fisheries from 1989 to 1990 in the region. In the Gulf of Mexico, commercial yield dropped by 9.2 percent, from 811,600 metric tons (894,600 tons) to 737,000 metric tons (812,174 tons) between 1989 and 1990. Recreational yield declined by 51 percent from 104.3 million fish to 50.3 million fish. Within the recreational fisheries where estimates were presented, declines were noted for groupers (-81 percent), snappers (-35 percent), sharks (-68 percent), and tuna (-41 percent). Increases were reported for king mackerel (31 percent and Spanish mackerel (two percent). It should be noted that decreased landings may also be influenced by increased regulations and catch limits imposed on fisheries or a reduction in fishing effort.

In the southeastern region most of the species important to both commercial fishermen and recreational anglers have been under management plans for several years. However, in many cases, these plans have not significantly reversed the downward slide of those fish stocks. In fact, since the plans have been enacted, the rate of decline has accelerated for some species (*e.g.*, snapper, grouper). Other species are being maintained at fractional levels of their historic averages. Issues such as: bycatch in the commercial shrimp fishery; a need to drastically reduce the harvest in all overexploited fisheries; and rebuild depleted stocks have yet to be dealt with on a broad scale.

There have been a few successes in turning heavily overexploited fisheries around. In the red drum, Spanish mackerel, and king mackerel fisheries, severe harvest, bag, and season limits have stopped any sharp decline of spawning stocks in these species. These fisheries have responded well to management measures and are examples of the fact that heavily exploited species can be maintained at harvestable levels under strict management measures.

Commercial Fisheries

During 1991, commercial landings of all fisheries in the Gulf of Mexico totaled approximately 771 million kg (1.7 billion pounds), valued at about $641 million (USDOC, 1992c). Menhaden, with landings of 499 million kg (1.1 billion pounds), valued at $54.4 million, was the most important Gulf species in quantity landed during 1990. Shrimp, with landings of 113 million kg (249.5 million pounds), valued at $391 million, was the most important Gulf species in value landed during 1990 (USDOC, 1991a). The 1990 Gulf oyster fishery accounted for 36 percent of the national total with landings of 10.6 million pounds of meats, valued at about $34

million. The Gulf blue crab fishery accounted for 18 percent of the national total, with landings of 20.6 million kg (45.5 million pounds), valued at $17 million (USDOC, 1991a).

Louisiana ranked first among central and western Gulf States in total commercial fishery landings for 1990, with nearly 499 million kg (1.1 billion pounds) landed, valued at $263 million. Menhaden landings totaled 866 millions pounds, valued at $41.7 million. Shrimp was the highest value fishery, with 54.2 million kg (119.5 million pounds) landed, valued at $153 million. In addition, during 1990, the following nine species each accounted for landings valued at over $1 million: black drum; striped mullet; shark; red snapper; vermilion snapper; bluefin tuna; yellowfin tuna; blue crab; and the American oyster (USDOC, 1991a). In 1990, Louisiana had about 24,000 licensed commercial saltwater fishermen (Sharkey, 1990).

Mississippi ranked second among central and western Gulf States in total commercial fishery landings for 1990, with 144.9 million kg (319.5 million pounds) landed, valued at $42 million. Shrimp was the most important fishery, with 6.9 million kg (15.2 million pounds) landed, valued at about $25.7 million. Menhaden landings were significant during 1990, with 124.7 million kg (275 million pounds) landed, valued at $11.7 million. In addition, during 1989, the following four species each accounted for landings valued at over $200,000: red snapper; Vermilion snapper; American oyster; and striped mullet (USDOC, 1991a). In 1990, Mississippi had about 3,500 licensed commercial saltwater fishermen (Quinn, 1990).

Texas ranked third among central and western Gulf States in total commercial fishery landings for 1990, with nearly 44.9 million kg (99 million pounds) landed, valued at $182 million. In quantity and value, shrimp ranked first, with about 41.7 million kg (92 million pounds). In addition, during 1990, the following three species each accounted for landings valued at over $1 million: yellowfin tuna, blue crab, and American oyster (USDOC, 1991a). In 1989, Texas had about 24,000 licensed commercial saltwater fishermen (Clagett, 1990).

Alabama had the lowest total commercial landings for 1990 of the central and western Gulf States, with 10.4 million kg (23 million pounds) landed, valued at $36 million. Shrimp was the most important fishery landed with 6.8 million kg (14.9 million pounds), valued at $30.9 million. In addition, during 1990, the following six species each accounted for landings valued at over $125,000: blue crab, shark, striped mullet, red snapper, flounder, and the American oyster (USDOC, 1991a). Alabama had about 4,000 licensed commercial saltwater fishermen during 1990 (Lazauski, 1990).

Florida's west coast ranked fourth among the five Gulf States in total commercial landings for 1988 with 64.9 million kg (143 million pounds) landed, valued at $131.4 million. Shrimp was the most important fishery species landed, with 7.1 million kg (15.7 million pounds) valued at $40 million. In addition, the following eight species

each accounted for landings valued at over $1 million: stone crab; spiny lobster; grouper and scamp; black mullet; American oyster; yellowtail snapper; red snapper; and yellowfin tuna (USDOC, 1989).

The Gulf of Mexico yielded the nation's largest regional commercial fishery by weight in 1990, and represented 57 percent of the national total by weight and 20 percent by value. Most commercial species harvested from federal waters of the Gulf are considered to be stressed or in need of significant management attention. Continued fishing at the present levels may result in rapid declines in commercial landings and eventual failure of certain fisheries. Commercial landings of traditional fisheries, such as red snapper and spiny lobster, have declined over the past decade despite substantial increases in fishing effort. Commercial landings of fisheries, such as shark and tuna, have increased exponentially over the past five years, and those fisheries are thought to be in danger of collapse (Angelovic, 1989; USDOC, 1991b).

Nearly all species significantly contributing to the Gulf of Mexico commercial catches are estuarine-dependent. The degradation of inshore water quality and loss of Gulf wetlands as nursery areas are considered significant threats to commercial fishing (Angelovic, 1989; Christmas *et al.*, 1988; Gulf States Marine Fisheries Commission, 1988) (See **Wetlands** and **Seagrasses** for discussion of importance as habitat and nursery areas). In addition to habitat concerns, conflicts between fishermen using fixed gear (traps) and mobile gear (trawls) continue to be a problem in parts of the Gulf (Federal Fisheries News Bulletin, 1989a and b).

Fishery Management Plans (FMPs) are developed by the Gulf of Mexico Fishery Management Council (GMFMC) to assess and manage commercial species of fish that are harvested from federal waters and in need of conservation. Since 1981, FMPs have been implemented for spiny lobster, stone crab, shrimp, coastal pelagics, coral, reef fish, red drum, swordfish, and sharks in the Gulf of Mexico. The Gulf States Marine Fisheries Commission (GSMFC) develops FMPs for interjurisdictional species of fish that are predominantly harvested in state jurisdictional waters. To date GSMFC has developed FMPs for Gulf menhaden, blue crab, Spanish mackerel, striped bass, oyster, and black drum. A FMP for striped mullet is well underway, while efforts are just beginning for a FMP for spotted seatrout.

The Gulf of Mexico shrimp fishery is the most valuable in the U.S., accounting for 72 percent of the total domestic production (USDOC, 1991a). Three species of shrimp--brown, white, and pink--dominate the landings. The shrimp fishery is facing a number of additional problems: an excessive number of vessels participating in the fishery; imports of less expensive shrimp from foreign countries accounting for 77.5 percent of domestic consumption; a ten percent decline in ex-vessel price of domestic shrimp over the past five years; increases in interest rates to finance acquisition of equipment, vessels, and other related fishing needs; increases in fuel prices; excessive costs of marine casualty insurance; regulations regarding the

use of turtle excluder devices; excessive bycatch of finfish; and conflicts with other targeted fisheries (Angelovic, 1989; Gulf States Marine Fisheries Commission, 1988). In an attempt to lessen anticipated conflicts between commercial fishing for shrimp, spiny lobster, and stone crab, the Gulf of Mexico Fishery Management Council (GMFMC) has closed areas in the eastern Gulf to shrimp trawling during the traditional trap fishing seasons for lobster and stone crab.

The red drum fishery was closed to all harvest in federal waters of the Gulf of Mexico on January 1, 1988. Stock assessments concluded that red drum were heavily fished prior to moving offshore to spawn and that those fish less than 12 years of age were poorly represented in the offshore spawning population (USDOC, 1989). In addition to the federal closure, states enacted stringent measures to reduce red drum mortality in their inshore areas. Red drum populations appear to be responding to these management measures, with increasing numbers of young fish appearing in coastal waters in recent years. With continued fishery management and recruitment of fish to the spawning stock, offshore stocks have the potential to increase.

Following the federal closure and state regulatory actions on red drum, black drum were accepted as a substitute within the commercial market. The intensive fishing effort for red drum was switched to black drum without the need to radically change fishing techniques or gear. Adding to the already existing pressure on black drum, this "new" fishery caused a great deal of concern for the status and sustainability of Gulf black drum stocks. In response to this concern, Gulf States established interim regulatory measures, and the Gulf States Marine Fisheries Commission developed an interstate FMP for the species. In response to new regulatory measures and, primarily, market changes, landings of black drum declined from 1989-1990 levels to historical levels prior to the 1987 increase. As a result, present harvest levels are well below that which would negatively affect recruitment and the spawning stock (Gulf States Marine Fishery Commission).

Red snapper resources in the Gulf of Mexico are believed to be severely overfished and bycatch is believed to contribute significantly to the decreased recruitment into the fishery. In terms of value and historical landings, red snapper is the most important species in the reef fish complex managed under a federal Fishery Management Plan.

For a number of fisheries, including the stone crab fishery, the major concern is whether harvest has reached or exceeded maximum sustainable yield. Until recently, the stone crab fishery has been expanding in terms of increasing catch within traditional fishing areas and previously unfished or underfished regions. However, the total harvest has declined steadily over the past several years. GMFMC is considering limitations on the number of fishermen and traps in this fishery.

Spiny lobster fishing is practiced predominantly in the eastern Gulf of Mexico. It is believed that the stock is showing signs of overfishing. Large numbers of

undersized lobsters are used to bait lobster fishing traps, and the number of traps in the fishery far exceeds the number required to harvest the present yield. Fishermen contend that the present fishery practices are the most optimal for their objectives. GMFMC is considering limitations on the number of fishermen and traps in the spiny lobster fishery.

The coastal pelagic FMP addresses a number of species. Two of the more important species are king and Spanish mackerel. Both species have been extensively overfished and are now under a managed rebuilding program. Since the early 1980s, there has been a marked absence of a strong year class of king mackerel. Spawning stock biomass has exhibited some gains and recruitment is stable at low levels. There is concern over the possible need for two management units for king mackerel within the Gulf and the impact of the increasing Mexican fishery. Spanish mackerel stocks are showing positive signs of recovery. Spawning stock biomass and recruitment appear to be increasing. Most of the Spanish mackerel catch is taken off Florida. Capture of 50-80 percent of the yearly commercial allocation within a period of three weeks by southeast Florida fishermen has raised questions of conflict with recreational fishermen who believe their allocation should be increased.

GSMFC has developed an interstate FMP for Spanish mackerel in response to the fact that the predominance of the harvest is from state jurisdictional waters. The Gulf States, especially Florida and Texas, have enacted strict regulatory measures, designed to be consistent with the GSMFC FMP, which are largely responsible for the increase in Spanish mackerel stocks in the Gulf of Mexico.

Commercial landings of swordfish have increased steadily over the past several years with serious implications for the future. The percentage of older fish and spawning biomass has declined significantly. Swordfish are now being managed as a highly migratory species under the authority of NMFS.

Blue marlin and white marlin are believed to be at or near the point of full exploitation. There is concern about the increasing mortality of marlin as bycatch associated with the escalating yellowfin tuna longline fishery. The tuna fishing industry has expanded at an alarming rate in the Gulf of Mexico over the past five years. Tuna are now included under the Magnuson Fishery Conservation and Management Act of 1976, and GMFMC can now manage the tuna fishing industry and address the marlin bycatch issue.

The taking of stony corals or gorgonian sea fans is prohibited. Fishing for soft octocorals is presently below the limits of maximum yield. There are significant concerns that butterfish trawlers may destroy coral reef habitat and take a large number of snappers and groupers as bycatch. In addition, a newly formed fishery for "live rock" for the ornamental trade is receiving attention due to the allegation that live rock fishing may purposefully or inadvertently include the harvest of stony coral. "Live rock" refers to rocks or biologically cemented gravel clusters that harbor

colonies of algae, anemones, hydroids, and other sessile invertebrates. A major use of live rock is to help maintain marine reef aquaria; apparently the live rock provides bacteria necessary for proper nitrogen cycling in the aquaria.

A strong market for shark has resulted in soaring catches over the past several years. Shark stocks are unable to sustain the present heavy fishing pressure and the fishery is in danger of collapse. A new FMP was released for public comment in 1992 (USDOC, 1992a) and is currently being implemented.

Impacts of Trawling. The commercial shrimp industry is the most important fishery in the southeastern U.S. In 1990, over 125.6 million kg (277 million pounds) of shrimp valued at $454 million were landed in the Gulf and South Atlantic regions (USDOC, 1991a). With the exception of localized harvesting techniques, most wild-caught shrimp are produced using trawls--nets towed along the sea floor. Shrimp trawls are inherently nonselective harvesting gear, that is nontarget species are caught along with the species being sought. Shrimp fishermen must sort through what comes on board in order to separate shrimp and other marketable species from the catch. The component of the catch which remains is typically shoveled back overboard and comprises what is known as bycatch. While red snapper bycatch in the shrimping industry was a major focus during 1990, bycatch of other species has become a significant issue (Seidel and Watson, 1990) (see **Table 2.2**). The magnitude of this bycatch, the fact that most of it is dead when returned to the water, and the fact that some species in the bycatch are experiencing severe population declines, make this an important issue in the Gulf of Mexico.

In addition to the nonselective nature of trawls, research indicates that they can be potentially damaging to the bottom community (Gaston, 1990). Recent studies on the effects of trawling emphasized the impacts on communities of bottom dwelling invertebrates. The seafloor is covered by thousands of organisms, including shrimp that live on the sediment surface and sometimes burrow beneath it. Crustaceans and worms build tubes that protrude above the bottom, stabilizing the sediments, and allowing the organisms access to oxygenated water. Shrimp graze the bottom, scavenging among the tube dwelling species. Trawls pulled over the bottom disrupt this community, destroying tubes, eliminating organisms on the sediment surface, and increasing the turbidity of the water. Videos taken of a bottom community off the coast of Florida showed trawling scars along the seafloor, damage to sponge communities and reefs, and disruption of other bottom fauna (Gaston, 1990).

Adverse changes to fish communities of the Gulf of Mexico have also been attributed to shrimp trawling (Gaston, 1990). Recent studies by NMFS showed a long-term decline in average biomass (weight) of fish caught by trawling, suggesting that younger fish have increasingly dominated the bycatch over time and that the shrimp fishery may be responsible for long-term changes in fish populations (Gaston, 1990). Furthermore, over the past 20 years, there were declines of specific near bottom fish populations, such as Atlantic croaker, spot, catfish, sand seatrout, and silver seatrout (Gaston, 1990).

Table 2.2 ***1989 Finfish Bycatch Estimates for Offshore Gulf Shrimp Trawlers***

Atlantic Croaker	**5.6**	**billion fish**
Sea Trouts	**1.3**	**billion fish**
Long-Spine Porgy	**1.3**	**billion fish**
Spot	**680**	**million fish**
Gulf Butterfish	**400**	**million fish**
Atlantic Cutlassfish	**130**	**million fish**
Hardhead Catfish	**112**	**million fish**
Atlantic bumper	**110**	**million fish**
Red Snapper	**20**	**million fish**
Spanish Mackerel	**3.2**	**million fish**
King Mackerel	**1.3**	**million fish**
Vermilion Snapper	**0.9**	**million fish**
Red Drum	**0.2**	**million fish**
Shark	**5.6**	**million pounds**

(Source: NMFS, shrimp bycatch data for 1989)

Incidental capture of sea turtles in shrimp trawls is believed to be the most important human cause of sea turtle mortality (Magnuson *et al.*, 1990). However, it should be noted that quantification of sea turtle mortality in shrimp nets has been the only major effort to quantify turtle mortality and is also the only area over which there is strong regulatory control. (See **Human Impacts/Interaction** for additional information on effects of human activities on sea turtles.) The incidence of sea turtle capture in shrimp trawls has been well documented (Murphy and Hopkins-Murphy, 1989; Magnuson *et al.*, 1990). The incidence of capture is compounded by the fact that sea turtles may congregate in shrimping areas to feed on discarded bycatch (Ruckdeschel and Shoop, 1988). In 1987, NMFS estimated that 47,973 turtles were captured annually in commercial shrimp trawls, of which 11,179 drowned (Henwood and Stuntz, 1987). That same year NMFS used its authority under the Endangered Species Act to issue regulations requiring seasonal use of Turtle Excluder Devices (TEDs) on shrimp trawls in offshore waters from North Carolina to Texas. There were federal and state delays, however, TEDs, as of September 1989, are now required in all southeast waters.

In May 1990, the National Academy of Sciences (NAS) estimated that as many as 55,000 sea turtles annually drown in American shrimp nets not equipped with TEDs. NAS concluded that incidental drowning in shrimp trawls kills more sea turtles than all other human activities combined (Crouse *et al.*, 1992).

Sea turtle strandings along coastal shorelines of the southeastern U.S. have been used as one index of mortality due to shrimping (Magnuson *et al.*, 1990). Increases in sea turtle strandings during commercial shrimp fishing seasons and decreases with the closing of these seasons have been observed (Schroeder and Maley, 1989). However, it should be noted that the occurrence of turtles is highest during the same time of year that the shrimp season is open.

Recreational Fishing

Marine recreational fishing participation grew through the 1970s and 1980s in spite of declining abundance of many target species and increasing competition with the commercial fishing sector (Schmied, 1993). The NMFS Marine Recreational Fisheries Statistics Survey for the Gulf and Atlantic Coasts (USDOC, 1990a) and a special report by Schmied and Burgess (1987) indicate there are about four million resident participants in marine recreational fishing and over two million tourists who angle for Gulf marine species. According to NMFS, over 40 percent of the nation's marine recreational fishing comes from the Gulf of Mexico, and marine anglers in the Gulf made over 13 million fishing trips in 1989, exclusive of Texas (USDOC, 1990a). Texas marine anglers using private boats expended over seven million man-hours to land almost three million saltwater fish during the 1986-1987 fishing years (Osburn *et al.*, 1988). High recreational fishing participation is partially explained by strong regional population growth, the tourism-based economies of many of the coastal communities, and the region's abundant sport fishing infrastructure (*e.g.*, boat ramps, marinas, piers, charter boats, head boats, and tackle shops) (Schmied, 1993).

Marine recreational fishing in the Gulf region is a major industry important to these states' economies. The marine recreational fishing industry accounts for an estimated $769 million in sales (equipment, transportation, food, lodging, insurance, and services) and employment for over 15,000 people, earning more than $158 million annually in the central and western Gulf of Mexico region (USDOI, 1992).

Significant changes in recent years that affect recreational fishing include an increase in the average expendable income and a decrease in the price of electronic technology which allows recreational fishermen to fish farther offshore. Technological advances, including boat construction, boat motors, fishing tackle, fishing techniques, fishing information, and electronics, have enhanced anglers' ability to seek and catch targeted species (Schmied, 1993).

Together, population increases, environmental degradation, and the increasing demand for fish have led to population declines in many marine species. Consequently, over the past ten years, there has been a rapid increase in state and federal fishing regulations to reduce fishing pressure, rebuild fish stocks, and minimize conflicts between resource users (Schmied, 1993).

A summary of the status of recreationally important species in the southeast U.S., including the Gulf of Mexico, is presented in **Table 2.3**. Of the 28 species or stocks of minor to major recreational importance, 50 percent were listed as overexploited. Another 25 percent were listed as fully exploited. Only seven percent were listed as underexploited. Of the 15 major recreational species, 11 were listed as overexploited.

Speckled trout are the most highly sought sport fish in coastal marine waters, whereas snapper and mackerel are some of the more popular offshore sport fish. Gulf snapper landings have shown a precipitous downward trend over the last several years, and proposals have been made to severely limit the catch by recreational fishermen (GMFMC, 1990). However, it should be noted that landings data may also be influenced by the increased regulations and catch limits imposed on some fisheries.

Table 2.3 Status of Recreational Fish Species in the Southeast U.S. for 1991

STATUS OF RECREATIONAL FISH SPECIES IN THE SOUTHEAST U S FOR 1991

Species (Stocks)	Importance to Rec. Fishing	Plan Date	Exploitation Status
Swordfish	Minor	1985	Over
Bluefin Tuna	Moderate	NA	Over
Yellowfin Tuna	Moderate	NA	UK
Blue Marlin	Moderate	1988	Fully
White Marlin	Moderate	1988	Fully
Sailfish	Moderate	1988	Moderately
Bigeye Tuna	Minor	NA	Under
Albacore	Minor	NA	Moderately
Skipjack	Minor	NA	Fully
King Mackerel (Atlantic)	Major	1983	Under
King Mackerel (Gulf)	Major	1983	Over
Spanish Mackerel (Atlantic)	Major	1983	Over
Spanish Mackerel (Gulf)	Major	1983	Over
Red Snapper (Gulf)	Major	1984	Over
Vermilion Snapper (Gulf)	Major	1984	UK
Black Sea Bass	Major	1984	Fully
Gag Grouper	Moderate	1984	Fully
Red Porgy	Major	1984	Over
Scamp	Moderate	1984	Over
Yellowtail Snapper	Major	1984	Fully
Grey Snapper	Major	1984	Fully
Red Drum (Atlantic)	Major	1990	Over
Red Drum (Gulf)	Major	1986	Over
Weakfish	Major	1985	Over
Atlantic Croaker	Major	NA	Over
Sharks (Large Coastal)	Moderate	NA	Over
Sharks (Small Coastal)	Moderate	NA	Under
Sharks (Pelagic)	Major	NA	UK (Probably over)

NA = Not Applicable
UK = Unknown

Source Status of Fishery Resources off the Southeastern U.S for 1991
NOAA Technical Memorandum NMFS-SEFSC-306

Aquaculture

Aquaculture is the farming of aquatic life. Aquaculture takes many forms and includes hundreds of different species of aquatic animals and plants. In the Gulf of Mexico region, aquaculture is a large enterprise that is continuing to grow. In the U.S., over ten percent of the fish and shellfish eaten are grown domestically (Lampton, 1991). From 1986 to 1988, U.S. aquaculture sales increased by more than 55 percent (Lampton, 1991).

The State of Mississippi is marketing approximately 159 million kg (350 million pounds) of catfish each year, and the demand for additional supplies is steadily rising (Lampton, 1991). Farm-grown catfish is Mississippi's largest cash crop. While catfish are the most important aquacultural foodfish at present, many other seafoods, including rainbow trout, salmon, tilapia, crawfish, mussels, alligator, shrimp, oysters, clams, redfish, spotted seatrout, grouper, and snapper are also farm-raised.

In 1991, aquaculture had stateside sales of $54 million in Florida, an increase of 55 percent from 1987 to 1991 (AP, 1993). Although Florida's aquaculture mainstay is tropical fish, some of the industry's other products include aquatic plants, alligators, bass, eels, tilapia, crawfish, game fish, oysters, clams, and other shellfish. Aquaculture sales in Florida, in 1991, included $33 million in tropical fish revenues, $10 million in plants, $4.5 million in alligators, $2 million each in catfish and shellfish, and about $3 million in other sales (AP, 1993).

High density pond, impoundment, or in-water culture of marine fish, crustaceans, and mollusks in monoculture or polyculture can result in high nutrient effluent and high nutrient loads and turbidity in receiving waters. Treatment chemicals for preventive control of disease or treatment of acute episodes can also be part of the effluent.

Non-indigenous species (*e.g.*, Pacific species) are being cultured in the Gulf of Mexico region; accidental escape and survival of these species in Gulf of Mexico and contiguous waters has occurred. Introduction of non-indigenous or indigenous species (such as California white sturgeon and Asian tiger shrimp) to Gulf of Mexico waters has the potential to displace feral stocks, alter predator/prey interactions, and introduce pathogens and parasites.

Genetic diversity and fitness of natural stocks of indigenous species can be, and have been, impacted by stocking animals without regard to broodstock origin and compatibility of stocks.

Coastal culture of animals and location of aquaculture facilities can impact natural species diversity and availability of habitat by reducing an area to monoculture or limited polyculture. Impoundment of coastal wetlands can reduce accessibility to needed nursery areas and change wetlands value.

Human Impacts/Interactions

Recreational Resources & Activities

The northern Gulf of Mexico coastal zone is one of the major recreational regions of the U.S., particularly for marine fishing and beach activities. Gulf Coast shorelines offer a diversity of natural and developed landscapes and seascapes. Major recreational resources include coastal beaches, barrier islands, coral reefs, estuarine bays and sounds, river deltas, and tidal marshes. Other resources include publicly owned and administered areas, such as national seashores, parks, beaches, and wildlife lands, as well as designated preservation areas, such as historic and natural sites and landmarks, wilderness areas, wildlife sanctuaries, and scenic rivers. Gulf Coast residents and tourists from throughout the nation, as well as from foreign countries, use these resources extensively and intensively for recreational activity. Commercial and private recreational facilities and establishments, such as resorts, marinas, amusement parks, and ornamental gardens also serve as primary interest areas.

The coastal shorelines of the Gulf contain extensive public park and recreation areas, private resorts, and commercial lodging. Most of the outdoor recreational activity focused on the Gulf shorefront is associated with accessible beach areas. Beaches are a major inducement for coastal tourism, as well as a primary resource for resident recreational activity. However, recreational resources, activities, and expenditures are not constant along the Gulf of Mexico shorefront, but are focused where public beaches are close to major urban centers. Beach use is a major economic factor for many Gulf coastal communities, especially during peak-use seasons in spring and summer.

The major recreational activity occurring on the outer continental shelf is offshore marine recreational fishing and diving. Also, a substantial recreational fishery, including scuba diving, is directly associated with oil and gas production platforms (USDOI, 1992).

Impacts on Coral Reef Systems

Coral reefs are multi-user resources, experiencing increased exploitation that results in some negative human impact on the resource (USDOI, 1984). Although natural events are far more severe than man's individual acts, human impacts on the reefs must be multiplied by the number and the frequency of occurrence, which in total may not allow the reef resources sufficient time for recovery.

Anchors, boat groundings, dredging, touching by divers, spearfishing, and oil drilling are a few commonly cited threats to corals. In terms of severity, dredging is the most damaging human activity in and around coral reefs (USDOI, 1984). Poorly

planned and managed dredging operations have caused the demise of many reefs. The physical impact of dredge gear (anchors, cables, chain, pipes, suction, and cutting heads) dislodge corals or cause lesions or scars that lead to infection and mortality. Reef organisms increase respiration to remove silt resulting in reduced dissolved oxygen levels. Coupled with increased respiration is reduced photosynthesis and oxygen production due to lowered light levels. High turbidity generated by dredging reduces light penetration throughout the water column (Johannes, 1975). Sediments excavated by dredging are often anaerobic and bind up available dissolved oxygen.

Anchor damage is a significant negative human impact on coral reefs at Dry Tortugas (Davis, 1977). Carelessly deployed anchors break fragile corals, dislodge reef framework, and scar corals, opening lesions for infection. Increased visits increase the number of anchorings and the potential for impact. Anchor ground tackle, lines, and chains also are documented as destructive agents (Davis, 1977). Anchor buoys, designated anchorages, and better public education are the best ways to mitigate this problem.

Groundings of commercial and recreational craft occur as a result of poor navigational skills, accidents, drug-related incidents, and in some cases, purposeful grounding to avoid sinking. Sailboats and powerboats cut swaths through live branching coral thickets and larger ships cause widespread destruction (Shinn, 1989). In the worst grounding of the decade, the *Wellwood* scarred 11,891 m^2 (128,000 ft^2) of coral on the Key Largo National Marine Sanctuary's Molasses Reef in 1984, and, in 1989, the damage was still readily apparent (Wilson, 1989). Groundings result in physical damage to the coral and in many cases toxic antifouling paint from ship hulls is driven into the corallites. Other negative effects of ship wrecks and grounding include fuel leakage and lost cargo. Salvage operations also pose a threat when they occur around a coral reef. Techniques used to free grounded or sunken vessels are often counter to reef conservation.

Coral reefs concentrate marine protein in a localized area, attracting both commercial and sport fishing interests that use various techniques to harvest fish and invertebrate stocks. Negative impacts occur as a result of gear deployment and harvesting. Lobster fishing methods, hook-and-line fishing methods, fish traps, and spearfishing have the potential to damage coral reefs.

Diving as a sport and hobby has increased and developed into a major industry in Florida. Examination of any popular reef shows the effects of divers, such as white coral skeletons showing through bruised or broken tissue on massive coral heads. Effects of humans are especially noticeable where branching corals, such as fragile staghorn coral or elkhorn coral, have been broken and pieces scattered about.

There is a cause for concern about Florida coastal waters as the population continues to grow and municipal sanitary sewage systems use ocean outfalls as an expedient means of disposal of sewage effluent disposal. The cities of Key West and Miami

pump their nutrient-rich sewage offshore, and waste from the vast majority of the exploding Florida Keys population is pumped into septic tanks. Septic tanks may not pollute bacteriologically, but they release nitrates and phosphates into the porous and permeable limestone, where they mix with the tidally fluctuating water table. At low tide, this clear but nitrate-rich ground water dribbles into the seawater along the shore, especially in finger channels where the permeable limestone is exposed. This kind of fertilization may be beneficial to seagrasses and mangroves, but it is deadly to corals unadapted to nutrient-rich waters (Shinn, 1989).

Manker (1975) reported on heavy metal accumulations in the sediments and corals off southeast Florida and noted higher concentrations of mercury, zinc, lead, and cobalt adjacent to population centers. Disposal of wastes from existing lighthouse navigational aids may be a problem (USDOI, 1984).

Southeastern Florida is a major truck farm area for vegetables and fruit. Use of agricultural chemicals (fertilizers, herbicides, pesticides) is intense. Porous soils, canal systems leading to the bays, and rapid runoff of surface materials following rains and irrigation are causes for concern (USDOI, 1984)

Evidence indicates that chronic petroleum hydrocarbon pollution is harmful to coral reef communities. Life history aspects, such as reproduction, development, larval recruitment, settlement, and juvenile growth appear to be affected by petroleum hydrocarbon pollution (USDOI, 1984). Potential oil pollution sources include tanker cleaning and cargo discharge, vessel sinkings and accidents, and accidental discharges from petroleum production and transportation activities.

The mechanical action of anchors, boat groundings, divers, etc. has an obvious, detrimental effect on coral growth and health, especially in localized areas. However, there are other serious and less publicized causes of coral death. Coral diseases, major causes of coral death, are possibly related to the worldwide rise in sea level and an over-abundance of nutrients (Shinn, 1989).

The worldwide phenomenon, known as the greenhouse effect, may be contributing to sea level rise (Shinn, 1989). Many researchers have concluded that combinations of temperature extremes, sedimentation, salinity fluctuations, and excess nutrients, all consequences of rising sea level, have been the major cause of reef demise, especially in Florida (Shinn, 1989). Humans may be exacerbating the situation both locally and on a global scale.

Over-fertilized, rapidly growing blue-green algae, fungi, and bacteria can out-compete and kill corals. The first signs of runaway growth are algal tufts on coral scars, which then may spread, leading to blackband disease. Death of an entire coral colony has been shown to occur during a single summer, when the disease spreads most quickly (Shinn, 1989). In branching corals, which suffer from whiteband disease, death occurs even more quickly. This disease affects both staghorn and elkhorn coral. In the summer of 1987, one of the warmest, calmest, and most

hurricane-free summers in Caribbean history, corals expelled their symbiotic algae and became snow white. The consensus among coral-reef scientists is that the unusually warm, still water broke the essential bond between the algae and their coral hosts (Shinn, 1989). With each bleaching, the coral animals slow their construction of the reef's framework. Growing only millimeters per year, the corals are already racing against the persistent natural forces of erosion that tear them down. Severe episodes of bleaching may tip the balance in favor of erosion. The 1987 bleaching event serves as a warning to what may occur as worldwide temperatures rise. Coral reefs, which have been able to adapt to gradually changing conditions in the geologic past, may not be able to cope with more rapid climatic changes (Bunkley-Williams and Williams, 1990).

Impacts on Seagrass Beds

The relative stability of seagrass beds, coupled with their complex physical structure and high rate of primary production, enable them to form the basis of an abundant and diverse animal community. No other marine plants are uniquely adapted for the position which seagrasses occupy in the shallow marine environment (Fonseca *et al.*, 1992). Recently, documented declines in seagrass beds have been implicated in reductions of fishery resources (Fonseca *et al.*, 1992).

Many human activities potentially affect the health of seagrass communities in estuarine and coastal ecosystems. In general, dredging and other disturbances of the bottom sediments or de-sedimentation rates can destroy several seagrass species. Dredging not only increases suspended material and accelerates sediment deposition, but also causes changes in the cycling potential of the sediment. Under these conditions seagrass density may be reduced considerably (Thayer *et al.*, 1975). Dredging and filling activities can destroy existing seagrass beds; dredged channels are typically too deep and provide insufficient light for seagrass growth (Fonseca *et al.*, 1992). Cumulative damage by propeller scarring and increased boat-wake wave energy have been demonstrated to have significant negative impacts on seagrass habitat, sometimes eclipsing the better-documented dredging impacts (Fonseca *et al.*, 1992).

Oil and chemical pollution can have significant negative impacts on seagrasses, as well as to the seagrass-associated fauna (Fonseca *et al.*, 1992). Many of the chemically-related impacts have been difficult to discern because they often occur in concert with other impacts, such as increased turbidity, which in and of itself can reduce or kill seagrasses. As water quality continues to deteriorate, linear losses of seagrasses and their associated animals will result, with limited opportunities for recovery (Fonseca *et al.*, 1992). Water transparency must be maintained and improved.

The activities of commercial fishermen using bottom trawls in the bays, sounds, and estuaries frequently damage seagrasses. Commercial harvesting of seagrasses is obviously an important negative influence.

Human Interaction With Wild Populations of Marine Mammals

Increasing interest by the public in observing, feeding, and approaching marine mammals in the wild has been accompanied by concerns that these activities could cause biological problems for the marine mammals and may be a violation of the Marine Mammal Protection Act (MMPA). The National Marine Fisheries Service (NMFS) has concluded that if an activity alters or disrupts normal behavior, it is considered a "take" and, therefore, is prohibited under the MMPA unless an exception has been made.

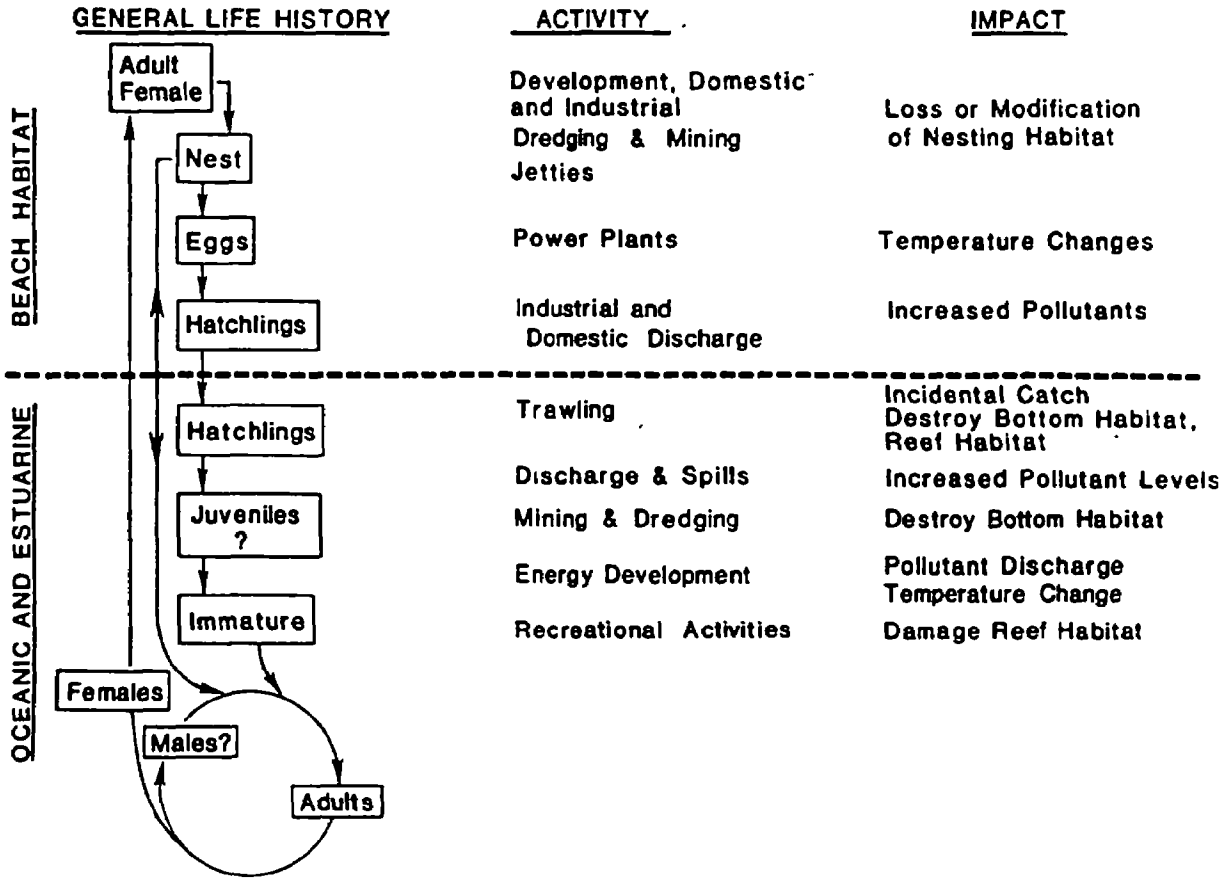
Since early 1988, NMFS has been aware that organized cruises were being conducted to allow paying patrons to feed wild populations of dolphins. Wild dolphin feeding programs could adversely affect the dolphins because they become attracted to fishing boats and other vessels not engaged in feeding programs and increase the likelihood that they will be entangled in fishing gear, shot by fishermen, or fed foreign objects. If dolphins depend on food provided by people, they may become less able to find and catch natural prey when feeding is discontinued. Artificial feeding programs may cause migratory dolphins to remain in areas after their primary prey species have left or otherwise reached their seasonal low, and the dolphins could then be subject to food shortages and inhospitable conditions. Dolphin, having become habituated to being fed when boats are around and people are in the water, could become aggressive in their efforts to get food and swimmers could be injured. Development and advertising of commercial feed-the-dolphin programs may increase the opportunity and encourage recreational and other boaters to feed and harass dolphins. Although it might be possible to regulate the types and quality of fish fed to dolphins during commercial programs, it would not be possible to regulate the types and quality of food provided by others or to prevent unnatural foods or foreign objects from being thrown to dolphins. Feeding dolphins could cause them to be attracted to vessels and increase the probability of their being struck. Feeding programs may expose dolphins to disease or make them more susceptible to diseases.

Impacts on Sea Turtles

All of the life history stages of sea turtles may be seriously impacted by human activities (see **Figure 2.6**). Urban and industrial development, petroleum exploitation, mineral sands mining, dredging, and commercial fishing appear to pose the greatest threats to turtle habitat (Coston-Clements and Hoss, 1983). These

activities may affect the well-being and survival of sea turtles in a variety of ways, from the direct physical destruction of nests to the more subtle effects of chemical pollutants on longevity and reproductive capacity.

Figure 2.6 ***Examples of Potential Impacts of Habitat Alterations on Sea Turtles***



(Source: Coston-Clements and Hoss, 1983)

Destruction or modification of beaches where turtles nest probably has the greatest impact on the ability of turtle populations to reproduce (Coston-Clements and Hoss, 1983). Threats on the nesting beaches include the destruction of nesting habitat from natural or human-accelerated beach erosion and the construction of sea walls, riprap, or other devices to protect oceanside development. Artificial lighting in developed areas disorients hatchlings when they emerge at night. Significant hatchling mortality can result as the young turtles crawl toward the lights. The same lights may deter some females from nesting, particularly green turtles, which appear to be more sensitive to this factor. Beach nourishment projects can disrupt nesting turtles, destroy nests, and leave beach sand too compact for subsequent nesting. Increased recreational use may destroy nests and eggs; deep tire tracks may prevent hatchlings from reaching the surf.

Clearing vegetation from the beach may reduce shade and increase nest temperatures, whereas large buildings may lower nest temperatures by increasing the time an area is shaded. Since temperature is an important factor in hatching success and sex determination, even small changes could cause increased mortality, delays in hatching, or sex ratio imbalance (Coston-Clements and Hoss, 1983).

In addition, predators, such as raccoons, fox, feral dogs, ghost crabs, and in some cases humans, take a significant amount of eggs from many nesting beaches.

In the intervals between depositing clutches of eggs, females remain close to shore, where they are particularly vulnerable to being killed or injured by accidents or being caught in fishing or trawl nets. Boat strikes also take a toll; in Florida, for example, between 1980 and 1985, 23 percent of stranded turtles had evidence of propeller wounds or cracked carapaces from boat collisions. It is unknown, however, what percentage of these wounds occurred pre- or post-mortem.

Oil spills, as well as cleanup operations, can also have harmful effects on sea turtles, especially if they occur during the nesting season. These harmful effects include the following: 1) directly fouling the turtles with oil and chemicals, 2) frightening females away from an area, 3) destroying nests, 4) creating physical obstructions (including booms) that would prevent hatchlings from reaching the ocean, and 5) creating light disorientation preventing females from nesting or hatchlings from reaching the water. Eggs, embryos, and hatchlings are more vulnerable than adults since volatile and water-soluble contaminants can be absorbed into the egg (Coston-Clements and Hoss, 1983).

Any activity that reduces or contaminates the food supply or destroys habitat will reduce the ability of turtles to survive. For example, damage to sea grasses by dredging, anchoring, or siltation will affect green turtles, which depend on grasses for food. Reef habitat destroyed by pollution or over-use by humans constitutes not only a loss of foraging areas, but also a loss of resting places for adult and immature hawksbills and loggerheads. Many filter feeding organisms that concentrate

pollutants are an important food source for turtles. Large areas of hypoxia in the northwest Gulf of Mexico might influence the feeding of ridley and loggerhead turtles (Coston-Clements and Hoss, 1983).

Throughout their life in the sea, turtles are subject to a host of human activities that threaten their survival. Probably the most serious threat to sea turtles in the South Atlantic and Gulf of Mexico is shrimp trawling (See **Impacts of Fishing** for a more detailed discussion). NMFS has estimated that nets from shrimp vessels drown over 11,000 sea turtles annually (Possardt, 1988). Other commercial fisheries in these waters cause additional deaths but to an unknown degree.

Marine pollution from oil and human refuse is another documented threat. Sea turtles readily eat plastic bags or plastic sheeting, which they mistake for a favorite food--jellyfish. This is a particular concern because all sea turtle species found in Gulf waters are listed as either threatened or endangered under the Federal Endangered Species Act. National Marine Fisheries Service and University of Texas scientists have examined the stomach contents of stranded (dead) sea turtles. Their findings indicate that one-third to one-half of the endangered and threatened species are ingesting plastic products or by-products, such as bottles, milk cartons, and water jugs (USEPA, 1990). Dead turtles also have been found in "ghost nets" and entangled in fishing lines and gear.

Non-plastic products also harm sea turtles. For example, scientists who studied the stomach contents of 111 stranded loggerhead turtles in the Gulf of Mexico found that more than half contained man-made debris. Of the turtles that could be identified as having died as a direct result of eating the debris, half had consumed non-plastic debris. In 1988, other sea turtles were found that had been killed by glass and metal. Three percent of Florida's sea turtle strandings, between 1980 and 1985, were linked to the ingestion of tar balls or were otherwise related to petroleum (Possardt, 1988).

Data collected from sea turtle strandings along the south Texas coast, from 1986 to 1988, showed that the animals were significantly affected by having eaten marine debris or--to a lesser extent--having become entangled in marine debris. The most common item found to cause entanglement was fishing line, followed by trawl nets, vegetable sacks, and other types of nets and rope (Center for Environmental Education, 1987). All five sea turtle species inhabiting Gulf waters have been found to consume or to become ensnared by marine debris.

Pollutants from industrial and residential development are perhaps the most pervasive and subtle threats to the survival of species of turtles. The effects are difficult to detect and evaluate and may not show up until the turtles have been exposed for many years. Chemicals, including oil, may mask olfactory cues or interfere with turtle perception and may cause chronic and insidious problems in reproduction. The decline of Kemp's ridley, a species characteristically found in waters where organic content and turbidity are high and prawns are abundant, may

be related to high levels of pollutants in discharges from the Mississippi River (Coston-Clements and Hoss, 1983). Thermal pollution, as heated effluents from power plants or desalination plants, may affect turtles indirectly by being detrimental to their food supply, or more directly by causing hatchlings to become disoriented and reduce their swimming speed.

Marine Debris

Marine debris kills and maims marine mammals, fish, shellfish, sea turtles, and birds. According to USEPA, an estimated two million seabirds and 100,000 marine mammals die on U.S. coasts each year from becoming entangled in marine debris or from ingesting plastic mistaken for food. During the National Beach Cleanup Day in September 1990, there were 142 reports nationwide of wildlife affected by debris either through apparent entanglement or ingestion.

Animals can mistake plastic pellets from resin spills and other physically degraded plastic products for fish eggs or other food sources. Such plastics are indigestible--debris can choke animals, block their digestive tracts, and cause intestinal ulcers. Some creatures accidentally feeding on plastic may feel a false sense of fullness and, as a result, slowly starve to death. Animals entangled by six-pack rings or discarded rope may strangle, suffocate, or exhaust themselves while trying to escape. Entanglement can also hamper the ability to catch food, and infections caused by cuts often lead to loss of limbs. Lost or discarded fishing nets (ghost nets) ensnare fish, crabs, diving seabirds, and other forms of marine life for several years after the nets are released. Economic losses are also important. While there have been no similar studies in the Gulf, New England studies show that lobster valued at $250 million is lost each year to "ghost traps" (Karter *et al.*, 1973).

Scientists have documented an increasing number of injuries and deaths among fish, marine and terrestrial mammals, birds, and turtles that have eaten or become entangled in marine debris. The most common source of entanglement was monofilament fishing line. Plastic bags, sheets, tar balls, and plastic particles were among the most common items ingested. These items are commonly found on Gulf beaches. Evidence of the continuing problem of entanglement occurred on March 11, 1991, when a female pygmy sperm whale died after becoming stranded on Matagorda Island, just off the Texas coast. The whale died from an infection caused by a plastic bag that she expelled from her mouth.

On New Year's Day, 1984, an infant pygmy sperm whale died, despite all efforts to save him, after becoming stranded on a Galveston beach in Texas. A postmortem examination (necropsy) revealed that he had eaten numerous large plastic bags, including a large trash bag, a bread wrapper, and a corn chip bag which created a false sense of fullness resulting in a slow death by starvation. In Florida, injuries and deaths caused by plastic debris--plastic jugs, disposable surgeons' gloves, plastic bags, and monofilament line--have been documented for four species of marine

mammals stranded along the state's coast: bottlenose dolphin, false killer whale, pygmy sperm whale, and West Indian (Florida) manatee (Barros *et al.*, 1989). Debris on beaches is also known to entangle terrestrial species, such as foxes and rabbits, who have been observed entangled in nets and other plastic items.

Of the world's 280 seabird species, 80, to date, are known to have ingested plastic debris items ranging from small plastic pellets to polystyrene pieces to cigarette lighters and toys. Seabirds are also prone to entanglement, especially in monofilament fishing lines. For example, the Japanese salmon-gill net fishery, in which more than 2,575 km (1,600 mi) of net is set each night, is reported to drown over 250,000 seabirds each year during a two-month fishing season (King, 1984). An early 1970s study in Florida reported that 80 percent of brown pelicans showed signs of injury from entanglement in fishing gear (Heneman, 1988).

Marine debris also has more subtle, ecological effects on the Gulf of Mexico. For instance many materials sink soon after being dropped into the water or after they collect heavy biological growth. According to USEPA (1990), it is likely that pockets of accumulated debris exist on the Gulf floor. Non-biodegradable material could disrupt biological communities and adversely affect fisheries. Meanwhile, biodegradable materials--such as food waste--create an oxygen demand, which in some areas may significantly decrease the oxygen available for marine life.

3 FEDERAL & STATE FRAMEWORK FOR ADDRESSING LIVING AQUATIC RESOURCES

Many federal agencies are mandated by legislative statutes to protect living aquatic resources and prevent adverse human impacts. These agencies include: U.S. Environmental Protection Agency, U.S. Department of Commerce, U.S. Department of the Interior, U.S. Department of Defense, U.S. Department of Agriculture, and U.S. Department of Transportation. Each of the five Gulf of Mexico states also has a regulatory framework for addressing living aquatic resources. In addition, the Gulf States Marine Fisheries Commission is authorized by federal and state statutes to protect fishery resources in the Gulf of Mexico. (For a description, see **Appendix A**.)

4 THE UNFINISHED AGENDA --
Both Current Commitments & Uncommitted Activities

Goal

This Living Aquatic Resources Action Agenda for the Gulf of Mexico sets forth a framework for conserving, protecting, and restoring the living aquatic resources in the Gulf; thereby allowing the use and enjoyment of its resources. The Gulf of Mexico Program has established the following long-term goal:

- Conserve and restore species diversity and health of aquatic resources while allowing sustainable development.

Action Agenda Framework

This chapter of the Action Agenda provides objectives, action items, and specific project descriptions for conserving and restoring living aquatic resources in the Gulf of Mexico and for meeting the long-term goal as stated above. Objectives and action items are grouped under five types of activity: 1) Monitoring & Assessment, 2) Research, 3) Planning & Standards, 4) Compliance & Enforcement, and 5) Public Education & Outreach (see **Index of Objectives and Action Items**). The seventy-five action items represent the Committee's best judgment today, based on existing data and information, as to what must be done initially to conserve and protect living aquatic resources in the Gulf of Mexico. As current action items are completed and future generations of this document are developed, it is anticipated that additional actions will emerge.

Lead. The Living Aquatic Resources Committee has identified a lead agency for each project--the agency with the most authority or jurisdiction over the particular issue. A proposed action item or project may involve the execution of legislative or regulatory authorities or programmatic initiatives which derive from these authorities. In other cases, a proposed action item or project may involve the facilitation or coordination of activities among several agencies or organizations. In these cases, and where there is no clear legislative authority involved, the "lead" could be the agency or organization who expresses an interest in taking on the task during Gulf of Mexico Program Committee deliberations, the action planning workshop or public comment period, or, in the Issue Committee's judgment, is best able to guide multiple parties in carrying out the activity. *This does not necessarily mean that the agency has agreed to carry out the activity or that the agency has the necessary funding. The Living Aquatic Resources Committee understands these action items will require commitments by agencies and organizations that are*

dependent on budget decisions. However, the Committee members hope this document provides the rationale and support for such commitments and that future iterations of this document will include additional specific commitments.

Initiation Date. The date indicated represents a determination by the Committee of the most realistic *initiation date* for the action item. As lead agencies begin implementation planning for specific action items, these target dates may change due to resource availability and prioritization within the individual agencies.

Some action items are cross referenced to other action items and are designated with a "→" sign in the left hand column. This signals a close relationship among those actions and a need for coordination.

The Gulf of Mexico Program recognizes the need to identify indicators of environmental progress relative to this Action Agenda for living aquatic resources. Many of the action items specified in Chapter 4 of this document will aid the Program in developing a baseline for measuring success in the future. For the time being, however, acceptance and completion of action items specified in this Action Agenda will be considered a measure of success. As future iterations of this document are written, and current action items and projects are completed, new action items and projects will be developed to better measure environmental progress.

Index of Living Aquatic Resources Objectives & Action Items

Monitoring & Assessment

Objective: Characterize the current status of living aquatic resources in the Gulf of Mexico and continue to monitor the status and trends of these resources.

Action Item 1: Develop and describe ecosystem boundaries for the Gulf of Mexico to be used in monitoring living aquatic resources

Action Item 2: Identify existing data sets and ongoing monitoring programs for living aquatic resources in the Gulf of Mexico

Action Item 3: Develop recommendations for indicator species and sampling strategies for monitoring living aquatic resources in the Gulf of Mexico

Action Item 4: Assess existing monitoring programs for living aquatic resources in the Gulf of Mexico.

Action Item 5: Develop standardized data collection and analysis systems for Gulf of Mexico programs to ensure data compatibility and interchange across organizational boundaries

Action Item 6: Compile a periodic living aquatic resources status and trends report for the Gulf of Mexico

Action Item 7: Maintain a Gulf of Mexico living aquatic resources data set directory to provide accessibility and standardization of data

Objective: Survey and monitor impacts to the living aquatic resources of the Gulf of Mexico caused by human access and physical use.

Action Item 8: Inventory illegal or unauthorized human activities in the Gulf of Mexico that impact living aquatic resources

Action Item 9: Inventory direct and indirect human interactions with living aquatic resources in the Gulf of Mexico.

Action Item 10: Evaluate the impacts live-aboard vessels have on living aquatic resources in coastal areas throughout the Gulf of Mexico

Action Item 11: Characterize and rank problems associated with human access to and impacts on living aquatic resources in the Gulf of Mexico

Objective: Assess and monitor the effects of fishing mortality on the health and abundance of living aquatic resources in the Gulf of Mexico.

Action Item 12: Synthesize and evaluate the existing data on fishing mortality and impacts on species in the Gulf of Mexico.

Action Item 13: Implement monitoring programs in the Gulf of Mexico for fisheries by-catch

Action Item 14: Determine stock assessment information needs by species within the Gulf of Mexico.

Action Item 15: Evaluate the status of fishery stocks in the Gulf of Mexico.

Index of Living Aquatic Resources Objectives & Action Items (continued)

Monitoring & Assessment (continued)

Objective: Identify, inventory, and monitor impacts to the Gulf of Mexico and its living aquatic resources resulting from human-caused contaminants (*i.e.*, sewage, petroleum products, chemicals, toxic pesticides, marine debris, viruses, and bacteria).

Action Item 16: Survey human-caused contaminant inputs to the Gulf of Mexico

Action Item 17: Identify the current use of antifouling paints on vessels throughout the Gulf of Mexico.

Action Item 18: Identify the availability and use of marine sanitation devices and pumpout facilities in the Gulf of Mexico

Action Item 19: Inventory and monitor dredged material disposal sites within the Gulf of Mexico region

Action Item 20: Survey and monitor the impacts of pollutants and non-indigenous species carried in ship ballast waters on the living aquatic resources of the Gulf of Mexico

Objective: Survey the potential impacts of aquaculture on living aquatic resources of the Gulf of Mexico.

Action Item 21: Inventory existing aquaculture facilities, and determine the extent of aquaculture production in the Gulf of Mexico region.

Action Item 22: Develop an historical data base and monitoring programs for aquaculture in the Gulf of Mexico.

Action Item 23: Assess the potential for aquaculture to reduce the mortality of overfished stocks or enhance existing stocks in the Gulf of Mexico

Objective: Inventory the occurrence and evaluate the reoccurrence potential of unusual mortality events of living aquatic resources in the Gulf of Mexico.

Action Item 24: Inventory historical occurrences of unusual mortality events of living aquatic resources in the Gulf of Mexico.

Action Item 25: Establish a Gulfwide network for unusual mortality events

Action Item 26: Establish and maintain specimen and information archives for unusual mortality events in the Gulf of Mexico.

Index of Living Aquatic Resources Objectives & Action Items (continued)

Research

Objective: Conduct research to identify, characterize, and enhance the sustainability of living aquatic resources in the Gulf of Mexico.

Action Item 27: Identify potential endangered species in the Gulf of Mexico, and determine research needs for these species

Action Item 28: Conduct workshops to identify the research needs for unique Gulf of Mexico ecosystems that provide important habitat for living aquatic resources

Action Item 29: Promote research programs that support the restoration of living aquatic resources in the Gulf of Mexico

Action Item 30: Evaluate the effectiveness of artificial reefs in the Gulf of Mexico

Action Item 31: Develop a predictive capability for changes in living aquatic resources in the Gulf of Mexico.

Objective: Determine the impacts and effects of human activities on the living aquatic resources in the Gulf of Mexico, including habitat availability, structure, and function.

Action Item 32: Assess biotic and abiotic interactions affecting the living aquatic resources of the Gulf of Mexico.

Action Item 33: Assess the behavioral changes of living aquatic resources in the Gulf of Mexico caused by human interaction

Action Item 34: Assess the impact of introduced species on the endemic living aquatic resources of the Gulf of Mexico.

Action Item 35: Determine the effects of fishing activities on different habitats in the Gulf of Mexico.

Action Item 36: Determine the effects of fishing activities on biological community relationships in the Gulf of Mexico

Objective: Assess and address the potential effects of aquaculture on the living aquatic resources of the Gulf of Mexico.

Action Item 37: Characterize aquaculture effluents and determine their impacts on receiving systems in the Gulf of Mexico

Action Item 38: Identify the effects of unintentional and controlled releases of aquaculture organisms in the Gulf of Mexico

Action Item 39: Conduct research to reduce the negative impacts of aquaculture facilities on living aquatic resources and their habitat in the Gulf of Mexico.

Index of Living Aquatic Resources Objectives & Action Items (continued)

Research (continued)

Objective: Determine the cause/effect relationships of unusual mortality events and their potential ecological effects in the Gulf of Mexico.

Action Item 40: Determine and isolate new indicators of causes of unusual mortalities in the Gulf of Mexico.

Action Item 41: Improve forensic pathology techniques to determine causation of unusual mortality events in the Gulf of Mexico

Action Item 42: Determine the effect of toxicants in unusual mortality events in the Gulf of Mexico.

Action Item 43: Determine and assess the presence of multiple and cumulative stresses in unusual mortality events in the Gulf of Mexico

Action Item 44: Develop methods to assess the ecological impact of unusual mortality events in the Gulf of Mexico

Index of Living Aquatic Resources Objectives & Action Items (continued)

Planning & Standards

Objective: Develop a future quantified "vision" of the status of living aquatic resources in the Gulf of Mexico that supports the concept of a "healthy" Gulf of Mexico.

Action Item 45: Convene workshops to establish measurable standards for determination of ecosystem "health" in the Gulf of Mexico

Objective: Develop consistent criteria, seek uniform management, develop specific strategies, and coordinate Gulfwide activities for the protection of living aquatic resources and ecosystems in the Gulf of Mexico.

Action Item 46: Determine the adequacy of the existing regulatory framework for protecting the living aquatic resources of the Gulf of Mexico

Action Item 47: Recommend appropriate new legislation which authorizes regulatory action, enforcement authority, and funding for living aquatic resources where inadequacies exist

Action Item 48: Evaluate existing Gulf of Mexico management strategies, techniques, and methodologies to reduce negative human impacts on living aquatic resources

Action Item 49: Facilitate the coordination and integration of Gulf of Mexico living aquatic resource issues and programs across jurisdictional and organizational lines

Action Item 50: Conduct a comparative analysis of the specific provisions of the coastal zone management plans of the five Gulf States that support the protection of living aquatic resources.

Action Item 51: Develop standardized criteria across the Gulf States for land acquisition and land management to reduce negative human impacts on living aquatic resources

Action Item 52: Promote consistent regulations across the five Gulf States to provide protection from poaching and incidental take of living aquatic resources

Action Item 53: Establish Gulfwide boater education requirements on the impacts of boating on living aquatic resources

Action Item 54: Develop a Gulfwide aquaculture plan.

Action Item 55: Develop fishery management plans for exploited fishery populations in the Gulf of Mexico.

Action Item 56: Investigate, develop, and implement alternative fishing gear, techniques, and methodologies to reduce incidental fishing mortality in the Gulf of Mexico

Action Item 57: Investigate methods to control the introduction of non-indigenous species from ship ballast waters in the Gulf of Mexico

Objective: Restore anadromous fish populations that have been impacted by dam construction, channelization, dredging, and other habitat modifications and protect the habitats, rivers, and critical areas important to the life histories of these species in the Gulf of Mexico.

Action Item 58: Implement the anadromous fish strategic plan for the Gulf of Mexico.

Action Item 59: Develop and implement the "Gulf Sturgeon Recovery Plan "

Index of Living Aquatic Resources Objectives & Action Items (continued)

Planning & Standards (continued)

Objective: Develop and implement a response strategy for unusual mortality events in the Gulf of Mexico.

Action Item 60: Develop preventive strategies for unusual mortalities in the Gulf of Mexico.

Action Item 61: Establish appropriate guidelines for responding to unusual mortality events in the Gulf of Mexico

Action Item 62: Establish response protocols for unusual mortality events in the Gulf of Mexico

Action Item 63: Develop and conduct response team training for unusual mortality events in the Gulf of Mexico

Action Item 64: Evaluate mechanisms and secure contingency funding for implementation of scientific response teams for unusual mortality events in the Gulf of Mexico

Compliance & Enforcement

Objective: Enhance enforcement capabilities to protect living aquatic resources throughout the Gulf of Mexico.

Action Item 65: Assess the current status of state and federal compliance and enforcement programs throughout the Gulf of Mexico to protect living aquatic resources

Action Item 66: Develop specific mechanisms to enhance enforcement capabilities throughout the five Gulf of Mexico States

Index of Living Aquatic Resources Objectives & Action Items (continued)

Public Education & Outreach

Objective: Promote the coordination and advancement of all relevant Gulfwide education programs that address any aspect of living aquatic resources.

Action Item 67: Develop an inventory of all Gulf of Mexico education programs that cover living aquatic resources.

Action Item 68: Identify resources to implement public education/outreach strategies and actions for the protection of living aquatic resources in the Gulf of Mexico

Objective: Develop a public education and awareness program for the general public and specific user groups regarding human impacts on the living aquatic resources of the Gulf of Mexico, and promote a conservation ethic.

Action Item 69: Develop an effective educational methodology and strategy for the general public regarding human impacts on the living aquatic resources of the Gulf of Mexico

Action Item 70: Develop Gulfwide general and targeted informational materials about human interactions with living aquatic resources

Objective: Develop a Gulfwide public education and awareness program for other key issues concerning living aquatic resources that are not being effectively addressed.

Action Item 71: Develop a Gulfwide program to increase public awareness and understanding of the implications of unusual mortality events and the need for research

Objective: Involve an informed public constituency in the support and maintenance of "healthy" Gulf of Mexico ecosystems.

Action Item 72: Facilitate a Gulfwide understanding of the relationship of a "healthy" functioning ecosystem to a "healthy" economy.

Action Item 73: Build a corps of informed citizens throughout the Gulf of Mexico to aid in the dissemination of information on the importance of living aquatic resources

Action Item 74: Develop a Gulfwide program to increase public reporting of unusual mortality events

Action Item 75: Develop a program to involve the public and private industry in promoting safe aquaculture practices in the Gulf of Mexico.

Monitoring & Assessment

Monitoring is necessary to determine baseline conditions and the status of living aquatic resources in the Gulf of Mexico. Many state, federal, and private monitoring efforts are presently underway but most of these efforts are designed to meet specific goals and do not necessarily address Gulfwide regulatory and environmental resource concerns. Although additional monitoring to address Gulfwide concerns may be necessary, enhanced coordination among existing programs will increase the likelihood that reliable, compatible data sets will be generated without duplicative effort. The Gulf of Mexico program hopes to provide this coordination through the work of its Issue Committees and will further strive to integrate monitoring programs across issue areas such as Living Aquatic Resources, Habitat Degradation, Toxic Substances & Pesticides, and Public Health.

Specific objectives, action items, and project descriptions follow:

Objective: Characterize the current status of living aquatic resources in the Gulf of Mexico and continue to monitor the status and trends of these resources.

Action Item 1: Develop and describe ecosystem boundaries for the Gulf of Mexico to be used in monitoring living aquatic resources.

Project Description: Develop, describe, and define a conceptual model of "nested ecosystems" for the Gulf of Mexico to be used in monitoring living aquatic resources. This model will include biotic and abiotic components on a spatial and temporal scale.
Lead: National Marine Fisheries Service in coordination with U.S. Fish & Wildlife Service, coastal states, and Programa Epomex.
Initiation Date: 1994
→ **31A, 31B**

Action Item 2: Identify existing data sets and ongoing monitoring programs for living aquatic resources in the Gulf of Mexico.

Project Description: Inventory, evaluate, and synthesize historical living aquatic resource data sets in the Gulf of Mexico. Identify ongoing monitoring programs. Using this inventory, identify data gaps for characterization of the status of living aquatic resources in the Gulf of Mexico.
Lead: National Marine Fisheries Service in concert with U.S. Fish & Wildlife Service, coastal states, U.S Environmental Protection Agency, and Programa Epomex.
Initiation Date: 1994
→ **22, 37A**

Action Item 3: Develop recommendations for indicator species and sampling strategies for monitoring living aquatic resources in the Gulf of Mexico.

Project Description: Convene a living aquatic resources monitoring workshop to define indicator species/assemblages and recommend sampling strategies for living aquatic resources in the Gulf of Mexico.
Lead: Gulf of Mexico Program--Living Aquatic Resources Committee in concert with National Marine Fisheries Service and U.S. Fish & Wildlife Service.
Initiation Date: 1995
→ **4**

Action Item 4: Assess existing monitoring programs for living aquatic resources in the Gulf of Mexico.

Project Description: Determine if existing monitoring programs are adequate to address workshop recommended strategies. Recommend measures to improve, enhance, or initiate needed living aquatic resources monitoring in the Gulf of Mexico.
Lead: Gulf of Mexico Program--Living Aquatic Resources Committee in concert with National Marine Fisheries Service, U.S. Fish & Wildlife Service, and Gulf State resource agencies.
Initiation Date: 1995
→ **3, 16**

Action Item 5: Develop standardized data collection and analysis systems for Gulf of Mexico programs to ensure data compatibility and interchange across organizational boundaries.

Project Description: Conduct a workshop to evaluate the compatibility of data collection procedures and formats for recreational and commercial fisheries
Lead: Gulf States Marine Fisheries Commission in concert with National Marine Fisheries Service and Gulf States.
Initiation Date: 1994

Action Item 6: Compile a periodic living aquatic resources status and trends report for the Gulf of Mexico.

Project Description: Convene a workshop every three years to assess the status and trends of living aquatic resources utilizing the selected indicator species/assemblages. Produce workshop proceedings to document, re-evaluate, and refine the ongoing monitoring programs.
Lead: Gulf of Mexico Program--Living Aquatic Resources Committee in concert with Gulf of Mexico Program--Technical Advisory Committee, National Marine Fisheries Service, and U.S. Fish & Wildlife Service.
Initiation Date: 1995

Action Item 7: Maintain a Gulf of Mexico living aquatic resources data set directory to provide accessibility and standardization of data.

Project Description: Create and maintain a directory of available data sets on Gulf of Mexico living aquatic resources and encourage compatibility of data collection.
Lead: Gulf of Mexico Program.
Initiation Date: 1994

Objective: Survey and monitor impacts to the living aquatic resources of the Gulf of Mexico caused by human access and physical use.

Action Item 8: Inventory illegal or unauthorized human activities in the Gulf of Mexico that impact living aquatic resources.

Project Description: Identify and inventory the type and level of illegal or unauthorized activities (poaching, harassment, recreational and commercial infractions, boating infractions, etc.) that impact the natural resources of the Gulf of Mexico.
Lead: National Marine Fisheries Service in concert with U.S. Fish & Wildlife Service, state enforcement agencies, U.S. Environmental Protection Agency, U S Attorney, and U.S. Coast Guard.
Initiation Date: 1994

Action Item 9: Inventory direct and indirect human interactions with living aquatic resources in the Gulf of Mexico.

Project Description: Identify and inventory the type, location (temporal and spatial), and level of direct and indirect human contact and its effects on living marine resources (*e.g.* dolphin feedings, boating impacts on manatees, interaction with sea turtles and fisheries, human access to coastal bird breeding and nesting areas).
Lead: National Oceanic & Atmospheric Administration in concert with U.S. Fish & Wildlife Service and state wildlife agencies.
Initiation Date: 1994

Action Item 10: Evaluate the impacts live-aboard vessels have on living aquatic resources in coastal areas throughout the Gulf of Mexico.

Project Description: Identify where groups of live-aboards are located and inventory related research on impacts to living aquatic resources. Assess the need for a monitoring program.
Lead: National Oceanic & Atmospheric Administration in concert with U.S. Environmental Protection Agency and appropriate state agencies.
Initiation Date: 1994

Action Item 11: Characterize and rank problems associated with human access to and impacts on living aquatic resources in the Gulf of Mexico.

Project Description: Develop the criteria to define, characterize, and rank problems associated with human access to and impacts on the living aquatic resources in the Gulf of Mexico.
Lead: National Park Service (based on experience for defining and assessing human impacts for federal lands) in cooperation with National Marine Fisheries Service, U.S. Fish & Wildlife Service, U.S. Environmental Protection Agency, and states.
Initiation Date: 1994

Objective: Assess and monitor the effects of fishing mortality on the health and abundance of living aquatic resources in the Gulf of Mexico.

Action Item 12: Synthesize and evaluate the existing data on fishing mortality and impacts on species in the Gulf of Mexico.

Project Description: Conduct a literature review of target and non-target fishing mortality in the Gulf of Mexico and assess the impact on the health and abundance of critical species.
Lead: Gulf of Mexico Program--Living Aquatic Resources Committee in coordination with National Marine Fisheries Service.
Initiation Date: 1994

Action Item 13: Implement monitoring programs in the Gulf of Mexico for fisheries by-catch.

Project Description A: Assess uses of fishery-dependent and fishery-independent data and the correlation between fishery-dependent and fishery-independent data and appropriate applications.
Lead: National Marine Fisheries Service in concert with states.
Initiation Date: Ongoing
→ **15**

Project Description B: Develop and implement monitoring programs incorporating fishery-dependent and fishery-independent data collection to assess the magnitude of fisheries by-catch.
Lead: National Marine Fisheries Service, in conjunction with Gulf fishing industry, Gulf & South Atlantic Fisheries Development Foundation, U.S. Fish & Wildlife Service, and coastal states.
Initiation Date: 1994

Action Item 14: Determine stock assessment information needs by species within the Gulf of Mexico.

Project Description: Review existing information to determine which species require stock assessments and conduct an inventory of the data collected or needed for performing stock assessments for those species.
Lead: Gulf of Mexico Fishery Management Council and Gulf States Marine Fisheries Commission, in concert with National Marine Fisheries Service, U.S. Fish & Wildlife Service, and states.
Initiation Date: Ongoing

Action Item 15: Evaluate the status of fishery stocks in the Gulf of Mexico.

Project Description: Conduct periodic stock assessments for Gulf of Mexico fisheries, that are key prey species or harvested either commercially or recreationally, using available fishery-dependent and fishery-independent data.
Lead: National Marine Fisheries Service in concert with U.S. Fish & Wildlife Service and states.
Initiation Date: Ongoing
→ **13A**

Objective: Identify, inventory, and monitor impacts to the Gulf of Mexico and its living aquatic resources resulting from human-caused contaminants (*i.e.*, sewage, petroleum products, chemicals, toxic pesticides, marine debris, viruses, and bacteria). *NOTE: Crosswalk to other GMP Action Agendas.*

Action Item 16: Survey human-caused contaminant inputs to the Gulf of Mexico.

Project Description: Identify, inventory, and survey sources and levels of authorized and unauthorized contaminants in the Gulf of Mexico that could affect living aquatic resources. Develop a large map of types and locations of such inputs (baseline) to assist in the establishment of a monitoring program.
Lead: U.S. Environmental Protection Agency in concert with Minerals Management Service, U.S. Coast Guard, National Oceanic & Atmospheric Administration, U.S. Fish & Wildlife Service, and appropriate state agencies.
Initiation Date: 1994
→ **4, 24B**

Action Item 17: Identify the current use of antifouling paints on vessels throughout the Gulf of Mexico.

Project Description: Identify the current extent and use of toxic antifouling boat paints on recreational and commercial vessels throughout the Gulf of Mexico.
Lead: U.S. Environmental Protection Agency.
Initiation Date: 1994

Action Item 18: Identify the availability and use of marine sanitation devices and pumpout facilities in the Gulf of Mexico.

Project Description: Survey the availability and usage of marine sanitation devices (MSDs) and pumpout stations at ports and marinas throughout the Gulf of Mexico.
Lead: U.S. Environmental Protection Agency in concert with U.S. Coast Guard, U.S. Fish & Wildlife Service, and appropriate state agencies.
Initiation Date: 1994

Action Item 19: Inventory and monitor dredged material disposal sites within the Gulf of Mexico region.

Project Description A: Identify, inventory, and map (with information on any pollutants found in the materials) disposal sites in the Gulf of Mexico, its estuaries, or other water/wetlands areas in the region.
Lead: U.S. Environmental Protection Agency in concert with Minerals Management Service, U.S. Army Corps of Engineers, National Oceanic & Atmospheric Administration, U.S Fish & Wildlife Service, and states.
Initiation Date: 1994

Project Description B: Develop a plan to assess and monitor the long-term effects of dredged material disposal sites and their impacts on surrounding bottom and water column areas, as well as living aquatic resources.
Lead: U.S. Environmental Protection Agency in concert with Minerals Management Service, U.S. Army Corps of Engineers, National Oceanic & Atmospheric Administration, U.S. Fish & Wildlife Service, and states.
Initiation Date: 1994

Action Item 20: Survey and monitor the impacts of pollutants and non-indigenous species carried in ship ballast waters on the living aquatic resources of the Gulf of Mexico.

Project Description: Identify, inventory, and map the occurrence of pollutants and introduction of non-indigenous species from the release of ship ballast waters into the Gulf of Mexico.
Lead: U.S. Fish & Wildlife Service--National Biological Survey in concert with National Oceanic & Atmospheric Administration.
Initiation Date: 1994
→ **34, 67**

Objective: Survey the potential impacts of aquaculture on living aquatic resources of the Gulf of Mexico.

Action Item 21: Inventory existing aquaculture facilities, and determine the extent of aquaculture production in the Gulf of Mexico region.

Project Description: Collect, summarize, and publish actual and potential aquaculture production by species, state, and nation in relation to native stocks. Develop and maintain a Gulfwide inventory and characterization of aquaculture facilities.
Lead: U.S. Fish & Wildlife Service in concert with Gulf States Marine Fisheries Commission, National Marine Fisheries Service, and Gulf of Mexico Program--Living Aquatic Resources (Aquaculture Working Group).
Initiation Date: 1994
→ **37A, 37B, 37C, 37D, 54A, 54B**

Action Item 22: Develop an historical data base and monitoring programs for aquaculture in the Gulf of Mexico.

Project Description: Review and characterize known and potential impacts of aquaculture on coastal and open areas of the Gulf of Mexico in order to establish monitoring programs.
Lead: U.S. Fish & Wildlife Service in concert with U.S. Environmental Protection Agency, National Marine Fisheries Service, and states.
Initiation Date: 1995
→ **2, 37A**

Action Item 23: Assess the potential for aquaculture to reduce the mortality of overfished stocks or enhance existing stocks in the Gulf of Mexico.

Project Description: Evaluate the ability of aquaculture production to reduce pressure on overfished stocks or to augment natural production of those stocks.
Lead: U.S. Department of Agriculture, in concert with U.S. Fish & Wildlife Service, National Marine Fisheries Service, and states.
Initiation Date: 1996

Objective: Inventory the occurrence and evaluate the reoccurrence potential of unusual mortality events of living aquatic resources in the Gulf of Mexico.

Action Item 24: Inventory historical occurrences of unusual mortality events of living aquatic resources in the Gulf of Mexico.

Project Description A: Prepare a comprehensive inventory of unusual mortalities of living aquatic resources in the Gulf of Mexico, including plants, mollusks, crustaceans, corals, fish, birds, turtles, and mammals.
Lead: Gulf of Mexico Program--Living Aquatic Resources Committee in cooperation with National Marine Fisheries Service, U.S. Fish & Wildlife Service, and U.S. Environmental Protection Agency.
Initiation Date: 1994

Project Description B: Develop a graphic display of unusual mortalities of living aquatic resources in the Gulf of Mexico. Incorporate known historical unusual mortalities into a geographical information system (GIS).
Lead: Gulf of Mexico Program--Data & Information Transfer Operations in conjunction with National Marine Fisheries Service and U.S. Fish & Wildlife Service.
Initiation Date: 1994
→ **16**

Action Item 25: Establish a Gulfwide network for unusual mortality events.

Project Description: Establish a Gulfwide network of unusual mortality event response scientists.
Lead: U.S. Environmental Protection Agency--Center for Marine & Estuarine Disease Research (Mammals), National Marine Fisheries Service--Office of Protected Resources (Mammals), U.S. Fish & Wildlife Service--Regional Offices (Sea Turtles), and states.
Initiation Date: 1993
→ **64**

Action Item 26: Establish and maintain specimen and information archives for unusual mortality events in the Gulf of Mexico.

Project Description: Expand and maintain bands of fixed, frozen and/or prepared tissues from specimens of unusual mortality events in the Gulf of Mexico. Provide centralized locations for study and future reference (tissue banks and archival).
Lead: National Marine Fisheries Service, Armed Forces Institute of Pathology, U.S. Environmental Protection Agency, Smithsonian Institution, and U.S. Fish & Wildlife Service.
Initiation Date: 1994
→ **62B**

Research

The Gulf of Mexico is a productive resource, but is susceptible to impacts of natural phenomena and human activities. Human activities may cause adverse effects on the Gulf's ecosystem. To protect the marine ecosystem from these threats, more complete knowledge is needed to understand some of the important biological and environmental forces that structure and control the system. Findings from monitoring efforts should be analyzed to understand and establish the underlying processes and relationships that result in particular observations.

Most research funds are administered by federal agencies or state program offices in support of specific missions, with only limited funding going to research that examines the cumulative effects of decisions on the ecosystem as a whole. This action planning process provides the necessary mechanism to enable producers, consumers, and funders of research to agree on the priorities. A closer connection should be established between the research agenda of the scientific community and the information needs of managers, regulators, and those involved in management decisions for the Gulf of Mexico. Once a research agenda is developed and implemented, the research results should be used to understand the underlying processes and relationships and make appropriate decisions regarding the conservation and management of Gulf of Mexico living aquatic resources.

Specific objectives, action items, and project descriptions follow:

Objective: Conduct research to identify, characterize, and enhance the sustainability of living aquatic resources in the Gulf of Mexico.

Action Item 27: Identify potential endangered species in the Gulf of Mexico, and determine research needs for these species.

> **Project Description:** Identify Gulf of Mexico living aquatic resource populations by relative numbers or distribution to determine those in chronic decline and those that may be endangered or threatened. Recommend needed research to support the protection and restoration of these species.
> **Lead:** U.S. Fish & Wildlife Service in concert with National Marine Fisheries Service and coastal state resource agencies.
> **Initiation Date:** 1995

Action Item 28: Conduct workshops to identify the research needs for unique Gulf of Mexico ecosystems that provide important habitat for living aquatic resources.

Project Description: Conduct workshops to identify research needs on the following sub-ecosystems that provide important habitat for living aquatic resources: pelagic sargassum, Big Bend seagrass, Florida Bay nursery area, Mississippi River plume, Texas barrier islands, Texas Flower Gardens, and Campeche Banks. *NOTE: Crosswalk with Habitat Degradation Action Agenda.*
Lead: Gulf of Mexico Regional Marine Research Program, in concert with Gulf of Mexico Program--Living Aquatic Resources Committee, Habitat Degradation Committee, and Gulf Coast State natural resource agencies.
Initiation Date: 1994

Action Item 29: Promote research programs that support the restoration of living aquatic resources in the Gulf of Mexico.

Project Description: Promote research programs to identify restoration or population augmentation alternatives for the Gulf of Mexico.
Lead: U.S. Fish & Wildlife Service in concert with National Marine Fisheries Service.
Initiation Date: 1994

Action Item 30: Evaluate the effectiveness of artificial reefs in the Gulf of Mexico.

Project Description: Determine the impact of artificial reefs on living aquatic resources in the Gulf of Mexico.
Lead: National Marine Fisheries Service in concert with coastal states, National Oceanic & Atmospheric Administration, and Minerals Management Service.
Initiation Date: 1995

Action Item 31: Develop a predictive capability for changes in living aquatic resources in the Gulf of Mexico.

Project Description A: Develop a predictive capability for changes in living aquatic resources in the Gulf of Mexico. Develop layered, interactive data bases utilizing bioindicators/assemblages to develop models which will predict changes in populations abundance, recruitment, and responses to aquatic perturbations.
Lead: National Marine Fisheries Service, in concert with U.S. Fish & Wildlife Service and coastal state natural resource agencies.
Initiation Date: 1996
→ 1

Project Description B: Develop layered, interactive data bases utilizing bioindicators/assemblages to develop models which will predict changes in population abundance, recruitment and responses to climate change.
Lead: National Marine Fisheries Service in concert with U.S. Fish & Wildlife Service and coastal state natural resource agencies.
Initiation Date: 1996
→ 1

Objective: Determine the impacts and effects of human activities on the living aquatic resources in the Gulf of Mexico, including habitat availability, structure, and function.

Action Item 32: Assess biotic and abiotic interactions affecting the living aquatic resources of the Gulf of Mexico.

Project Description: Evaluate and report on the effects of selected biotic and abiotic factors on the survival, temporal and spatial distribution, and health of living aquatic resources.
Lead: National Oceanic & Atmospheric Administration in concert with U.S. Fish & Wildlife Service, U.S. Environmental Protection Agency, and Gulf States.
Initiation Date: 1995

Action Item 33: Assess the behavioral changes of living aquatic resources in the Gulf of Mexico caused by human interaction.

Project Description: Evaluate and report on behavioral impacts or changes on living aquatic resources in the Gulf of Mexico caused by human interaction.
Lead: National Marine Fisheries Service in concert with coastal states.
Initiation Date: 1994

Action Item 34: Assess the impact of introduced species on the endemic living aquatic resources of the Gulf of Mexico

Project Description: Determine and report on the impact of introduced species on endemic living aquatic resources of the Gulf of Mexico.
Lead: National Marine Fisheries Service in concert with U.S. Fish & Wildlife Service and coastal states.
Initiation Date: 1994
→ **20**

Action Item 35: Determine the effects of fishing activities on different habitats in the Gulf of Mexico.

Project Description: Conduct case study research comparing fished and non-fished areas in the Gulf of Mexico to determine impacts on habitat from trawling, oyster dredging, and recreational boat traffic. *NOTE: Crosswalk with Habitat Degradation Committee.*
Lead: National Marine Fisheries Service in concert with coastal states and U.S. Fish & Wildlife Service.
Initiation Date: 1995

Action Item 36: Determine the effects of fishing activities on biological community relationships in the Gulf of Mexico.

Project Description A: Conduct studies to determine effects of fishing activities on the relative abundance of other living aquatic resources and predator/prey, host/parasite relationships in the Gulf of Mexico. Compare species abundance and diversity in coastal communities from similar habitats under exploited and unexploited (sanctuaries) conditions
Lead: National Marine Fisheries Service in concert with U.S. Environmental Protection Agency, U.S. Fish & Wildlife Service, and coastal states.
Initiation Date: 1995

Project Description B: Conduct studies to determine impacts of changing fishing behavior and technology. Compare species abundance in Gulf of Mexico marine communities in similar habitats before and after changes in fishing behavior and technology.
Lead: National Marine Fisheries Service in concert with coastal states.
Initiation Date: 1996

Objective: Assess and address the potential effects of aquaculture on the living aquatic resources of the Gulf of Mexico.

Action Item 37: Characterize aquaculture effluents and determine their impacts on receiving systems in the Gulf of Mexico

Project Description A: Identify and quantify the biological, chemical, and physical components of effluents from aquaculture operations in the Gulf of Mexico.
Lead: U.S. Environmental Protection Agency in concert with U.S. Department of Agriculture, U.S. Fish & Wildlife Service, National Marine Fisheries Service, Gulf States Marine Fisheries Commission, and private industry.
Initiation Date: 1995
→ **2, 21, 22**

Project Description B: Develop and/or refine methods to qualitatively and quantitatively assess the impact of aquaculture effluents in the Gulf of Mexico.
Lead: U.S. Environmental Protection Agency in concert with National Institute for Environmental Health & Science and U.S. Food & Drug Administration.
Initiation Date: 1996
→ **21**

Project Description C: Identify the potential effects of biotoxins, chemical contaminants, and pathogens in aquaculture systems in the Gulf of Mexico and determine if there are human health risks associated with consumptive use of aquaculture products.
Lead: U.S. Food & Drug Administration in concert with U.S. Department of Agriculture, National Marine Fisheries Service, and Gulf of Mexico Program--Public Health Committee.
Initiation Date: 1994
→ **21**

Project Description D: Develop and/or refine methods to detect the presence of contaminants within aquaculture systems in the Gulf of Mexico and evaluate potential risks to aquaculture organisms and consumers.
Lead: U.S. Environmental Protection Agency in concert with U.S. Food & Drug Administration.
Initiation Date: 1994
→ **21**

Action Item 38: Identify the effects of unintentional and controlled releases of aquaculture organisms in the Gulf of Mexico.

Project Description A: Develop methods for aquaculture product identification, such as a long-term marking and detection technique for aquaculture organisms in commerce and in the wild (*i.e.*, tags, genetic markers, visible markers, morphometries).
Lead: U.S. Department of Agriculture in concert with U.S. Food & Drug Administration, National Marine Fisheries Service, and industry.
Initiation Date: 1995

Project Description B: Identify potential risks to native living resources in the Gulf of Mexico from releases of aquaculture organisms and their associated parasites and pathogens.
Lead: U.S. Fish & Wildlife Service in concert with National Marine Fisheries Service, U.S. Department of Agriculture, U.S. Food & Drug Administration, and U.S. Environmental Protection Agency.
Initiation Date: 1995

Project Description C: Assess the risk of drug-resistant strains of human and animal pathogens associated with the use of drugs and other chemicals in aquaculture systems.
Lead: U.S. Food & Drug Administration.
Initiation Date: 1995

Project Description D: Determine how genetic engineering and hybridization affect the fitness of introduced and wild stocks and their potential impact on the indigenous species in the Gulf of Mexico.
Lead: U.S. Fish & Wildlife Service in concert with U.S. Food & Drug Administration, National Marine Fisheries Service, and states.
Initiation Date: 1995

Action Item 39: Conduct research to reduce the negative impacts of aquaculture facilities on living aquatic resources and their habitat in the Gulf of Mexico.

Project Description A: Determine the functions and values (ecological, monetary, aesthetic) of natural wetlands and shelf systems and assess the impacts of aquaculture facilities on these habitats. *NOTE: Crosswalk with Habitat Degradation Action Agenda.*
Lead: National Oceanic & Atmospheric Administration and U.S. Fish & Wildlife Service in concert with U.S. Environmental Protection Agency.
Initiation Date: 1995

Project Description B: Determine the feasibility and costs of using non-wetland (upland, lowland containment areas) sites for marine aquaculture production in the Gulf of Mexico.
Lead: U.S. Department of Agriculture in concert with Soil Conservation Service.
Initiation Date: 1995

Project Description C: Develop new or more effective best management practices for aquaculture practices that increase efficiency of land and water usage in the Gulf of Mexico region. Utilize practices that increase the efficiency and yield of aquaculture operations and reduce negative impacts on living aquatic resources.
Lead: U.S. Department of Agriculture in concert with National Oceanic & Atmospheric Administration, U.S. Fish & Wildlife Service, Soil Conservation Service, and private industry.
Initiation Date: 1995

Objective: Determine the cause/effect relationships of unusual mortality events and their potential ecological effects in the Gulf of Mexico.

Action Item 40: Determine and isolate new indicators of causes of unusual mortalities in the Gulf of Mexico.

Project Description: Develop new biological indicators for use with living specimens from the same site as an unusual mortality event to help determine the causes of unusual mortality events in the Gulf of Mexico.
Lead: U.S. Environmental Protection Agency--Center for Marine & Estuarine Disease Research in concert with states, National Marine Fisheries Service, and U.S. Fish & Wildlife Service.
Initiation Date: 1994

Action Item 41: Improve forensic pathology techniques to determine causation of unusual mortality events in the Gulf of Mexico.

Project Description: Develop new methods in forensic pathology to determine causation of unusual mortality events in the Gulf of Mexico.
Lead: U.S. Environmental Protection Agency--Center for Marine & Estuarine Disease Research in concert with National Marine Fisheries Service, U.S. Fish & Wildlife Service, and states.
Initiation Date: 1994

Action Item 42: Determine the effect of toxicants in unusual mortality events in the Gulf of Mexico.

Project Description: Conduct laboratory studies to confirm the cause/effect relationships hypothesized from investigations of unusual mortality events in the Gulf of Mexico. Evaluate the effects of suspected toxicants identified from tissues, water, or sediments and to confirm diagnosis of microbial pathogens (Koch's postulates).
Lead: U.S. Environmental Protection Agency--Center for Marine & Estuarine Disease Research in concert with National Marine Fisheries Service, U.S. Fish & Wildlife Service, and states.
Initiation Date: 1995

Action Item 43: Determine and assess the presence of multiple and cumulative stresses in unusual mortality events in the Gulf of Mexico.

Project Description: Develop data bases and establish a model to evaluate the impact of multiple and cumulative stresses on specific organisms and populations in relation to unusual mortality events in the Gulf of Mexico.
Lead: U.S. Environmental Protection Agency--Center for Marine & Estuarine Disease Research in concert with National Marine Fisheries Service, and U.S. Fish & Wildlife Service.
Initiation Date: 1995

Action Item 44: Develop methods to assess the ecological impact of unusual mortality events in the Gulf of Mexico.

Project Description: Develop methods to estimate the direct impact of unusual mortality events on population dynamics of affected species and the indirect effects on predator and prey species in the Gulf of Mexico.
Lead: U.S. Environmental Protection Agency--Center for Marine & Estuarine Disease Research in concert with National Marine Fisheries Service, and U.S. Fish & Wildlife Service.
Initiation Date: 1995

Planning & Standards

The most effective way to protect and conserve living aquatic resources is to control those activities and actions that threaten them. It will cost far more to restore depleted species populations than to control actions before their status becomes critical. This should be a shared responsibility among all in the Gulf region--federal, state, and local governments, the private sector, and citizens. In addition, cooperation and consistency among various management plans, regulations, and policies is essential.

Specific objectives, action items, and project descriptions follow:

Objective: Develop a future quantified "vision" of the status of living aquatic resources in the Gulf of Mexico that supports the concept of a "healthy" Gulf of Mexico.

Action Item 45: Convene workshops to establish measurable standards for determination of ecosystem "health" in the Gulf of Mexico.

Project Description: Convene workshops of federal, state, and academic program partners to identify measurable standards of Gulf of Mexico "health" and standards for habitat values, ecological values, and economic and social values. Publish and distribute workshop materials widely to build a consensus on the "vision."
Lead: Gulf of Mexico Program in concert with National Oceanic & Atmospheric Administration--National Marine Fisheries Service and National Ocean Service, U.S. Environmental Protection Agency, U.S. Fish & Wildlife Service, and state natural resource agencies.
Initiation Date: 1995

Objective: Develop consistent criteria, seek uniform management, develop specific strategies, and coordinate Gulfwide activities for the protection of living aquatic resources and ecosystems in the Gulf of Mexico. (The intent is to avoid duplication of effort and ensure maximum efficiency in use of public funds.)

Action Item 46: Determine the adequacy of the existing regulatory framework for protecting the living aquatic resources of the Gulf of Mexico.

Project Description A: Convene a workshop of Gulf of Mexico Program federal and state agencies to identify existing legislation, regulations, compliance and enforcement programs, and funding to protect living aquatic resources, evaluate the adequacy of these programs, and achieve management uniformity. Encourage the incorporation of workshop results into strategic plans of appropriate agencies, as well as Gulf of Mexico Program Action Agendas.
Lead: Gulf of Mexico Program--Living Aquatic Resources Committee in concert with Gulf of Mexico Program partners, National Marine Fisheries Service, U.S. Fish & Wildlife Service, Gulf States Marine Fisheries Commission, Gulf of Mexico Fishery Management Council, U.S. Army Corps of Engineers, and state resource agencies.
Initiation Date: 1995

Project Description B: Evaluate and compare the different state and federal legislation or regulatory actions concerned with restoration or rehabilitation of living aquatic resources damaged by spills or contaminants, and establish responsible agencies for the restoration and rehabilitation of living aquatic resources affected by human-caused contaminant exposure (oil/petroleum, sewage, foreign species, chemicals, pesticides).
Lead: U.S. Environmental Protection Agency in concert with National Oceanic & Atmospheric Administration, U.S. Fish & Wildlife Service, U.S. Army Corps of Engineers, U.S. Coast Guard, and states.
Initiation Date: 1994

Project Description C: Work with the states to prevent the loss of beaches and nesting habitats used by living aquatic resources. Develop recommendations on coastal construction and development activities in beach areas, and dredging activities in nearshore waters, that could impact the nesting habitats of birds and turtles.
Lead: U.S. Fish & Wildlife Service and U.S. Army.
Initiation Date: 1994

Action Item 47: Recommend appropriate new legislation which authorizes regulatory action, enforcement authority, and funding for living aquatic resources where inadequacies exist.

Project Description A: Support legislation in each state and at the federal level that restricts "feeding" of wild populations of protected marine animals (manatees, dolphins, birds, etc.).
Lead: U.S. Fish & Wildlife Service and National Marine Fisheries Service in concert with state game and freshwater fish or marine resource agencies.
Initiation Date: 1994

Project Description B: Survey and examine existing legislation, regulations, and agency policies for relevance in reducing unusual mortality events and identify areas of existing legislation that could be improved.
Lead: Gulf of Mexico Program--Living Aquatic Resources Committee in concert with states and federal agencies.
Initiation Date: 1994

Project Description C: Apply knowledge gained from scientific response efforts to recommend new legislation (where applicable) relating to unusual mortality events.
Lead: Gulf of Mexico Program--Living Aquatic Resources Committee in concert with expert panel/workshop results.
Initiation Date: 1995

Action Item 48: Evaluate existing Gulf of Mexico management strategies, techniques, and methodologies to reduce negative human impacts on living aquatic resources.

Project Description: Review the research record on significant human impacts identified by models, and evaluate the adequacy of existing management strategies in the Gulf of Mexico to reduce negative human impacts on living aquatic resources.
Lead: National Park Service in concert with U.S. Fish & Wildlife Service, National Marine Fisheries Service, and states.
Initiation Date: 1994

Action Item 49: Facilitate the coordination and integration of Gulf of Mexico living aquatic resource issues and programs across jurisdictional and organizational lines.

Project Description A: Encourage the use of existing venues (Gulf States Marine Fisheries Commission or Gulf of Mexico Fishery Management Council) for holding workshops and reviews on specific Gulfwide activities related to living aquatic resources.
Lead: Gulf States Marine Fisheries Commission in concert with National Marine Fisheries Service, Gulf of Mexico Fishery Management Council and coastal state resource agencies.
Initiation Date: 1994

Project Description B: Integrate actions across Gulf of Mexico Program Action Agendas to address factors affecting living aquatic resources. At Co-Chair meetings, Living Aquatic Resources (LARS) Committee representatives shall make presentations regarding updates and areas/topics of concern. LARS Committee will review all Action Agendas and LARS Steering Committee will hold semi-annual review panel meetings.
Lead: Gulf of Mexico Program--Living Aquatic Resources Committee.
Initiation Date: Ongoing

Project Description C: Incorporate Living Aquatic Resources Committee objectives into an effective large marine ecosystem (LME) research protocol to include Mexico and the wider Caribbean. Identify pertinent joint international programs of fishery research and management and conduct LME symposia (Gulf and Caribbean) to highlight physical and biological ecosystem modifiers.
Lead: National Marine Fisheries Service in concert with U.S. Environmental Protection Agency, U.S. Department of State, and U.S. Fish & Wildlife Service.
Initiation Date: 1994

Action Item 50: Conduct a comparative analysis of the specific provisions of the coastal zone management plans of the five Gulf States that support the protection of living aquatic resources.

Project Description: Review and conduct a comparative analysis of the provisions of the five Gulf States' coastal zone management plans and other coastal land management initiatives that reduce human impacts on living aquatic resources. Produce a report to transfer the results to all states for incorporation as appropriate.
Lead: National Oceanic & Atmospheric Administration(coastal zone management) and U.S. Fish & Wildlife Service.
Initiation Date: 1994

Action Item 51: Develop standardized criteria across the Gulf States for land acquisition and land management to reduce negative human impacts on living aquatic resources.

Project Description: Conduct a workshop with the five Gulf States and appropriate federal agencies to develop recommendations for standardized minimum criteria for land acquisition and land management plans for reducing human impacts on living aquatic resources.
Lead: U.S. Fish & Wildlife Service in concert with National Oceanic & Atmospheric Administration.
Initiation Date: 1994

Action Item 52: Promote consistent regulations across the five Gulf States to provide protection from poaching and incidental take of living aquatic resources.

Project Description: Evaluate current regulations at the state and federal levels that provide protection from poaching and incidental take of living aquatic resources. Make recommendations on a Gulfwide approach to this issue.
Lead: U.S. Fish & Wildlife Service in concert with Gulf States Marine Fisheries Commission, National Marine Fisheries Service, and states.
Initiation Date: 1994

Action Item 53: Establish Gulfwide boater education requirements on the impacts of boating on living aquatic resources.

Project Description: Establish boater education requirements in all Gulf States that include the environmental impacts of boating and the environmental laws that boaters have to obey.
Lead: States in concert with U.S. Coast Guard.
Initiation Date: 1994
→ **70E**

Action Item 54: Develop a Gulfwide aquaculture plan.

Project Description A: Review and evaluate baseline data on the types of activities and locations of facilities for aquaculture in the Gulf of Mexico region.
Lead: Gulf States Marine Fisheries Commission.
Initiation Date: 1995
→ **21, 37**

Project Description B: Identify and evaluate existing plans, standards, and permitting for aquaculture within the five Gulf States in order to establish a Gulfwide aquaculture plan.
Lead: Gulf States Marine Fisheries Commission.
Initiation Date: 1995
→ **21, 37**

Project Description C: Using the information generated by Action Item 54 (Projects A &B), establish a task force to produce a Gulfwide aquaculture plan to address commercial production and stock enhancement. This plan should include implementation measures, as well as minimum uniform standards for aquaculture facilities in the Gulf of Mexico (territorial and federal) and model legislation to assure the orderly development of aquaculture in the Gulf of Mexico.
Lead: Gulf States Marine Fisheries Commission in concert with U.S. Department of Agriculture, National Oceanic & Atmospheric Administration, U.S. Fish & Wildlife Service, U.S. Environmental Protection Agency, states, U.S. Army Corps of Engineers, Soil Conservation Service, and National Marine Fisheries Service.
Initiation Date: 1995
→ **37**

Project Description D: Establish Gulfwide aquaculture product labeling and safety standards. *(NOTE: Crosswalk with Public Health Action Agenda.)*
Lead: National Oceanic & Atmospheric Administration, in concert with U.S. Food & Drug Administration, U.S. Fish & Wildlife Service, industry, and states.
Initiation Date: 1995
→ **37**

Action Item 55: Develop fishery management plans for exploited fishery populations in the Gulf of Mexico.

Project Description A: Develop comprehensive interjurisdictional fishery management plans (FMP) for populations affected by fishing activities in the U.S. Exclusive Economic Zone (EEZ). Plans already completed include: billfish, coral, mackerel, reef fish, red drum, sharks, shrimp, spiny lobster, stone crab, and swordfish.
Lead: Gulf of Mexico Fishery Management Council in concert with National Marine Fisheries Service and Gulf Coast States.
Initiation Date: Ongoing

Project Description B: Develop comprehensive interjurisdictional fishery management plans (FMP) for populations affected by fishing activities in Gulf State territorial waters. Plans already completed include: blue crab, Spanish mackerel, menhaden, striped bass, black drum, and oysters.
Lead: Gulf State Marine Fishery Commission in concert with Gulf Coast States.
Initiation Date: Ongoing

Project Description C: Inform Gulf of Mexico user and citizens groups of the pending need for state and federal regulations to facilitate the implementation of fishery management plans, and encourage them to participate in a process of adopting comparable rules in their respective states.
Lead: Gulf States Marine Fisheries Commission in concert with Gulf State natural resources agencies.
Initiation Date: Ongoing

Action Item 56: Investigate, develop, and implement alternative fishing gear, techniques, and methodologies to reduce incidental fishing mortality in the Gulf of Mexico.

Project Description A: Investigate and develop alternate fishing methodologies, including by-catch reduction devices, to increase effectiveness and reduce negative impacts on living aquatic resources in the Gulf of Mexico.
Lead: National Marine Fisheries Service in concert with Gulf & South Atlantic Fisheries Development Foundation, industry, and Sea Grant.
Initiation Date: 1994

Project Description B: Implement and expand a "new technology" transition program for fishing activities (new gear technology and other technical advances). Utilizing the present SeaGrant Cooperative Extension and Advisory Program: 1) expand coordination with the federal/state lab system and industrial interests; 2) produce a listing of activities and potential technology transfer from each institution; and 3) establish incentives for adoption of new technologies.
Lead: Sea Grant Advisory Programs in concert with federal/state/academic institutions and industry.
Initiation Date: 1994

Action Item 57: Investigate methods to control the introduction of non-indigenous species from ship ballast waters in the Gulf of Mexico.

Project Description: Develop alternatives and best management practices for reducing or ending the introduction of non-indigenous species from ship ballast waters in the Gulf of Mexico.
Lead: U.S. Coast Guard and U.S. Fish & Wildlife Service, in concert with Port Authorities, National Marine Fisheries Service, and U.S. Environmental Protection Agency.
Initiation Date: 1995
→ **20**

Objective: Restore anadromous fish populations that have been impacted by dam construction, channelization, dredging, and other habitat modifications and protect the habitats, rivers, and critical areas important to the life histories of these species in the Gulf of Mexico.

Action Item 58: Implement the anadromous fish strategic plan for the Gulf of Mexico.

Project Description A: Implement the "Strategic Plan for Restoration and Management of Anadromous Fish in the Gulf of Mexico," with particular emphasis on restoring striped bass in appropriate Gulf rivers.
Lead: Gulf States Marine Fisheries Commission in concert with U.S. Fish & Wildlife Service and National Marine Fisheries Service.
Initiation Date: 1994

Project Description B: Distribute the anadromous fish strategic plan for the Gulf of Mexico to local state and regional planning agencies, and hold workshops to promote an understanding and implementation of the plan.
Lead: Gulf States Marine Fisheries Commission in concert with U.S. Fish & Wildlife Service and National Marine Fisheries Service.
Initiation Date: 1994

Action Item 59: Develop and implement the "Gulf Sturgeon Recovery Plan."

Project Description: Complete and implement the "Gulf Sturgeon Recovery Plan." Encourage activities that will contribute to the recovery of the species.
Lead: U.S. Fish & Wildlife Service in concert with Gulf States Marine Fisheries Commission and National Marine Fisheries Service.
Initiation Date: Ongoing

Objective: Develop and implement a response strategy for unusual mortality events in the Gulf of Mexico.

Action Item 60: Develop preventive strategies for unusual mortalities in the Gulf of Mexico.

Project Description A: Evaluate and analyze data to develop preventive strategies and reoccurrence potential for unusual mortalities in the Gulf of Mexico.
Lead: Gulf of Mexico Program--Living Aquatic Resources Committee in concert with National Marine Fisheries Service--Office of Protected Resources (Mammals), U.S. Fish & Wildlife Service--Regional Offices (Sea Turtles), and U.S. Environmental Protection Agency--Center for Marine & Estuarine Disease Research (Mammals).
Initiation Date: 1994

Project Description B: Evaluate approaches to assigning economic cost to past and new unusual mortality events, and determine the economic loss incurred from unusual mortality events in the Gulf of Mexico.
Lead: U.S. Environmental Protection Agency--Center for Environmental Statistics in concert with National Oceanic & Atmospheric Administration--National Ocean Service and states.
Initiation Date: 1996

Action Item 61: Establish appropriate guidelines for responding to unusual mortality events in the Gulf of Mexico.

Project Description: Establish guidelines for the type and level of response to unusual mortality events in the Gulf of Mexico (*i.e.*, who responds, appropriate level of response, and timeline for response).
Lead: U.S. Environmental Protection Agency--Center for Marine & Estuarine Disease Research in concert with National Marine Fisheries Service, U.S. Fish & Wildlife Service, and states.
Initiation Date: 1995

Action Item 62: Establish response protocols for unusual mortality events in the Gulf of Mexico.

Project Description A: Establish minimum standards for field and laboratory procedures in responding to unusual mortality events in the Gulf of Mexico: sample collection, gross necropsy and pathology, tissue fixation, histological techniques, and tissue analyses. Include recommendations for quality assurance (QA) and chain of custody.
Lead: U.S. Environmental Protection Agency--Center for Marine & Estuarine Disease Research in concert with National Marine Fisheries Service, U.S. Fish & Wildlife Service, and states.
Initiation Date: 1995

Project Description B: Develop a rapid/sensible response authorization protocol to qualified cooperators for necropsy, transport, and disposal of biological samples from unusual mortality events.
Lead: U.S. Environmental Protection Agency--Center for Marine & Estuarine Disease Research in concert with National Marine Fisheries Service, U.S. Fish & Wildlife Service, and states.
Initiation Date: 1995
→ **26**

Action Item 63: Develop and conduct response team training for unusual mortality events in the Gulf of Mexico.

Project Description: Develop a training program and response protocols for scientific personnel who would be responding to unusual mortality events in the Gulf of Mexico. Conduct a pilot training session and make recommendations on changes and the frequency of training classes.
Lead: U.S. Environmental Protection Agency--Center for Marine & Estuarine Disease Research in concert with National Marine Fisheries Service, U.S. Fish & Wildlife Service, and states.
Initiation Date: 1995

Action Item 64: Evaluate mechanisms and secure contingency funding for implementation of scientific response teams for unusual mortality events in the Gulf of Mexico.

Project Description: Evaluate mechanisms and secure contingency funding for implementation of scientific response teams for unusual mortality events in the Gulf of Mexico.
Lead: Gulf of Mexico Program in concert with U.S. Environmental Protection Agency--Center for Marine & Estuarine Disease Research, National Marine Fisheries Service, U.S. Fish & Wildlife Service, and states.
Initiation Date: 1994
→ **25**

Compliance & Enforcement

The effectiveness of regulatory programs is greatly enhanced by active compliance monitoring and enforcement programs. Strong permit conditions are only effective if met by permittees. Enforcement surveillance and resolution of violations are essential to an effective regulatory program.

Currently many federal and state regulatory programs do not have the number of field level personnel which are required to achieve effective compliance and enforcement. Other incentives for compliance should be explored.

Specific objectives, action items, and project descriptions follow:

Objective: Enhance enforcement capabilities to protect living aquatic resources throughout the Gulf of Mexico.

Action Item 65: Assess the current status of state and federal compliance and enforcement programs throughout the Gulf of Mexico to protect living aquatic resources.

Project Description A: Assess current status of state and federal compliance and enforcement programs in the Gulf of Mexico for fishing.
Lead: Gulf of Mexico Program.
Initiation Date: 1994

Project Description B: Convene a workshop of federal, state, and international enforcement officers to identify the adequacy of enforcement. Review enforcement laws and statutes relevant to unusual mortality events and determine which are not being fully enforced. Identify obstacles to enforcement and recommend possible solutions to ensure that prevention of unusual mortality events is emphasized in the enforcement of existing and newly proposed legislation.
Lead: Gulf of Mexico Program--Living Aquatic Resources Committee in concert with U.S. Coast Guard and appropriate representatives of enforcement components of state and other federal agencies.
Initiation Date: 1995

Project Description C: Coordinate enforcement of fishery regulations through meetings of the standing law enforcement committees of the Gulf States Marine Fisheries Commission and Gulf of Mexico Fishery Management Council.
Lead: Gulf States Marine Fisheries Commission and Gulf of Mexico Fishery Management Council law enforcement committees in concert with National Marine Fisheries Service.
Initiation Date: Ongoing

Action Item 66: Develop specific mechanisms to enhance enforcement capabilities throughout the five Gulf of Mexico States.

Project Description A: Enhance the capability to enforce aquaculture and fisheries regulations in the Gulf of Mexico States. Develop methodologies to differentiate between aquaculture and wild-caught products to facilitate enforcement of pertinent regulations.
Lead: Gulf States Marine Fisheries Commission with all appropriate agencies.
Initiation Date: 1994

Project Description B: Ensure all regulatory and enforcing agents throughout the Gulf of Mexico are cross deputized in all states, to ensure maximum enforcement capabilities.
Lead: National Marine Fisheries Service in concert with states, U.S. Fish & Wildlife Service, and U.S. Coast Guard.
Initiation Date: 1994

Project Description C: Standardize data collection and reporting procedures throughout the Gulf of Mexico for environmental violations related to living aquatic resources.
Lead: Gulf of Mexico Program--Data & Information Transfer Operations.
Initiation Date: 1994

Public Education & Outreach

People living in two-thirds of the U.S. ultimately affect the environmental quality and living aquatic resources of the Gulf of Mexico. Therefore, effective conservation and protection of living aquatic resources requires an ongoing commitment from an informed citizenry. Public outreach nurtures such a commitment.

Public information, education, and involvement are three components of an effective outreach strategy, which can reap significant benefits both for the Gulf of Mexico and for citizens utilizing its resources. An effective strategy can foster recognition of the Gulf as a regional and national resource; stimulate civic, governmental, and private sector support for changing lifestyles; develop the financial commitments necessary to preserve the resource; and enable all individuals, whether living on the coast or along the upper stretches of the Mississippi, to see themselves as caretakers of a vital, shared resource.

Public information needs include the following:

- Knowledge about impacts of human activities on living aquatic resources;
- Risk assessments and communication;
- Information briefs on priority items/issues;
- How to use and apply information; and
- How the governmental process works in relation to "getting things accomplished."

Specific objectives, action items, and project descriptions follow:

Objective: Promote the coordination and advancement of all relevant Gulfwide education programs that address any aspect of living aquatic resources.

Action Item 67: Develop an inventory of all Gulf of Mexico education programs that cover living aquatic resources.

Project Description: Develop an inventory of Gulf of Mexico education programs that concern living aquatic resources, including the following five areas: 1) ecosystem status and trends; 2) impacts of fishing; 3) human impacts/interaction; 4) unusual mortality events; and 5) aquaculture Publish a listing of all state, federal, and Gulfwide education programs for resource agencies and groups to determine gaps in coverage.
Lead: Gulf of Mexico Program--Public Education & Outreach Operations in concert with Gulf Coast State SeaGrant programs.
Initiation Date: 1994

Action Item 68: Identify resources to implement public education/outreach strategies and actions for the protection of living aquatic resources in the Gulf of Mexico.

Project Description: Identify all potential funding sources, including government, contract and grant opportunities, foundations and corporations, and resource sharing that could fund Gulfwide public education and outreach on the effects of human interactions on living aquatic resources. Share this information with all potential implementors.
Lead: Gulf of Mexico Program in concert with state and federal funding agencies.
Initiation Date: 1994

Objective: Develop a public education and awareness program for the general public and specific user groups regarding human impacts on the living aquatic resources of the Gulf of Mexico, and promote a conservation ethic.

Action Item 69: Develop an effective educational methodology and strategy for the general public regarding human impacts on the living aquatic resources of the Gulf of Mexico.

Project Description: Review existing methodologies and strategies for reaching the general public, and make recommendations for educating key groups within the Gulf of Mexico region regarding human impacts on the living aquatic resources of the Gulf.
Lead: Gulf of Mexico Program--Public Education & Outreach Operations in concert with state education departments.
Initiation Date: 1994
→ **70A**

Action Item 70: Develop Gulfwide general and targeted informational materials about human interactions with living aquatic resources.

Project Description A: Develop and distribute materials and curricula for Gulf of Mexico educators on the impacts of human interaction with living aquatic resources (based on the strategy developed in Action Item 69).
Lead: Gulf of Mexico Program--Public Education & Outreach Operations.
Initiation Date: 1994
→ **69**

Project Description B: Develop and distribute materials for policy-makers in the Gulf of Mexico on the impacts of human interaction with living aquatic resources.
Lead: Gulf of Mexico Program--Public Education & Outreach Operations.
Initiation Date: 1994

Project Description C: Develop and distribute materials to speakers bureaus, and develop public service announcements (PSAs) on the impacts of human interaction with living aquatic resources.
Lead: Gulf of Mexico Program--Public Education & Outreach Operations.
Initiation Date: 1994

Project Description D: Develop educational information directed at tourists and the tourism industry about the importance of conserving and managing a healthy Gulf of Mexico ecosystem and the effects of human impacts on living aquatic resources.
Lead: Gulf of Mexico Program--Public Education & Outreach Operations in concert with National Marine Fisheries Service, U.S. Fish & Wildlife Service, and states.
Initiation Date: 1995

Project Description E: Develop and distribute educational materials for boaters in the Gulf of Mexico that review the impacts boats have on living aquatic resources, including the use of toxic boat paints and cleaners; the discharge of sewage, oily water, and trash; propeller-scarring, erosion of shorelines from boat wakes; anchor damage; etc.
Lead: U.S. Coast Guard in concert with Center for Marine Conservation, states, and Gulf of Mexico Program--Public Education & Outreach Operations.
Initiation Date: 1994
→ 53

Project Description F: Develop and distribute materials to developers, builders, and planners in the Gulf of Mexico on the importance of barrier islands, protected areas, and beaches to nesting birds, sea turtles, and other animals, their fluid nature, and the importance of building inland from these zones to eliminate the need for coastal armoring.
Lead: U.S. Army Corps of Engineers in concert with U.S. Fish & Wildlife Service.
Initiation Date: 1994

Project Description G: Produce a Gulfwide compendium of fishing regulations. Support the Gulf States Marine Fisheries Commission in publishing an annual compendium of fishing regulations and establish mechanisms to provide current regulations to citizens in an effective and timely manner.
Lead: Gulf States Marine Fisheries Commission in concert with Gulf of Mexico Fishery Management Council and state resource agencies.
Initiation Date: 1994

Objective: Develop a Gulfwide public education and awareness program for other key issues concerning living aquatic resources that are not being effectively addressed.

Action Item 71: Develop a Gulfwide program to increase public awareness and understanding of the implications of unusual mortality events and the need for research.

Project Description: Establish a Gulfwide public awareness program that: 1) provides education on the ecological implications of unusual mortality events for all species; 2) publicizes the potential of unusual mortality events to serve as an indicator of environmental conditions; 3) publicizes the economic impact of unusual mortality events; and 4) informs the public of research needs to address the occurrence/prevention of unusual mortality events.
Lead: Gulf of Mexico Program--Public Education & Outreach Operations.
Initiation Date: 1995

Objective: Involve an informed public constituency in the support and maintenance of "healthy" Gulf of Mexico ecosystems.

Action Item 72: Facilitate a Gulfwide understanding of the relationship of a "healthy" functioning ecosystem to a "healthy" economy.

Project Description: Develop materials and programs to educate the Gulfwide public, industry, and government about the relationship of a "healthy" ecosystem to a "healthy" economy. Promote the concept that a healthy Gulf ecosystem is an international, national, and regional asset.
Lead: Gulf of Mexico Program--Public Education & Outreach Operations in concert with National Oceanic & Atmospheric Administration--National Marine Fisheries Service, U.S. Environmental Protection Agency, and U.S. Fish & Wildlife Service.
Initiation Date: 1995

Action Item 73: Build a corps of informed citizens throughout the Gulf of Mexico to aid in the dissemination of information on the importance of living aquatic resources.

Project Description: Establish Gulfwide networks for educators, students, conservation and environmental groups, or other organizations to assist in educating the public. Convene periodic workshops for public media workers (outdoor writers, environmental reporters, travel writers).
Lead: Gulf of Mexico Program--Public Education & Outreach Operations in concert with National Oceanic & Atmospheric Administration--Sea Grant and National Marine Fisheries Service, U.S. Fish & Wildlife Service, and Center for Marine Conservation.
Initiation Date: 1994

Action Item 74: Develop a Gulfwide program to increase public reporting of unusual mortality events.

Project Description: Evaluate reporting mechanisms for unusual mortality events in the Gulf of Mexico. Implement the most efficient and appropriate programs that: 1) contain broad distribution of reporting procedures and forms and 2) involve follow-up, with status reports back to citizens.
Lead: U.S. Environmental Protection Agency--Gulf of Mexico Program in concert with National Oceanic & Atmospheric Administration, U.S Fish & Wildlife Service, and coastal states.
Initiation Date: 1994

Action Item 75: Develop a program to involve the public and private industry in promoting safe aquaculture practices in the Gulf of Mexico.

Project Description: Develop and disseminate informational and instructional materials on safe aquaculture practices to aquaculturists, students and the public in the Gulf of Mexico.
Lead: Gulf States Marine Fisheries Commission in concert with state Sea Grant agencies.
Initiation Date: 1994

In Closing...

We intend this document to be a beginning, not an end. Our hope is that this Action Agenda will serve as an inspiration and a call to action for the millions who live and work in the Gulf of Mexico region. Together, our coordinated actions can make a difference in conserving and restoring the living aquatic resources of the Gulf of Mexico.

The Gulf of Mexico Program
Living Aquatic Resources Committee

Ackerman, B.B. 1992. Personal communication. February 1992 manatee count. Florida Department of Natural Resources, Marine Research Institute. St. Petersburg, FL.

Angelovic, J.W. 1989. Written communication. Condition of the fisheries. U.S. Department of Commerce, National Marine Fisheries Service, Southeast Fisheries Center. Internal Memorandum. St. Petersburg, FL.

Associated Press. 1993. "Aquaculture making big splash in Florida." *The News Herald*. Tuesday, February 23, 1993.

Barros, N.B., D.K. Odell and G.W Patton. 1989. "Ingestion of Plastic Debris by Stranded Marine Mammals from Florida." In: *Proceedings From The Second International Congress on Marine Debris*. Honolulu, HI. April 1989.

Beeler, E.E. and T.J. O'Shea. 1988. *Distribution and Mortality of the West Indian Manatee (Trichechus manatus) in the Southeastern United States: A Compilation and Review of Recent Information*. Volume 2: The Gulf of Mexico Coast. National Geology Research Center Report No. 88-09.

Bellrose, F.C. 1968. *Waterfowl Migration Corridors East of the Rocky Mountains in the United States*. Illinois Natural History Survey, Biological Notes No. 61. State of Illinois Department of Registration and Education Natural History Survey Division.

Bortone, S.A. and J.L. Williams. 1986. *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (South Florida)--Gray, Lane, Mutton, and Yellowtail Snappers*. U.S. Fish & Wildlife Service Biological Report 82(11.52). U.S. Army Corps of Engineers, TR EL-82-4.

Bright, T.J. and E.C. Jaap. 1976. *Ecology and Management of Coral Reefs and Organic Banks*. Paper presented at the annual meeting of the American Institute of Biological Sciences in New Orleans, LA, June 1, 1976.

Brooks, J.M., H.B. Cox, W.R. Bryant, M.C. Kennicutt II, R.G. Mann and T.J. McDonald. 1986. "Association of Gas Hydrates and Oil Seepage in the Gulf of Mexico." *Organic Geochemistry*.

Brooks, J.M., M.C. Kennicutt II, I.R. MacDonald, D.L. Wilkinson, N.L. Guinasso Jr. and R.R. Bidigare. 1989. *Gulf of Mexico Hydrocarbon Seep Communities: Part IV--Descriptions of Known Chemosynthetic Communities*. Offshore Technology Conference, May 1-4, 1989, Houston, TX.

Buff, V. and S. Turner. "The Gulf Initiative." *Coastal Zone*. 1987.

Bunkley-Williams, L. and E.H. Williams, Jr. 1990. "Global Assault on Coral Reefs." *Natural History*. April 1990. Published by the American Museum of Natural History. New York, NY.

Burrell, V.G., Jr. 1986. *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (South Atlantic)--American Oyster*. U.S. Fish & Wildlife Service. Biological Report 82(11.57). U.S. Army Corps of Engineers, TR EL-82-4.

Byles, R.A. 1989. "Satellite Telemetry of Kemp's Ridley Sea Turtle, *Lepidochelys kempi*, in the Gulf of Mexico." In: Eckert, S.A., K.L. Eckert and T.H. Richardson (compilers). *Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology*. NOAA Technical Memorandum NMFS-SERC-232.

Byrd, M.A. 1978. "Dispersal and Movements of Six North American Ciconiiforms." In: Sprunt A., IV, J.C. Ogden and S. Winckler (eds). *Wading Birds*. National Audubon Society. New York, NY.

Caldwell, D.K. and M.C. Caldwell. 1989. "Pygmy Sperm Whale - *Kogia breviceps*" (de Blainville, 1838): "Dwarf Sperm Whale - *Kogia simus*" (Owen, 1866). In: Ridgway, S.H. and R. Harrison (eds). *Handbook of Marine Mammals*. Vol. 3: The Sirenians and Baleen Whales. Academic Press, Inc.

Center for Environmental Education. 1987. *COASTWEEKS*. The Entanglement Network Newsletter. No. 2, November 1987.

Christmas, J.Y., J.T. McBee, R.S. Waller and F.C. Sutter III. 1982. *Habitat Suitability Index Models: Gulf Menhaden*. U.S. Department of the Interior, Fish & Wildlife Service. FWS/OBS-82/10.23.

Christmas, J.Y., D.J. Etzold, L.B. Simpson and S. Meyers. 1988. *The Menhaden Fishery of the Gulf of Mexico United States: A Regional Management Plan*. Gulf States Marine Fisheries Commission. Ocean Springs, MS.

Clagett, J. 1990. Written communication. 1989 fishing license computer data. Texas Parks & Wildife, Coastal Fisheries Division.

Clapp, R.B., R.C. Banks, D. Morgan-Jacobs and W.A. Hoffman. 1982a. *Marine Birds of the Southeastern United States and Gulf of Mexico*. Volume I. Gaviiformes. U.S. Fish & Wildlife Service, Office of Biological Services. FWS/OBS-82/01.

Clapp, R.B., R.C. Banks, D. Morgan-Jacobs and W.A. Hoffman. 1982b. *Marine Birds of the Southeastern United States and Gulf of Mexico.* Volume II. Gaviiformes. U.S. Fish & Wildlife Service, Office of Biological Services. FWS/OBS-82/01.

Collard, S.B. and L.H. Ogren. 1989. "Dispersal Scenarios for Pelagic Post-Hatchling Sea Turtles." *Bulletin of Marine Science.*

Conley, W.J. and B. Hoffman. 1987. "Nesting Activity of Sea Turtles in Florida, 1979-1985." *Florida Sci.* 50(4).

Continental Shelf Associates, Inc. (CSA). 1990. *Synthesis of Available Biological, Geological, Chemical, Socioeconomic, and Cultural Resource Information for the South Florida Area.* U.S. Department of the Interior, Minerals Management Service, Atlantic OCS Region. OCS Study/MMS 90-0019.

Corliss, J.B., J. Dymond, L.I. Gordon, J.M. Edmond, R.P. von Herzen, R.K. Ballard, K. Green, D. Williams, A. Baingridge, K. Crane and T.H. van Andel. 1979. "Submarine Thermal Springs on the Galapagos Rift." *Science.*

Coston-Clements, L. and D.E. Hoss. 1983. *Synopsis of Data on the Impact of Habitat Alteration on Sea Turtles Around the Southeastern United States.* NOAA Technical Memorandum NMFA-SEFC 117. U.S. Department of Commerce, National Oceanic & Atmospheric Administration, National Marine Fisheries Service.

Crouse, D.T., M. Donnelly, M.J. Bean, A. Clark, W.R. Irvin and C.E. Williams. 1992. *The TED Experience: Claims and Reality.* A report by Center for Marine Conservation, Environmental Defense Fund, and National Wildlife Federation. April 1992.

Cummings, W.C. 1985. "Bryde's Whale - *Balaenoptera edeni.*" In: Ridgway, S.H. and R. Harrison (eds). *Handbook of Marine Mammals.* Vol 3: The Sirenians and Baleen Whales. Academic Press, Inc.

Darnell, R.M. 1988. "Marine Biology." In: Phillips, N.W. and B.M. James (eds) *Offshore Texas and Louisiana Marine Ecosystems Data Synthesis.* Volume II. Draft final report to the Minerals Management Service, Gulf of Mexico OCS Region. Contract No. 14-12-0001-30380.

Darnell, R.M. 1992. "Biology of the Estuaries and Inner Continental Shelf of the Northern Gulf of Mexico." In: *The Environmental and Economic Status of the Gulf of Mexico.* Proceedings from the Gulf of Mexico Symposium, December 2-5, 1990, New Orleans, LA.

Darnell, R.M. and J.A. Kleypas. 1987. *Eastern Gulf Shelf Bio-Atlas: A Study of the Distribution of Demersal Fishes and Penaeid Shrimp of Soft Bottoms of the Continental Shelf From the Mississippi River Delta to the Florida Deys.* OCS Study MMS 86-0041.

Darnell, R.M. and T.M. Soniat. 1979. "The Estuary/Continental Shelf as an Interactive System." In: Livingston, R.J. (ed). *Ecological Processes in Coastal and Marine Systems.* Plenum Press.

Darnell, R.M., R.E. Defenbaugh and D. Moore. 1983. *Atlas of Biological Resources of the Continental Shelf, NW Gulf of Mexico* BLM Open File Report No. 82-04. U.S. Department of the Interior, Bureau of Land Management. New Orleans, LA.

Davis, G.E. 1977. "Anchor Damage to a Coral Reef on the Coast of Florida." *Biol. Conserv.* Vol. 11.

Defenbaugh, R.E. 1976. *A Study of the Benthic Macroinvertebrates of the Continental Shelf of the Northern Gulf of Mexico.* Unpublished Ph.D. dissertation. Texas A&M University. College Station, TX.

Dunbar, J.B., L.D. Britsch and E.B. Kemp III. 1992. *Land Loss Rate: Report 3, Louisiana Coastal Plain.* UASCE Technical Report. GL-90-2. Department of the Army-WES-CE. Vicksburg, MS.

Federal Fisheries News Bulletin. 1989a. *Reduction of Open Area of Tortugas Shrimp Sanctuary.* National Marine Fisheries Service. St. Petersburg, FL. August 89-25.

Federal Fisheries News Bulletin. 1989b. *Sharks to Come Under Management in U.S. Atlantic Ocean Waters.* National Marine Fisheries Service. St. Petersburg, FL. August 89-32.

Fonseca, M.S., W.J. Kenworthy and G.W. Thayer. 1992. "Seagrass Beds: Nursery For Coastal Species." In: R.H. Stroud (ed). *Stemming The Tide of Coastal Fish Habitat Loss.* Proceedings of A Symposium on Conservation of Coastal Fish Habitat, Baltimore, MD, March 7-9, 1991. Published by the National Coalition for Marine Conservation, Inc. Savannah, GA.

Foster, A.M., L.A. Patrick and J.M. Barkuloo. 1988. *Striped Bass and Sturgeon Egg and Larva Studies on the Apalachicola River.* 1987 Progress Report. U.S. Fish & Wildlife Service. Panama City, FL.

Fritts, T.H., A.B. Irvine, R.D. Jennings, L.A. Collum, W. Hoffman and M.S. McGehee. 1983. *Turtles, Birds and Mammals in the Northern Gulf of Mexico and Nearby Atlantic Waters.* FWS/OBS-82/65. U.S. Fish & Wildlife Service, Office of Biological Services. Washington, DC.

Gambell, R. 1985a. "Fin Whale - *Balaenoptera physalus.*" In: Ridgway, S.H. and R. Harrison (eds). *Handbook of Marine Mammals.* Vol 3: The Sirenians and Baleen Whales. Academic Press, Inc.

Gambell, R. 1985b. "Sei Whale - *Balaenoptera borealis.*" In: Ridgway, S.H. and R. Harrison (eds). *Handbook of Marine Mammals.* Vol 3: The Sirenians and Baleen Whales. Academic Press, Inc.

Gaston, G.R. 1990. "Shrimping and Bycatch--The Problem is in the Trawl." *Water Log.* Mississippi-Alabama SeaGrant Legal Program. Vol. 10, No. 4.

Ginsburg, R.N. and N.P. James. 1974. "Holocene Carbonate Sediments of Continental Shelves." In: *Geology of Continental Margins.* C.A. Burk and C.L. Drake (eds.). Springer-Verlag. New York, NY.

Godcharles, M.F. and M.D. Murphy. 1986. *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (South Florida)--King Mackerel and Spanish Mackerel.* U.S. Fish & Wildlife Service Biological Report 82(11.58). U.S. Army Corps of Engineers, TR EL-82-4.

Grimes, C. 1988. "Aggregation of Icthyoplankton About the Mississippi River Plume Front: Potential Importance of the Plume to Recruitment." In: *Proceedings of the Ninth Annual Gulf of Mexico Information Transfer Meeting.* Sponsored by Minerals Management Service, Gulf of Mexico OCS Region. October 25-27, 1988. OCS Study MMS 89-0060. New Orleans, LA.

Gulf of Mexico Fishery Management Council. 1990. *Public Hearing Comments on the Proposed Amendment to the Gulf of Mexico Reef Fish Management Plan.* New Orleans, LA.

Gulf States Marine Fisheries Commission (GSMFC). 1988. *Thirty-Eighth Annual Report (1986-1987) to the Congress of the United States and to the Governors and Legislators of Alabama, Florida, Louisiana, Mississippi and Texas.* Ocean Springs, MS.

Gulf States Marine Fisheries Commission (GSMFC). 1991. *A Strategic Plan for Restoration and Management of Gulf of Mexico Anadromous Fisheries.* Ocean Stprings, MS.

Harrison, P. 1983. *Seabirds: An Identification Guide.* Houghton Mifflin Co.

Hayman, P., J. Marchant and T. Prater. 1986. *Shorebirds: An Identification Guide to the Waders of the World.* Houghton Mifflin Co.

Heneman, B. 1988. *Persistent Marine Debris in the North Sea, Northwest Atlantic Ocean, Wider Caribbean Area, and the West Coast of Baja California.* Center for Environmental Education. Washington, DC.

Henwood, T.A. and W.E. Stunz. 1987. "Analysis of Sea Turtle Capture and Mortalities During Commercial Shrimp Trawling." *Fish Bulletin.* Vol. 85, No. 4.

Heynig, J.E. 1989. "Cuvier's Beaked Whale - *Ziphius cavirostris*" (G. Cuvier, 1823). In: Ridgway, S.H. and R. Harrison (eds). *Handbook of Marine Mammals.* Vol 3: The Sirenians and Baleen Whales. Academic Press, Inc.

Hildebrand, H.H. 1982. "A Historical Review of the Status of Sea Turtle Populations in the Western Gulf of Mexico." In: Bjorndal, K.A. (ed). *Biology and Conservation of Sea Turtles.* Proceedings of the World Conference on Sea Turtle Conservation. Novermber 26-30, 1979. Smithsonian Institution Press. Washington, DC.

Hoese, H.D. and R.H. Moore. 1977. *Fishes of the Gulf of Mexico: Texas, Louisiana, and Adjacent Waters.* Texas A&M University Press. College Stations, TX.

Huff, J.A. 1975. "Life History of the Gulf of Mexico Sturgeon, *Acipenser oxyrhynchus desotoi*, in Suwannee River, Florida." *Marine Resources.* Publication No. 16.

Hunt, G.L., Jr. and D.C. Schneider. 1987. "Scale-Dependent Processes in the Physical and Biological Environment of Marine Birds." In: Croxall, J.P. (ed). *Seabirds: Feeding Ecology and Role in Marine Ecosystems.* Cambridge University Press.

Iverson, R.L. and H.F. Bittaker. 1986. "Seagrass Distribution and Abundance in Eastern Gulf of Mexico Coastal Waters." *Estuarine, Coastal Shelf Sci.* 22:577-602.

Jaap, E.C. 1984. *The Ecology of the South Florida Coral Reefs: A Community Profile.* FWS/OBS-82/08. U.S. Fish & Wildlife Service, Office of Biological Services. Washington, DC.

Jaap, E.C. and P. Hallock. 1990. "Reef Ecosystems." In: Meyers, R.L. and J.J. Ewel (eds). *Ecosystems in Florida.* University Central Florida Press. Orlando, FL.

Johannes, R.E. 1975. "Pollution and Degradation of Coral Reef Communities." In: R.E. Johannes and E.J. Ferguson Wood (eds). *Tropical Marine Pollution.* Elsevier Scientific Publishing Co. Amsterdam, Netherlands.

Karter. S., R.A. Milne, and M. Sainsbury. 1973. "Polystyrene Waste in the Severn Estuary." *Marine Pollution Bulletin IV.*

Kennicutt, M.C. II and B. Gallaway. 1985. *Recent Discoveries of Deep Water Communities in the Northwestern Gulf of Mexico.* Abstract of presentation of contract No. 30212 at Minerals Management Service's Information Transfer Meeting in New Orleans, LA, October 22-24, 1985.

Kilgen, R.H. and R.J. Dugas. 1989. *The Ecology of Oyster Reefs of the Northern Gulf of Mexico: An Open File Report.* U.S. Fish & Wildlife Service, National Wetlands Research Center. NWRC-open file report 89-02. Slidell, LA.

King, W.B. 1984. "Incidental Mortality of Seabirds in Gillnets in the North Pacific." In: J.P. Croxall, P.G.H. Evans and R.W. Schreiber (eds). *Status and Conservation of the World's Seabirds.* International Council for Bird Preservation. ICBP Technical Publication No. 2.

Kushlan, J.A. 1978. "Feeding Ecology of Wading Birds." In: Sprunt, A., J.C. Odgen and S. Winckler (eds). *Wading Birds.* Research Report No. 7 of the National Audubon Society.

Lampton, B. 1991. "Farming for Fishes." *Florida Sportsman.* Vol. 23, No. 4. April 1991.

Lazauski, H.G. 1990. Written communication. 1989 fishing license computer data. Alabama Department of Conservation and Natural Resource, Marine Resources Division.

Leatherwood, S. and R.R. Reeves. 1983. *The Sierra Club Handbook of Whales and Dolphins.* Sierra Club Books. San Francisco, CA.

LGL Ecological Research Associates, Inc. and Texas A&M University. 1986. *Gulf of Mexico Continental Slope Study, Annual Report: Year 2.* Prepared for the Minerals Management Service, Gulf of Mexico OCS Region. OCS Study/MMS 86-0089, 86-0090, and 86-0091.

Lintin, T.L. 1988. "Socioeconomics." In: Phillips, N.W. and B.M. James (eds). *Offshore Texas and Louisiana Marine Ecosystems Data Synthesis.* Final report to the Minerals Management Service, Gulf of Mexico OCS Region. Contract No. 14-12-0001-30380. Vol. II and III.

Lowe, J.A., D.R.G. Farrow, A.S. Pait, S.J. Arenstam and E.F. Lavan. 1991. *Fish Kills in Coastal Waters, 1980-1989.* U.S. Department of Commerce, National Oceanic & Atmospheric Administration, National Ocean Service, Strategic Environmental Assessments Division. September 1991.

Ludwick, J.C. and W.R. Walton. 1957. "Shelf-Edge, Calcareous Prominences in the Northwestern Gulf of Mexico." In: *Bulletin of the Amercian Association of Petroleum Geologists.* September 1957.

Madge, S. and H. Burn. 1988. *Waterfowl: An Identification Guide to the Ducks, Geese, and Swans of the World.* Houghton Mifflin Co.

Mager, A. and R. Ruebsamen. 1988. "National Marine Fisheries Service Habitat Conservation Efforts in the Coastal Southeastern United States." *Marine Fisheries Review.* 50(3).

Magnuson, J.J., K.A. Bjorndal, W.D. DuPaul, G.L. Granham, D.W. Owens, C.H. Peterson, P.C.H. Pritchard, J.I. Richardson, G.E. Saul and C.W. West. 1990. *Decline of the Sea Turtles: Causes and Prevention.* National Research Council. National Academy of Sciences Press. Washington, DC.

Manker, J.P. 1975. *Distribution and Concentration of Mercury, Lead, Cobalt, Zinc, and Chromium in Suspended Particles and Bottom Sediments - Upper Florida Keys, Florida Bay and Biscayne Bay.* Ph.D. Thesis. Rice University. Houston, TX.

Martin, R.P. 1990. Written communication. 1990 survey of brown pelican rookeries along coastal Louisiana. Louisiana Natural Heritage. Unpublished data.

McDowell, R.M. 1988. *Diadromy in Fishes Migrations Between Freshwater and Marine Environments.* Truder Press and Croom Helm.

Mead, J.G. 1977. "Records of Sei and Bryde's Whales From the Atlantic Coast of the United States, the Gulf of Mexico, and the Caribbean." In: *Report of the Special Meeting of the Scientific Committee on Sei and Bryde's Whales.* Rept. Int. Whal. Comm. (Special Issue I), Internatinal Whaling Commission. Cambridge, UK.

Mead, J.G. 1989. "Beaked Whales of the Genus - *Mesoplodon.*" In: Ridgway, S.H. and R. Harrison (eds). *Handbook of Marine Mammals.* Vol 3: The Sirenians and Baleen Whales. Academic Press, Inc.

Miller, W.G. 1992. "An Investigation of Bottlenose Dolphin *Tursiops truncatus* Deaths in East Matagorda Bay, Texas, January 1990." *Fishery Bulletin.* 90(4).

Moore, J.C. and E. Clark. 1963. "Discovery of Right Whales in the Gulf of Mexico." *Science* 141:269.

Mullin, K., W. Hoggard, C. Roden, R. Lohoefener, C. Rogers and B. Taggart. 1991. *Cetaceans on the Upper Continental Slope in the North-Central Gulf of Mexico*. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA.

Muncy, R.J. 1984. *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (South Atlantic)--White Shrimp*. U.S. Department of the Interior, Fish & Wildlfie Service (FWS/OBS-82/11.27) and U.S. Army Corps of Engineers, Coastal Ecology Group, Waterways Experiment Station (TR EL-82-4).

Murphy, T.M. and S.R. Hopkins-Murphy. 1989. *Sea Turtle and Shrimp Fishing Interactions: A Summary and Critique of Relevant Information*. Center for Marine Conservation. Washington, DC.

National Research Council. 1985. *Oil in the Sea: Input, Fates, and Effects*. National Academy Press. Washington, DC.

National Research Council. 1990. *The Decline of Sea Turtles: Causes and Prevention*. Committee on Sea Turtle Conservation. National Academy Press. Washington, DC.

Nelson, D.A. 1988. *Life History and Environmental Requirements of Loggerhead Turtles*. U.S. Fish & Wildlife Service. Biological Report 88(23) TREL-86-2 (rev).

Nelson, D.A. and D.W. Ahrenholz. 1986. "Population and Fishery Characteristics of Gulf Menhaden, *Brevoortia patronus*." *Fishery Bulletin*. 84(2).

Nicholls, J. 1990. Personal communication. Meeting regarding threatened and endangered species on the Chandeleur and Breton Islands, LA. August 30, 1990. Slidell, LA.

Nicholson, L. (ed). 1986. *Striped Bass Fishery Management Plan (Gulf of Mexico)*. Gulf States Marine Fisheries Commission. Ocean Springs, MS.

NMFS Miami & Charleston Laboratories. 1993. "The 1992 Texas Mortality Event and NMFS Investigation." *Strandings*. Newsletter of the Southeast Marine Mammal Stranding Network. Vol. 1, No. 2. Winter 1993.

Odenkirk, J., F.M. Parauka and P.A. Moon. 1985. "Radio Tracking and Spawning Observations of the Gulf of Mexico Sturgeon." U.S. Fish & Wildlife Service. Panama City, FL. Unpublished manuscript.

Ogden, J.C. 1978. "Recent Population Trends of Colonial Wading Brids on the Atlantic and Gulf Coastal Plains." In: Sprunt A., IV, J.C. Ogden and S. Winckler (eds). *Wading Birds*. National Audubon Society. New York, NY.

Ogren, L., F. Berry, K. Bjorndal, H. Kumpf, R. Mast, G. Medina, H. Reichart and R. Witham (compilers). 1989. *Proceedings of the Second Western Atlantic Turtle Symposium, October 12-16, 1987, Mayaguez, Puerto Rico.* U.S. Department of Commerce, National Oceanic & Atmospheric Administration. NOAA Technical Memorandum NMFS SEFC-226 Panama City, FL.

Osburn, H.R., M.F. Osborn, and H.R. Maddux. 1988. *Trends in Finfish Landings by Sport-Boat Fishermen in Texas Marine Waters, May 1974-May 1987.* Texas Parks & Wildlife Department. Austin, TX.

Parrish, G. 1990. "Stranded Dolphins Puzzle Scientists." *Texas Shores.* Vol. 23, No. 1. Spring 1990.

Pequegnat, W.E. 1983. *The Ecological Communities of the Continental Slope and Adjacent Regimes of the Northern Gulf of Mexico.* Final report to MMS.

Perret, W.S., J.E. Weaver, R.O. Williams, P.L. Johansen, T.D. McIlwain, R.C. Raulerson, and W.M. Tatum. 1980. *Fishery Profiles of Red Drum and Spotted Seatrout.* April 1980, No. 6. Gulf States Marine Fisheries Commission.

Portnoy, J.W. 1977. *Nesting Colonies of Seabirds and Wading Birds, Coastal Louisiana, Mississippi, and Alabama.* FWS/OBS-77/07. U.S. Fish & Wildlife Service, Office of Biological Services. Washington, DC.

Possardt, E. 1988. "Sea Turtle Conservation in the Southeastern Continental United States." *Endangered Species Technical Bulletin.* Vol. 13, No. 8. Department of the Interior, U.S. Fish & Wildlife Service. Washington, DC.

Prunier, K.T. 1992. "A Brief History of the SE Marine Mammal Stranding Network." *Strandings.* Newsletter of the Southeast Marine Mammal Stranding Network. Vol. 1, No. 1. Spring 1992.

Quinn, T. 1990. Written communication. 1989 fishing license computer data. Mississippi Department of Wildlife, Fisheries & Parks, Bureau of Marine Resources.

Rabalais, N.N., R.E. Turner, W.J. Wiseman, Jr. and D.F. Boesch. 1991. "A Brief Summary of Hypoxia on the Northern Gulf of Mexico Continental Shelf: 1985-1988." Pages 35-47 In R.V. Tyson and T.H. Pearson (eds.), *Modern and Ancient Continental Shelf Anoxia.* Geological Society Special Publication No. 58. The Geological Society. London.

Rezak, R. and T.J. Bright. 1981. *Northern Gulf of Mexico Topographic Features Study.* Final report to the BLM, contract No. AA551-CT8-35. Texas A&M Research Foundation and Texas A&M University, Department of Oceanography. College Station, TX.

Rezak, R., T.J. Bright and D.W. McGrail. 1983. *Reefs and Banks of the Northwestern Gulf of Mexico: Their Geological, Biological, and Physical Dynamics.* Final Technical Report No. 83-1-T.

Rice, D.W. 1989. "Sperm Whale - *Physeter macrocephalus* (Linnaeus, 1758)." In: Ridgway, S.H. and R. Harrison (eds). *Handbook of Marine Mammals.* Vol 4: River Dolphins and the Larger Toothed Whales. Academic Press, Inc.

Ruckdeschel, C. and C.R. Shoop. 1988. "Gut Contents of Loggerheads: Findings, Problems and New Questions." In: B.A. Schroeder (compiler). *Proceedings, Eighth Annual Workshop on Sea Turtle Conservation and Biology.* NOAA Technical Memorandum NMFS-SEFC-214. Southeast Fisheries Science Center. Miami, FL.

Ryder, R.R. 1978. "Breeding Distribution, Movements, and Mortality of Snowy Egrets in North America." In: Sprunt A., IV, J.C. Ogden and S. Winckler (eds). *Wading Birds.* National Audubon Society. New York, NY.

Schmidly, D.J. 1981. *Marine Mammals of the Southeastern United States Coast and the Gulf of Mexico.* FWS/OBS-80/41. U.S. Fish & Wildlife Service, Office of Biological Services. Washington, DC.

Schmied, R.L. 1993. "The Use of Angler Ethics Education to Support Marine Fisheries Management." *Trends.* Vol. 30, No. 2. U.S. Department of the Interior, National Park Service, National Recreation & Park Association. Washington, DC.

Schmied, R.L. and E.D. Burgess. 1987. "Marine Recreational Fisheries in the Southeastern United States: An Overview." *Marine Fisheries Review.* 49(2).

Schroeder, B.A. and C.A. Maley. 1989. "1988 Fall/Winter Strandings of Marine Turtles Along the Northeast Florida and Geogia Coasts." In: S.A. Eckert, K.L. Eckert and T.H. Richardson (compilers). *Proceedings, Eighth Annual Workshop on Sea Turtle Conservation and Biology.* NOAA Technical Memorandum NMFS-SEFC-214. Southeast Fisheries Science Center. Miami, FL.

Seidel, W.R. and J.W. Watson. 1990. "Shrimp Trawl Bycatch Reduction." In: *Proceedings of the Third Annual MARFIN Conference.* October 31-November 1, 1990. Orlando, FL.

Sharkey, J. 1990. Written communication. 1989 fishing license computer data. Louisiana Department of Wildlife & Fisheries, Seafood Division.

Shaw, R.F., J.H. Cowan, Jr. and T.L. Tillman. 1985. "Distribution and Density of *Brevoortia patronus* (Gulf Menhaden) Eggs and Larvae in the Continental Shelf Waters of Western Louisiana." *Bulletin of Marine Science.* (36(1).

Shinn, E.A. 1989. "What is Really Killing the Corals?" *Sea Frontiers.* Publication of the Internatinal Oceanographic Foundation/University of Miami. Vol. 35, No. 2. March-April 1989.

State of Florida Marine Fisheries Commission. 1988. Written communications. Various biological reports prepared for the commission meetings as information background.

Steele, P. and H.M. Perry (eds). 1990. *The Blue Crab Fishery of the Gulf of Mexico United States: A Regional Management Plan.* Gulf States Marine Fisheries Commission. Ocean Springs, MS.

Stewart, B.S. and S. Leatherwood. 1985. "Minke Whale - *Balaenoptera acutorostrata.*" In: Ridgway, S.H. and R. Harrison (eds). *Handbook of Marine Mammals.* Vol 3: The Sirenians and Baleen Whales. Academic Press, Inc.

Sutter, F.C. and T.D. McIlwain. 1987. *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Gulf of Mexico)--Sand Seatrout and Silver Seatrout.* U.S. Fish & Wildlife Service Biological Report 82(11.72). U.S. Army Corps of Engineers, TR EL-82-4.

Texas Parks & Wildlife Department. 1989. Written communication. *Texas Colonial Waterbird Census Summary - 1988.* Nongame and Endangered Species Program Wildlife Division, Texas Parks & Wildlife Department. 7-N-570-02/13/89.

Thayer, G.W. and J.F. Ustach. 1981. "Gulf of Mexico Wetlands: Value, State of Knowledge and Research Needs." In: *Proceedings of a Symposium on Environmental Research Needs in the Gulf of Mexico.* Key Biscayne, FL. May, 1981. NOAA. Washington, D.C.

Thayer, G.W., D.A. Wolfe and R.B. Williams. 1975. "The Impact of Man on Seagrass Systems." *American Scientist.* Vol. 63.

Thompson, N.B. 1988. "The Status of Loggerhead, *Caretta caretta;* Kemp's Ridley, *Lepidochelys kempi;* and Green, *Chelonia mydas* Sea Turtles in U.S. Waters." *Marine Fisheries Review.* 50(3).

Turner, R.E. and M.S. Brody. 1983. *Habitat Suitability Index Models: Northern Gulf of Mexico Brown Shrimp and White Shrimp.* U.S. Fish & Wildlife Service. FWS/OBS-82/10.54. Washington, DC.

Turner, R.E. and D.R. Cahoon. 1987. Causes of Wetland Loss in the Coastal Central Gulf of Mexico. Prepared under MMS Contract 14-12-0001-30252. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. OCS Study MMS 87-0119, 87-0120, and 87-0121. New Orleans, LA.

U.S. Department of Commerce. 1986. *Marine Environmental Assessment: Gulf of Mexico 1985 Annual Summary.* National Oceanic & Atmospheric Administration. Washington, DC.

U.S. Department of Commerce. 1988. *Fisheries of the United States, 1987.* Current Fisheries Statistics No. 8700. National Marine Fisheries Service. Washington, DC.

U.S. Department of Commerce. 1989. *Fisheries of the United States, 1988.* Current Fishery Statistics No. 8800. National Marine Fisheries Service. Washington, DC.

U.S. Department of Commerce. 1990a. National Oceanic and Atmospheric Administration. National Ocean Service. *A Special Earthweek Report: 50 Years of Population Change along the Nation's Coasts 1960-2010.* April 1990.

U.S. Department of Commerce. 1990b. National Oceanic and Atmospheric Administration. National Ocean Service. *Estuaries of the United States: Vital Statistics of a National Resource Base.* October 1990.

U.S. Department of Commerce. 1991a. *Fisheries of the United States, 1990.* Current Fishery Statistics No. 9000. National Marine Fisheries Service. Washington, DC.

U.S. Department of Commerce. 1991b. *Fishing Trends & Conditions in the Southeast Region, 1990.* Newlin, K. (ed). National Marine Fisheries Service, Southeast Fisheries Center. Miami, FL.

U.S. Department of Commerce. 1992a. *Our Living Oceans: Report on the Status of U.S. Living Marine Resources, 1992.* National Oceanic & Atmospheric Administration, National Marine Fisheries Service. NMFS-F/SPO-2.

U.S. Department of Commerce. 1992b. *Status of Fishery Resources off the Southestern United States for 1991.* NOAA Technical Memorandum NMFS-SEFSC-306.

U.S. Department of Commerce. 1992c. *Fisheries of the United States.* National Oceanic & Atmospheric Administration. National Marine Fisheries Service. Current Fishery Statistics No. 9100. Washington, DC.

U.S. Department of the Interior. 1984. *The Ecology of the South Florida Coral Reefs: A Community Profile.* Fish & Wildlife Service/Minerals Management Service. FWS/OBS-82/08. MMS 84-0038

U.S. Department of the Interior. 1986. *Whooping Crane Recovery Plan.* Fish & Wildlife Service. Albuquerque, NM.

U.S. Department of the Interior. 1987. Recovery Plan for the Choctawhatchee, Perdido Key and Alabama Beach Mouse. Fish & Wildlife Service. Atlanta, GA.

U.S. Department of the Interior. 1988a. *Great Lakes and Northern Great Plains Piping Plover Recovery Plan.* Fish & Wildlife Service. Twin Cities, MN.

U.S. Department of the Interior. 1988b. Fisheries Activities, Fish & Wildlife Service Field Office, Panama City, Florida. Unpublished Annual Report for 1987.

U.S. Department of the Interior. 1989. Annual narrative report. Fish & Wildlife Service. San Bernard National Wildlife Refuge. Angelton, TX.

U.S. Department of the Interior. 1990. *Gulf of Mexico Sales 131, 135, and 137: Central, Western, and Eastern Planning Areas--Final Environmental Impact Statement.* Volumes I and II. Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA.

U.S. Department of the Interior. 1992. *Gulf of Mexico Sales 142 and 143: Central and Western Planning Areas--Final Environmental Impact Statement.* Volumes I and II. Minerals Management Service, Gulf of Mexico OCS Region, in cooperation with U.S. Environmental Protection Agency. New Orleans, LA.

U.S. Environmental Protection Agency. 1989. *Our National Gulf Treasure: Fact Sheet.* GMP-FS-001. Gulf of Mexico Program Office. John C. Stennis Space Center, MS.

U.S. Environmental Protection Agency. 1990. *Report to Congress on Plastics.*

U.S. Environmental Protection Agency. 1991. *Gulf Facts.* Gulf of Mexico Program. John C. Stennis Space Center, MS.

Vaughan, D.S., J.V. Merriner and J.W. Smith. 1988. "The U.S. Menhaden Fishery: Current Status and Utilization." In: N. Davis (ed). *Fatty Fish Utilization: Upgrading From Feed to Food.* University of North Carolina, Sea Grant Publication. Raleigh, NC.

Watkins, W.A. and W.E. Schevill. 1976. "Right Whale Feeding and Baleen Rattle." *Jour. Mammalogy* 57(1).

Wilson, C. 1989. (Associated Press). "Groundings, boater, disease attack coral." *The News Herald.* Sunday, Nov. 12, 1989. Panama City, FL.

Winn, H.E. and N.E. Reichley. 1985. "Humpback Whale - *Megaptera novaeangliae.*" In: Ridgway, S.H. and R. Harrison (eds). *Handbook of Marine Mammals.* Vol 3: The Sirenians and Baleen Whales. Academic Press, Inc.

Wooley, C.M., P.A. Moon and E.J. Crateau. 1982. "A Larval Gulf of Mexico Sturgeon (*Acipenser oxyrhynchus desotoi*) from the Apalachicola River, Florida." *Northeast Gulf Science.* 5(2).

Wooley, C.M. and E.J. Crateau. 1985. "Movement, Microhabitat, Exploitation and Management of Gulf of Mexico Sturgeon, Apalachicola River, Florida." *North American Journal of Fisheries Management.*

Yochem, P.K. and S. Leatherwood. 1985. "Blue Whale - *Balaenoptera musculus.*" In: Ridgway, S.H. and R. Harrison (eds). *Handbook of Marine Mammals.* Vol 3: The Sirenians and Baleen Whales. Academic Press, Inc.

FEDERAL LEVEL

U.S. Department of Commerce (USDOC)

National Oceanic & Atmospheric Administration (NOAA)

- **Strategic Environmental Assessments (SEA) Division.** NOAA's Strategic Environmental Assessments (SEA) Division develops comprehensive information about environmental quality as it relates to estuarine and oceanic resources. These data are used for national and regional assessments to develop practical strategies to balance conservation requirements and use demands.

- **Coastal Ocean Program (COP).** The Coastal Ocean Program (COP) is a cross-cutting NOAA effort to provide the highest quality science delivered in time for important coastal policy decisions. COP activities are organized around four goals. These address the major coastal ocean issues of Environmental Quality, Fisheries Productivity, and Coastal Hazards; the fourth, Information Delivery, operates at the science-policy interface.

- **Habitat Strategic Plan.** NOAA has recently developed the Habitat Strategic Plan, the agency's long-range strategy for coordinated and concerted action to address the deterioration of the nation's coastal, estuarine, and riverine habitats and populations of living marine resources dependent upon such habitats. NOAA's legislative responsibilities and capabilities in habitat protection, wetlands ecology, resource conservation, toxicology, ocean system dynamics, fishery management, biological processes, and coastal habitat management provide a solid foundation for addressing these issues through an inter-disciplinary approach. NOAA has invested over $100 million per year in programs and activities that focus on habitat-related problems and issues along the nation's coasts and throughout its Exclusive Economic Zone (EEZ), including its protectorates and trust territories in the Pacific Ocean and Caribbean Sea.

  The NOAA Habitat Strategic Plan provides detailed, agency-wide guidance for addressing the priority issues affecting habitat important to living marine resources throughout the nation's coastal waters. This document complements "NOAA's Investment in Coastal Environmental Quality," which is being published separately, but focuses specifically on living marine resources' habitats. NOAA's role in this effort is: 1) to develop the scientific understanding of how human activities affect natural ecosystem functioning, and 2) assess and predict the effects of specific land and water development proposals on coastal environments and their living marine resources. NOAA's goal for habitat protection is to "protect, conserve, and restore the quantity and quality of habitats of living marine resources to maintain populations of commercial, recreational, and ecologically important species at optimal sustainable levels."

- **National Ocean Service (NOS).** The National Marine Sanctuary and National Estuarine Research Reserve programs are administered by the Sanctuaries and Reserves Division, National Ocean Service, NOAA. Marine sanctuaries and estuarine research reserves are designed and managed to meet the following goals: 1) enhance resource protection through the implementation of a comprehensive, long-term management plan tailored to specific resources; 2) promote and coordinate research to expand scientific knowledge of significant marine resources and improve management decision-making; 3) enhance public awareness, understanding, and wise use of the marine environment through public interpretive and recreational programs; and 4) provide for optimum compatible public and private use of special marine areas.

  National Estuarine Research Reserve Program. The National Estuarine Research Reserve Program was established by the Coastal Zone Management Act of 1972, and is administered by the Sanctuaries and Reserves Division, National Ocean Service, NOAA. Three estuarine research reserves have been established in the Gulf of Mexico: Rookery Bay National Estuarine Research Reserve and Apalachicola National Estuarine Research Reserve in Florida, and Weeks Bay National Estuarine Research Reserve in Alabama.

  Rookery Bay National Estuarine Research Reserve, at more than 3,440 hectares (8,500 acres), preserves a large mangrove-filled bay and two creeks, along with their drainage corridors. Management of the sanctuary is performed by the Florida Department of Natural Resources, The Conservancy, and the National Audubon Society. This unique management structure was created when the two private organizations granted a dollar-per-year, 99 year lease of the land to the State of Florida. Federal and state funds will add additional key acreage to the existing core area. The diversity of the area's fauna can be recognized by the porpoises that feed there and the bald eagles and whitetail deer that make Rookery Bay their permanent residence.

  At more than 76,890 hectares (190,000 acres), the Apalachicola National Estuarine Research Reserve is one of the largest remaining naturally functioning ecosystems in the nation, and it is also the first sanctuary on the mouth of a major navigable river. The major business activity of Apalachicola, which is adjacent to the sanctuary, centers around the oyster industry, and it is expected that the sanctuary will benefit this and other fishing industries by protecting the environment and by providing research information that will help assure the continued productivity of the bay/river ecosystem. A USFWS refuge and a state park, which represent a unique cooperative effort at ecosystem protection, exist within the boundaries of the reserve.

  Weeks Bay National Estuarine Research Reserve constitutes a small estuary of approximately 1,225 hectares (3,028 acres), comprising open shallow waters with an average depth of less than 1.5 m (5 ft) and extensive vegetated wetland areas.

It receives waters from the spring-fed Fish and Magnolia Rivers and connects through a narrow opening with Mobile Bay, the principal element of coastal Alabama.

Marine Protection, Research & Sanctuaries Act (MPRSA) of 1972. The National Marine Sanctuary Program was established by the Marine Protection, Research & Sanctuaries Act (MPRSA) of 1972 (Title III), and is administered by the Sanctuaries and Reserves Division, National Ocean Service, NOAA. MPRSA provides for the establishment of marine sanctuaries and may include the regulation of the fishery resource within them. Only sites with special national significance are selected for marine sanctuary status. Sites selected for consideration are evaluated on the merits of resource and human-use values and on the public benefits to be derived from sanctuary status.

The Flower Garden Banks were designated a marine sanctuary in December 1991. This site, located 177 km (110 mi) offshore, represents the northern-most coral reef community in the western Gulf of Mexico. The borders of the sanctuary encompass a total of 114 km^2 (44 mi^2). The area is a valuable representation of a tropical coral reef community dominated by hermatypic coral and associated reef fishes and invertebrates. The U.S. Department of the Interior has protected the biological resources of the Banks from possible damage due to oil and gas exploration and development activities by the establishment of a "No Activity Zone" and by operational restrictions. The Gulf of Mexico Fishery Management Council, in its proposed FMP for corals, has designated the area within the 50 fathom [91.4 m (300 ft)] isobath at the Banks as a Habitat Area of Particular Concern (HAPC).

The Florida Keys National Marine Sanctuary are: "spectacular, unique, and nationally significant marine environments, including seagrass meadows, mangrove islands, and extensive living coral reef...These marine environments support rich biological communities possessing extensive conservation, recreational, commercial, ecological, historical, research, educational, and aesthetic values which give this area special national significance...These environments...support high levels of biological diversity, are fragile and easily susceptible to damage from human activities and possess high value to human beings if properly conserved...(and) are subject to damage and loss of their ecological integrity from a variety of sources of disturbance...Action is necessary...requiring promulgation of a management plan and regulations to protect sanctuary resources" (H.R. 5909). The area of the Sanctuary includes essentially all submerged lands and waters, including living marine and other resources, from the mean high-water mark of the Keys out to the 91.4 m (300 ft) isobath, excluding Fort Jefferson National Monument.

- **National Status & Trends Program (NS&T).** This program documents the current status and long-term trends in the quality of estuaries and coastal waters. It provides data on concentrations of pollutants in finfish, shellfish, and

sediments and measures the effects of environmental degradation by toxic chemicals in finfish, shellfish, and sediments. It also measures biological parameters that reflect stress associated with human-induced perturbations, assesses marine environmental quality, and recommends federal responses. Under this program, NOAA conducts sampling throughout the Gulf of Mexico.

- **National Status and Trends Mussel Watch Program (NSTMWP).** The Mussel Watch Program has consisted of sampling and analyzing bivalves from U.S. coastal areas since 1986. Sampling sites include coverage of the Gulf Coast from southernmost Texas to southernmost Florida.

- **Benthic Surveillance Program (BSP).** The Benthic Surveillance Program collects samples of sediment, bottom-dwelling mollusks, and bottom-feeding fish from numerous sites throughout the country. Samples are analyzed for substances such as toxic metals, polynuclear aromatic hydrocarbons, and chlorinated organic chemicals.

- **National Shellfish Register (NSR).** NSR contains information on shellfish contamination incidents and provides important indicators of the extent to which shellfish in U.S. waters are contaminated. NSR uses a classification system based on concentrations of coliform bacteria and natural marine biotoxins. Productive shellfish waters can be classified as approved, prohibited, conditionally approved, or restricted. NSR provides limited information on the current status of shellfishing areas and still less on past trends, in part because the classification scheme is not used consistently by the states. NSR has been issued periodically since 1966 and was last published in 1985.

- **Coastal Zone Act Management Act of 1972 (CZMA).** The Coastal Zone Management Act was enacted by Congress in 1972 to improve the nation's management of coastal resources, which were being irretrievably damaged or lost due to poorly planned development. Specific concerns were the loss of living marine resources and wildlife habitat, decreasing open space for public use, and shoreline erosion. Congress also recognized the need to resolve the conflicts between various uses that were competing for coastal lands and waters. The basic goal of the CZMA is to encourage and assist coastal states to voluntarily develop comprehensive management programs. CZMA establishes a state-federal partnership in which the states take the lead in managing their coastal resources, while the federal government provides financial and technical assistance and agrees to act in a manner consistent with the federally-approved state management programs.

  The Coastal Zone Management Act of 1972 encourages coastal and Great Lakes states to develop and implement management programs to achieve wise use of land and water resources in the coastal zone and authorizes the National Oceanic and Atmospheric Administration (NOAA) to issue grants for state coastal management programs.

Reauthorization Amendments of 1990 (CZARA). Section 6217 requires states to establish coastal nonpoint programs, which must be approved by both NOAA and USEPA. The central purpose of Section 6217 is to strengthen the links between federal and state coastal zone management and water quality programs in order to enhance state and local efforts to manage land use activities that degrade coastal waters and coastal habitats. This is to be accomplished primarily through the implementation of 1) management measures in conformity with guidance published by USEPA under Section 6217(g) of the CZARA and 2) additional state-developed management measures as necessary to achieve and maintain applicable water quality standards.

National Marine Fisheries Service

NMFS implements approved Fishery Management Plans under the Magnuson Act. The Southeast Fisheries Center directly supports federal programs for the conservation and wise use of living marine resources in the southeastern U.S. The Center conducts research and provides scientific and technical information on fishery resources, marine habitats, and the harvest and use of seafood products. Center scientists also conduct research on marine species protected under federal laws and work with international scientific organizations to achieve conservation goals.

- **Magnuson Fishery Conservation & Management Act (MFCMA) of 1976.** The Magnuson Fishery Conservation & Management Act of 1976 (MFCMA) established a fisheries conservation zone for the U.S. and its possessions and delineated an area from the individual states' seaward boundary out 322 km (200 nautical miles). MFCMA created eight Regional Fishery Management Councils (FMCs) and mandated a continuing planning program for marine fisheries management by the Councils. MFCMA, as amended, requires that a Fishery Management Plan (FMP), based upon the best available scientific and economic data, be prepared for each commercial species (or related group of species) of fish that is in need of conservation and management within each respective region.

  Based on Congressional direction, the MFCMA must be reauthorized every few years. At the time of reauthorization, Congress also considers amendments to the Act that will update and improve the fishery management system. The individual FMCs also take part in the process by recommending changes to the Act that they believe are necessary to improve the fishery management system.

  In 1990, Congress reauthorized the MFCMA with some changes. Tuna, swordfish, sharks, and billfish are now included for protection under the Act. Responsibility for their management and conservation has been given to the appropriate FMCs.

  To date, the following FMPs have been implemented in the Gulf of Mexico: shrimp, in 1981; stone crab, in 1982; spiny lobster, in 1982; coastal pelagic fish, in

1983; coral, in 1984; reef fish, in 1984; swordfish, in 1985; red drum, in 1987; and sharks, in 1993. The FMPs are amended and updated as new information from studies and public input is received and assessed.

- **Marine Mammal Protection Act of 1972.** The Marine Mammal Protection Act (MMPA) of 1972, as amended, establishes a national policy designed to protect and conserve marine mammals and their habitats. This policy is established so as not to diminish such species or population stocks beyond the point at which they cease to be a significant, functioning element in the ecosystem, nor to diminish such species below their optimum sustainable population. The Secretaries of Commerce and Interior have delegated authority for administering the Act to NMFS, which is responsible for all cetacean and pinnipeds (except walruses), and to USFWS, which is responsible for walruses, sea otters, manatees, and dugongs.

  The Marine Mammal Commission and its delegated administrators are responsible for reviewing and advising federal agencies on the protection and conservation of marine mammals because activities under the authority of federal agencies may constitute a "take" as defined under the MMPA. If it is ascertained that taking may occur, an exemption to or waiver of the Act's moratorium of taking would be required for the responsible parties. The Act provides particular exemptions to the taking of marine mammals by Alaskan Natives under certain conditions. The Act authorizes the Commission to make recommendations on the prohibition of the taking and importation of marine mammals and marine mammal products, except as expressly provided for by an international treaty, convention, or agreement to which the U.S. is a party.

  A provision of the Act directs the Secretary of Commerce to allow an exception, on request, for those engaged in oil and gas activities, from the "taking" prohibitions stated within the Act when the taking is unintentional, involves small numbers of individuals, and has negligible effects, provided that satisfactory provisions have been made to monitor and report the taking.

U.S. Department of the Interior (USDOI)

U.S. Fish & Wildlife Service (USFWS)

USFWS becomes involved in management of Gulf of Mexico living aquatic resources through a variety of legislative avenues, including the Endangered Species Act, Fish & Wildlife Coordination Act, Anadromous Fish Conservation Act, Marine Mammal Protection Act, and Federal Aid in Sport Fish Restoration Act. The Service assists in coastal and marine habitat protection through the review of federal projects and permit actions and by providing comments to regulatory agencies. USFWS is the primary federal agency responsible for the protection and recovery of threatened and endangered populations of coastal birds, manatees, and

Gulf sturgeon, and provides a supporting role in the recovery of sea turtles. USFWS operates a system of national wildlife refuges that encompasses a substantial amount of coastal estuarine habitat important to fisheries in the Gulf of Mexico. USFWS law enforcement officers assist other agencies in enforcing fisheries and wildlife laws affecting coastal resources. USFWS Fisheries Resource Offices participate in the management of interjurisdictional fisheries of the Gulf of Mexico and its rivers through various interagency committees, commissions and councils. Through the Federal Aid program, the Service distributes millions of dollars annually to coastal state agencies for fisheries and habitat improvement projects.

The U.S. Fish & Wildlife Service focuses attention on nonpoint source pollution problems in a number of areas. USFWS has conducted research to define the scope and effect of pollutants from urban and agricultural runoff, mining, silviculture, and hydromodification on fish and wildlife species and their habitats. USFWS has also conducted special information and education efforts to encourage farm owners to participate in the USDA Conservation Reserve Program and worked with the Agricultural Extension Service to develop a pamphlet emphasizing the benefits of riparian vegetation in reducing nonpoint source pollution.

USFWS routinely provides recommendations on BMPs to control nonpoint source pollution when reviewing permit/license applications, federal project construction and operation plans, resource management plans, conservation easements, and other types of land management activities. Measures to mitigate damage to fish and wildlife resources or their habitats are included in these recommendations.

- **Federal Aid in Sport Fish Restoration Act.** This Act is commonly referred to as the Dingell-Johnson Act and the Wallop-Breaux Amendment. The Act authorizes the federal government to collect taxes on the sale of recreational fishing and boating equipment and the Secretary of the Interior to apportion these revenues to state fish and wildlife agencies for sport fish restoration and management purposes in fresh and marine waters.

- **Fish & Wildlife Coordination Act.** Under this Act, USFWS and NMFS review and comment on aspects of proposals for work and activities sanctioned, permitted, assisted, or conducted by federal agencies that take place in or affect navigable waters. The review focuses on potential damage to fish and wildlife and their habitat, particularly in near shore waters, and may, therefore, serve to provide protection to fishery resources from federal activities. Federal agencies must consider the recommendations of the two agencies.

- **Fish Restoration & Management Projects Act.** Under this Act, the Department of Interior apportions funds to state fish and game agencies for fish restoration and management projects. Funds for protection of threatened fish communities located within state waters, including marine areas, could be made available under this Act.

- **Endangered Species Act of 1973.** The Endangered Species Act of 1973, as amended, establishes a national policy designed to protect and conserve threatened and endangered species and the ecosystems upon which they depend. The Act is administered by USFWS and NMFS. The Act provides for the listing of threatened or endangered plant and animal species. Once listed as a threatened or endangered species, taking (including harassment) is prohibited. The process ensures that projects authorized, funded, or carried out by federal agencies do not jeopardize the species existence or result in habitat destruction or modification critical to species existence.

- **National Fishing Enhancement Act of 1984.** Title II of Public Law 98-623, also known as the Artificial Reef Act, establishes broad artificial-reef development standards and a national policy of the U.S. to encourage the development of artificial reefs that will enhance fishery resources and commercial and recreational fishing. The Secretary of Commerce provided leadership in developing a National Artificial Reef Plan that identifies design, construction, siting, and maintenance criteria for artificial reefs and that provides a synopsis of existing information and future research needs. The Secretary of the Army issues permits to responsible applicants for reef development projects in accordance with the National Plan, as well as regional, state, and local criteria and plans. The law also limits the liability of reef developers complying with permit requirements and amends the Reefs for Marine Life Conservation Law to include the availability of all surplus federal ships for consideration as reef development materials. Although the Act mentions no specific materials other than ships for use in reef development projects, the Secretary of the Interior cooperated with the Secretary of Commerce in developing the National Plan, which identifies oil and gas structures as acceptable materials of opportunity for artificial-reef development.

Minerals Management Service (MMS)

MMS supports and administers a large, multidisciplinary studies program to develop information needed for assessment and mitigation of impacts to human, marine, and coastal environments that may be affected by Outer Continental Shelf (OCS) oil and gas activities. MMS's Outer Continental Shelf Environmental Studies Program has recently (1991) funded a series of studies through Texas A&M University on the distribution and abundance of marine mammals in the north-central and western Gulf of Mexico designed to produce a first-step estimate of the potential effects of deep-water exploration and production on these species. The studies include systematic aerial and shipboard surveys, behavioral observations, and the tagging and subsequent tracking of a limited number of sperm whales using satellite telemetry. Data acquired from both shipboard surveys and remote sensing will be used to characterize preferred habitats of cetaceans in the study area, whereas data acquired from behavioral observations will be used to determine preferred geographic areas and temporal patterns of critical activities such as feeding, breeding, and mating.

MMS adopted a Rigs-to-Reefs policy in 1985 in response to the Artificial Reef Act and to broaden interest in the use of petroleum platforms as artificial reefs.

National Park Service (NPS)

National parks and monuments are under the jurisdiction of NPS. NPS manages fish in the coastal and near shore parks. Management, enforcement, and research activities are conducted by NPS.

U.S. Geological Survey (USGS)

USGS has conducted considerable coral reef research and assisted or cooperated with other institutions and agencies to facilitate logistics and support of coral reef research.

U.S. Environmental Protection Agency (USEPA)

- **Clean Water Act (CWA).** In general, USEPA strives to achieve the objectives of the Clean Water Act (CWA). CWA directs USEPA to develop criteria for water quality that accurately reflect the latest scientific knowledge about the effects of pollutants on aquatic life and human health. In developing criteria to protect water quality, USEPA examines the effects of specific pollutants on plankton, fish, shellfish, wildlife, plant life, aesthetics, and recreation in any body of waters. This includes specific information on the concentration and dispersal of pollutants through biological, physical, and chemical processes as well as the effects of pollutants on biological communities as a whole.

  USEPA periodically publishes the results of these examinations to help states determine the levels of pollutants that can exist in the water column and the sediment while still maintaining designated uses. These levels are called "water quality criteria." Criteria can also describe the biological and physical characteristics that a lake, river, or estuary must have to support a healthy environment for fish and wildlife. States then use these criteria to help set water quality standards that protect the uses of their waters.

  USEPA is responsible for establishing all water quality criteria and for developing the framework for the issuance of National Pollutant Discharge Elimination System (NPDES) permits for municipal and industrial discharges. USEPA establishes standards for oil and hazardous substances discharges from boats into federal waters and promulgates performance standards for marine sanitation devices.

  USEPA has published a guidance document for developing water quality standards for wetlands. This document provides guidance to states which must include wetlands in their definitions of state waters and thus protect the quality

of those waters. As a part of that process, states will have to identify "beneficial uses," adopt criteria, and apply antidegradation policies to their wetlands.

National Estuary Program (NEP). In 1987, the National Estuary Program was established in the Water Quality Act, an amendment to the Clean Water Act. The purpose of the Program is to identify nationally significant estuaries, to protect and improve their water quality, and to enhance their living resources. Under the Program, which is administered by USEPA, comprehensive management plans are developed to protect and enhance environmental resources. The governor of a state may nominate an estuary for the Program and request that a Comprehensive Conservation and Management Plan (CCMP) be developed for that estuary. Representatives from federal, state, and interstate agencies, academic and scientific institutions, and industry and citizen groups work during a five-year period to define objectives for protecting the estuary, to select the chief problems to be addressed in the Plan, and to ratify a pollution control and resource management strategy to meet each objective. At present, there are twenty-one estuaries in the Program; five in the Gulf of Mexico (Galveston Bay, Tampa Bay, Sarasota Bay, Barataria-Terrebonne Estuarine Complex, and recently, Corpus Christi Bay).

The Galveston Bay National Estuary is the seventh largest estuary in the U.S. and the largest in Texas. The bay system provides 1,554 km^2 (600 mi^2) of very shallow water, averaging less than 3 m (10 ft) in depth. On the average, precipitation in the bay area watershed equals or exceeds what is lost through evaporation, and nearly ten million acre-feet of freshwater enter the bay annually. The resulting low salinity in the bay is the key to its productivity, providing ideal conditions for the growth of fish, crabs, shrimp, and oysters. In addition, the bay is surrounded by 526 km^2 (203 mi^2) of estuarine marsh, 36 km^2 (14 mi^2) of forested wetlands, and 158 km^2 (61 mi^2) of freshwater ponds and lakes. These ecological resources filter runoff to the bay system and provide a rich source of nutrients that enhances biological productivity, as well as provide valuable habitat for many economically important species.

The Barataria-Terrebonne Estuarine Complex consists of an extensive array of estuarine wetlands and bodies of water containing more coastal wetlands than any other estuarine system in the U.S. At least 19 percent of the nation's estuary-dependent commercial fisheries is sustained by the Complex. It is also used for recreation by boaters, fishermen, and hunters, supporting important elements of the local economy and culture. As much as half of the national loss of coastal wetlands may have occurred in the Complex.

Sarasota Bay National Estuary is a small estuary on the southwest coast of Florida. Although generally regarded as a "clean" bay, it is threatened by overuse and growth pressure. Storm water runoff and habitat loss have been identified as primary issues of concern in the restoration and enhancement of the estuary. Seven goals have been identified as targets upon which to focus the attention of

all interested parties. Demonstration projects to begin the restoration of native, productive habitat to the bay system have been started, and these and others will be an integral part of the final comprehensive plan for the bay.

Tampa Bay National Estuary is the largest open-water estuary in Florida and supports a myriad of uses, such as commercial and recreational fishing, shipping, sanitary and electrical services, waterfront development, tourism, and recreation. The water quality is good to excellent in much of the lower and middle bay, declining in old Tampa Bay, and undesirable in the Hillsborough area.

- **National Environmental Policy Act of 1970 (NEPA).** NEPA requires that all federal agencies recognize and give appropriate consideration to environmental amenities and values in the course of their decision-making. In an effort to create and maintain conditions under which man and nature can exist in productive harmony, NEPA requires that federal agencies prepare an environmental impact statement (EIS) prior to undertaking major federal actions that significantly affect the quality of the human environment. Within these statements, alternatives to the proposed action that may better safeguard environmental values are to be carefully assessed.

- **Environmental Monitoring & Assessment Program (EMAP).** EMAP is a long-term, interagency monitoring activity designed to evaluate the status and trends of U.S. ecological resources and the effectiveness of pollution control. EMAP conducts annual surveys to assess the health of plants and animals, the quality of their surroundings, and the presence of pollutants by examining key indicators at designated sites. The indicators are representative of the general condition of a site's estuarine resources. The indicators address three areas of concern: 1) estuarine biotic integrity; 2) aesthetic appeal for public use of the estuarine resources; 3) and exposure of biota to pollutants.

  EMAP is structured on a regional scale by dividing all of the nation's coastal waters, bays, and estuaries into regions for study; the Louisianian Province corresponds to the Gulf of Mexico area. The information collected is used to address large areas such as the Gulf of Mexico, rather than smaller systems like Galveston Bay. An intense study of every bay and estuary would be too costly. Within each region, scientific measurements will be made every year at randomly selected stations. From July-August 1991, EMAP sampled 183 sites between Anclote Anchorage, FL, and the Rio Grande, TX. All sampling is conducted during the summer months because summer is when plants and animals generally are most active and when the effects of pollution are most severe.

U.S. Department of Defense (USDOD)

U.S. Army Corps of Engineers (USACE)

USACE contracts and regulates coastal engineering projects particularly harbor dredging and beach renourishment projects. USACE also reviews and is the permitting agency for coastal development projects and artificial reefs.

- **Clean Water Act (CWA), as amended.** USACE has the responsibility for the permit program and federal projects under §404 of the CWA for the discharge of dredged and fill material. The USACE evaluation of a §404 permit application is a two part test which involves determining whether the project complies with the §404(b)(1) guidelines and conducting a public interest review. Federal projects are reviewed in the same manner.

  Applicants must demonstrate that a discharge, which may be released to the aquatic environment during dredging and disposal operations, will not have an unacceptable adverse impact on the aquatic ecosystem. Furthermore, applicants must discuss possible alternatives, the extent and permanence of beneficial and/or detrimental aspects, and the probable cumulative impacts of the proposed activity. Discharges can be permitted only if all appropriate steps are taken to mitigate the adverse impacts of the discharge on the ecosystem, including compensating for unavoidable impacts.

  The public interest review is a balancing test in which the public and private need for and benefits of a project are weighed against that project's adverse impact to the environment, as measured by criteria developed by USEPA in conjunction with the USACE. These criteria generally consider aesthetics, recreation, historic values, economics, water supply, water quality, energy needs, and flood damage prevention. In addition, the USACE conducts an environmental assessment under NEPA to determine whether the project has significant environmental impacts.

  USACE can deny permits to those applicants whose projects it determines are not in the public interest. Generally, USACE permits will not be issued where the necessary state or local authorizations have been denied. Under CZMA, objection by Gulf States to a project may also preclude the USACE from issuing permits.

U.S. Coast Guard (USCG)

The 1978 Waterways Safety Act charges USCG with marine environmental protection. USCG is the general enforcement agency for all marine activity in the federal zone. Among its responsibilities are enforcement of sanctuary and fishery management regulations, management of vessel salvage, coordination of oil spill

cleanup operations and sea and search and rescue operations, interdiction of illegal alien and drug traffic, and maintenance of navigational aids such as buoys and lighthouses.

U.S. Department of Agriculture (USDA)

Soil Conservation Service (SCS)

The Soil Conservation Service (SCS) is the U.S. Department of Agriculture's primary technical agency in the areas of soil and water conservation and in water quality. SCS focuses its assistance on non-federal land. It works primarily with private landowners in planning and applying measures to reduce soil erosion, conserve water, protect and improve water quality, and protect other renewable natural resources such as plants, animals, and air. The guiding principle is the use and conservation treatment of the land and water in harmony with its capabilities and needs. SCS works with private landowners and others to preserve, protect, and restore wetlands and to develop wildlife and fisheries habitat.

U.S. Forest Service (USFS)

The U.S. Forest Service (USFS) administers large units of land called "National Forests" in most of the fifty states, as well as "National Grasslands" in some states. USFS is directly responsible for management of natural resources in the National Forests and Grasslands. Federal/state cooperative programs are aimed at protecting and enhancing the quality of all forest resources including watershed, timber, and wildlife values.

STATE LEVEL

Alabama

- **Department of Conservation & Natural Resources.** The Marine Resources Division of the Department of Conservation & Natural Resources is responsible for management of Alabama's marine fisheries resources. The Enforcement Section patrols Alabama's coastal waters, enforcing both state and federal rules on conservation and protection of marine resources. The Biological Section investigates fish kills and prepares pollution reports. Currently, the most stressed marine resource in Alabama is the oyster resource.

  Sportfish Restoration Act. Under the Sportfish Restoration Act, federal excise tax monies support the management of marine recreational fisheries. A tagging and monitoring program will monitor growth, movement, and harvest. A project is underway to gather data to characterize the by-catch of recreational finfish by the trawl fishery and to develop indices of the relationships between post larval and juvenile finfish abundance and adult recreational finfish capture. Ten new artificial reefs have been constructed from bridge rubble and railroad boxcars. A public information pamphlet lists all public fishing reefs off shore of Alabama. Federal anadromous fish funds are being utilized to fund field work to document the occurrence of natural striped bass reproduction and characterize the genetic makeup of the adult population.

  Biological functions not covered by federal aid, such as fish kill investigations and all facets of oyster management, are supported by commercial and recreational fishing license sales. During 1989, 14 fish kills were investigated by the fisheries staff on kills ranging in severity from 200 to 1,900,000 fish killed.

Florida

- **Department of Natural Resources (DNR).** The Department of Natural Resources (DNR) is responsible for management of all marine fisheries and resources in state waters. This includes lobster, snook, snapper, grouper, other commercial and sport species, mangrove, seagrass, and coral reef communities. DNR has specific police powers through the Florida Marine Patrol to enforce state and some federal statutes.

  DNR works to promote the recovery of the five endangered species of sea turtles through biological and ecological research, population census, assessment of mortality factors, and habitat protection, utilizing permit reviews and coordination of research and management efforts in the state permit system. DNR is pursuing various strategies to ensure the future of Florida's sea turtle population. These include promoting the use of turtle excluder devices to

reduce incidental mortality of sea turtles in shrimp trawls, increasing the protection of nesting beaches and foraging habitats, assisting with implementation of lighting ordinances, providing standardized guidelines and training to sea turtle conservationists, and developing improved turtle nest protection programs on beaches. The manatee research effort includes a salvage and necropsy program and aerial censuses to assess abundance and distribution.

The Commercial Fisheries Statistics Cooperative effort with the National Marine Fisheries Service provides catch and effort data on all state fisheries and the effects of management decisions. DNR also conducts a Stock Enhancement Research Program.

The Florida Marine Research Institute, Division of Marine Resources, within DNR, conducts studies to determine the age, growth, reproduction, and stock structure of various marine finfish and shellfish species.

The primary responsibilities of Florida's Bureau of Marine Resource Regulation & Development are the classification and monitoring of shellfish growing waters, the inspection of shellfish and blue crab processing plants, resource assessment, and resource rehabilitation and development. DNR has a mandate to "improve, enlarge, and protect the oyster and clam resources of the state" and is actively engaged in collecting oyster shell from processing plants and constructing and restoring oyster reefs on public bottoms. The Division of Marine Resources promotes depuration as a practical method for cleaning potentially contaminated shellfish, to ensure product quality, and to protect public health. In 1990, the Division issued 17 relay permits to leaseholders and depuration facilities.

Florida's Bureau of Marketing and Extension Services spearheads the state's seafood marketing activities. Florida's Bureau of Sanctuaries and Research Services administers the National Estuarine Research Reserve and National Marine Sanctuary Programs through cooperative agreements with NOAA. These programs are designed to provide resource protection in estuarine and marine systems through environmental education, scientific research, and on-site management (including enforcement). There are two designated reserves in Florida at Apalachicola and Rookery Bay.

The major objectives of the Office of Fisheries Management and Assistance Services are to 1) act as DNR liaison to the Marine Fisheries Commission; 2) act as DNR liaison to Florida's rapidly growing aquaculture industry; 3) establish a marine biological emergency response team to handle short-term marine life disasters; 4) improve and expand Florida's artificial fishing reef development program; 5) establish an informational outreach program for distributing DNR and Marine Fisheries Commission rules, regulations, and information regarding marine resources to sports and commercial fishermen; 6) establish a fisheries

dependent data collection program for recreational and commercial fisheries; and 7) act as technical liaison for DNR to Florida's local mosquito control program.

- **Department of Environmental Regulation (DER).** Within state waters, the Department of Environmental Regulation (DER) has management powers over environmental change caused by human activity. All major engineering projects must be reviewed prior to permitting Both environmental monitoring and research are conducted. In the area of permitting, DER reviews permits for any human activity that affects the marine environment. Coastal dredging and marine pollution are both managed through state statutes.

  Under special powers, the Department of Administration (DOA) can enact "State Areas of Critical Concern" and decree special regulations for indefinite periods if growth or other activities overload the capacity of local government to adequately manage the resources.

Louisiana

The Department of Wildlife & Fisheries (DWF) executes laws and implements policies enacted for the protection, conservation, and replenishment of wildlife and aquatic species within Louisiana. The Department is charged with the responsibility for management of all renewable resources on all wildlife management areas, refuges and preserves that it may own or lease, which would include some regulatory powers over water quality for those water bodies within its jurisdiction.

The Marine Fisheries Division has developed bioprofiles for a range of marine species and conducted stock assessments for largemouth bass, mullet, sheepshead, catfish, crappie, red drum, shrimp, spotted seatrout, bowfin, blue crab, oyster, pompano, and sand seatrout to provide analyses for fisheries management decision-making. The Division is participating in a tagging program for red drum and conducts monthly environmental monitoring of Louisiana Offshore Oil Port (LOOP) operations. In 1986, the Louisiana Artificial Reef Program was established to offset the loss of recreational and commercial fishing opportunities associated with the removal of offshore oil and gas platforms.

The Marine Fisheries Division also sets season frameworks for shrimp and is supporting industry task forces for both shrimp and crab to better manage the resources. It also conducts a comprehensive monitoring program to provide information about the status of finfish stocks.

Louisiana's fish kill program is conducted by three agencies: Department of Environmental Quality (DEQ); DWF; and Department of Agriculture. DWF investigates kills caused by naturally occurring fish diseases, while DEQ responds to and investigates all kills.

Mississippi

The responsibilities of the Bureau of Marine Resources, Department of Wildlife, Fisheries & Parks, include saltwater fisheries management, coastal wetlands management, and the enforcement of state and federal laws that pertain to the regulation of the use and harvest of coastal, estuarine, and marine resources. The Bureau's fisheries management program is geared towards providing for the continued wise utilization of fishery resources while at the same time ensuring the health and vitality of the state's valuable renewable marine resources. Biologists continually monitor shellfish and finfish stocks in state waters and both sports and commercial harvest levels in order to provide the Mississippi Commission of Wildlife, Fisheries, and Parks with the best available scientific information on which to base its management decisions. Staff biologists work in cooperation with USFDA to provide a shellfish management program that is in full compliance with all applicable federal guidelines.

Fisheries landings data are collected to indicate potential problem areas and as a gauge of the success of existing fisheries regulations and practices. Biological data for selected commercially important finfish species are collected to support the development of fishery management plans. Information for selected pelagic and reef fishes is submitted to NMFS to support the proper management of these resources. A shrimp monitoring and assessment program is conducted for commercial, recreational, and live bait shrimping.

Management of molluscan shellfish resources includes harvest management, assessment and monitoring of population dynamics and reef characteristics, and reef rehabilitation and cultivation. Compliance with recommended National Shellfish Sanitation Program guidelines includes classification of shellfish growing waters using sanitary surveys and sanitary control of the harvesting, processing, and distribution of shellfish. Regulation of oyster, shrimp, and other shellfish processing plants is accomplished through inspections of plants for compliance with established safe, sanitary processing guidelines.

The Bureau of Marine Resources and the Bureau of Pollution Control (within the Department of Environmental Quality) investigate fish kills. The Bureau of Pollution Control is responsible for all state waters, while the Bureau of Marine Resources may investigate some coastal kills.

The Bureau of Marine Resources provides aquaculture regulatory information to active and potential aquaculturists, conducts cultivation/marketing permit discussions and site inspections, provides recommendations on site specific specifications and issuance of associated permits, and monitors aquaculture permitted facilities for compliance with permit conditions.

Mississippi is participating in a joint project with Alabama to restore striped bass population to coastal waters of the two states. The state is also procuring and deploying concrete structures on permitted reef sites to expand reef fish habitat.

For the 1989/1990 fiscal year, marine enforcement officials made 178 seafood-related arrests. Over $45,000 in fines were collected in each of the three coastal counties.

Texas

The Texas Parks & Wildlife Department (TPWD) operates the state parks system and wildlife refuges. TPWD is responsible for reviewing and commenting on state and federal permits affecting Texas wildlife resources.

The Coastal Fisheries Branch is responsible for making management recommendations regarding the state's saltwater fishery resources within Texas bays and estuaries and out to nine nautical miles in the Gulf of Mexico. The goal of the Coastal Fisheries Program is to develop management plans for selected fisheries utilizing the concept of optimum yield. Management plans include harvest regulations, resource stock enhancements, or habitat enhancements based on monitoring programs and the best scientific information available. The Branch determines sizes and changes in sizes of finfish and shellfish populations caused by environmental conditions and fishing, determines landings of marine species and the associated social and economic characteristics of the fisheries, develops mariculture techniques for selected species, and educates the consumer regarding high quality, wholesale seafood products.

TPWD and the Texas Natural Resource Conservation Commission (TNRCC) are the two agencies that respond and document fish kills. TNRCC has the lead on water quality problems relating to discharges, while TPWD responds to, investigates, and is responsible for recovering damages to fish and wildlife for all kills.

Gulf States Marine Fisheries Commission (GSMFC)

The Gulf States Marine Fisheries Commission (GSMFC) was established through the enactment of enabling legislation by the five states of the Gulf of Mexico region and the consent of the U.S. Congress in 1949, through Public Law 81-66. GSMFC's principal objective is the conservation, development, and full utilization of the fishery resources of the Gulf of Mexico, to provide food, employment, income and recreation to the people of the U.S. GSMFC is composed of three members from each of the five Gulf States: the head of the fishery resource agency of the state, a member of the state legislature, and a governor-appointed citizen who has a knowledge of and interest in marine fisheries.

In executing the Gulf State Marine Fisheries Compact, GSMFC recommends actions to the five state governors and legislatures on programs helpful to the management of fisheries; consults with and advises the five states on fishery conservation problems; and advises and testifies before the U.S. Congress on legislation and marine policies that affect the Gulf States. One of the most important functions of GSMFC is to serve as a forum for: 1) the discussion of various problems and programs associated with marine management, industry, and research, and 2) the development of a coordinated Gulf of Mexico policy to address these issues for the betterment of the resource and all who are concerned. Member states relinquish none of their rights or responsibilities to regulate their own fisheries.

Since the 1970s, GSMFC has had the responsibility for administrative support and coordination of the Gulf State-Federal Fisheries Management Program. This program was designed to develop management plans for transboundary stocks that migrate freely through state and federal boundaries. In 1986, this program was replaced with the Interjurisdictional Fisheries Management Program (Title III, Public Law 99-659). GSMFC has completed fishery management plans (FMPs) for shrimp, menhaden, Spanish mackerel, blue crab, oyster, and black drum, as well as amendments to these plans. Another important function of GSMFC is to coordinate state-federal cooperative research and data collection programs. Examples include the cooperative red drum research program, the Southeast Area Monitoring & Assessement Program (SEAMAP), and the Southeast Recreational Fisheries Information Network [RecFin (SE)].

AL	Alabama
ATSDR	Agency for Toxic Substances & Disease Registry
BSP	Benthic Surveillance Program
CAC	Citizens Advisory Committee--Gulf of Mexico Program
CCMP	Comprehensive Conservation & Management Plan
COP	Coastal Ocean Program
CSA	Continental Shelf Associates, Inc.
CWA	Clean Water Act
CZARA	Coastal Zone Act Reauthorization Amendments
CZMA	Coastal Zone Management Act
DEQ	Department of Environmental Quality--Louisiana
DOA	Department of Administration--Florida
DWF	Department of Wildlife & Fisheries--Louisiana
EMAP-E	Environmental Monitoring & Assessment Program--Estuaries
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
DER	Department of Environmental Regulation--Florida
DNR	Department of Natural Resources--Florida
FL	Florida
FMC	Fishery Management Council
FMP	Fishery Management Plan
GIS	Geographic Information System
GMFMC	Gulf of Mexico Fishery Management Council
GMP	Gulf of Mexico Program
GSMFC	Gulf States Marine Fisheries Commission
HAPC	Habitat Area of Particular Concern
LA	Louisiana
LARS	Living Aquatic Resources
LME	Large Marine Ecosystem
LOOP	Louisiana Offshore Oil Port
MC	Management Committee--Gulf of Mexico Program
MFCMA	Magnuson Fishery Conservation & Management Act
MMPA	Marine Mammal Protection Act
MMS	U.S. Minerals Management Service
MPRSA	Marine Protection, Research & Sanctuaries Act
MS	Mississippi
MSD	Marine Sanitation Device
NAS	National Academy of Science
NASA	National Aeronautics and Space Administration
NEP	National Estuary Program
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NPDES	National Pollutant Discharge Elimination System

NPS	National Park Service
NRC	National Research Council
NS&T	National Status & Trends
NSTMWP	National Status & Trends Mussel Watch Program
OCS	Outer Continental Shelf
PRB	Policy Review Board--Gulf of Mexico Program
SCS	Soil Conservation Service
SEA	Strategic Environmental Assessments
SEAMAP	Southeast Area Monitoring & Assessment Program
SEUS	Southeast Marine Mammal Stranding Network
TAC	Technical Advisory Committee--Gulf of Mexico Program
TED	Turtle Excluder Device
TNRCC	Texas Natural Resource Conservation Commission
TPWD	Texas Parks & Wildlife Department
TX	Texas
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USDOC	U.S. Department of Commerce
USDOD	U.S. Department of Defense
USDOE	U.S. Department of Energy
USDOI	U.S. Department of the Interior
USEPA	U. S. Environmental Protection Agency
USFDA	U.S. Food & Drug Administration
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

acute	Sudden, severe, critical, intense, but usually of short duration.
aphotic zone	Zone where the levels of light entering through the surface are not sufficient for photosynthesis or for animal response.
areas of high marine productivity	Areas such as open bays, estuaries, and sounds that are used by finfish and shellfish as nursery and/or spawning grounds and may contain oyster reefs; nearshore Gulf areas that are important harvest grounds for menhaden and industrial bottom fish and/or finfish and shellfish spawning grounds; coral areas in the vicinity of the Florida Keys.
basin	A depression of the earth in which sedimentary materials accumulate or have accumulated, usually characterized by continuous deposition over a long period of time; a broad area of earth beneath which the strata dip, usually from the sides toward the center.
cetacean	A marine mammal such as a whale, dolphin, or porpoise.
coelobite	Organisms that live in the cavities of reefs--cryptic organisms They are normally small and encrusting and include foraminifera.
continental margin	The ocean floor that lies between the shoreline and the abyssal ocean floor. It includes the provinces of the continental shelf, continental slope, and continental rise.
continental shelf	The continental margin province that lies between the shoreline and the abrupt change in slope called the shelf edge, which generally occurs around a water depth of 200m. The shelf is characterized by a gentle slope (ca. 0.1°).
continental slope	The continental margin province that lies between the continental shelf and continental rise, characterized by a steep slope (ca. 3° -6°) and located around depths of 3,000-4,000m.
critical habitat	Specific areas essential to the conservation of a protected species and that may require special management considerations or protection.
designated environmental preservation areas	Gulf of Mexico shorefront areas that have been established for the quality and significance of their natural environments. They have been legislatively, administratively, or privately protected from the developmental influences of humans and are managed solely for the preservation, understanding, and appreciation of their natural attributes. Included are National Parks and Preserves, National and State Wilderness Areas, National Marine and Estuarine Sanctuaries, National Landmarks, Wildlife Sanctuaries, Florida Aquatic Preserves, and Environmentally Endangered Lands.
detritivores	Animals whose diet consists of detritus and the microbial fauna attached to detrital particles.
detritus	Particulate organic matter originating primarily from the physical breakdown of dead animal and plant tissue (may also include the breakdown of inorganic material).

essential habitat	Specific areas crucial to the conservation of a species and that may necessitate special considerations
Exclusive Economic Zone (EEZ)	The maritime region adjacent to the territorial sea; extending 200 nautical miles from the baseline of the territorial sea, in which the U.S. has exclusive rights and jurisdiction over living and nonliving natural resources.
geochemical	Of or relating to the science dealing with the chemical composition of and the actual or possible chemical changes in the crust of the earth.
geomorphology	The science of surface land forms and their interpretation on the basis of geology and climate.
geophysical	Of or relating to the physics of the earth, especially the measurement and interpretation of geophysical properties of the rocks in an area.
habitat	A specific type of place that is occupied by an organism, a population, or a community.
herbivores	Animals whose diet consists of plant material.
incidental take	Takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by a federal agency or applicant.
major shorefront recreational beaches	Those frequently visited sandy areas along the shorefront exposed to the Gulf of Mexico that support a multiplicity of recreational activity, most of which is focused at the land-water interface. Included are National Seashores and other selected areas in the National Parks System, State Park and Recreational Areas, county and local parks, urban beach fronts, and private resort areas.
marshes	Persistent, emergent non-forested wetlands characterized by vegetation consisting predominantly of cordgrasses, rushes, and cattails.
nearshore waters	Offshore, open waters that extend from the shoreline out to the limit of the territorial seas (12 nautical miles).
nepheloid	A layer of water near the bottom that contains significant amounts of suspended sediment causing an increase of turbidity.
offshore marine recreational fishing	Hook-and-line sport fishing, from a boat seaward of the beach, for fun, food, and occasional incidental profit, inclusive of spearfishing.
organic matter	Material derived from living plant or animal organisms.
Outer Continental Shelf (OCS)	All submerged lands that comprise the continental margin adjacent to the U.S. and seaward of state offshore lands.
penaeids	Chiefly warm water and tropical prawns belonging to the family Penaeidae.
plankton	Passively floating or weakly motile aquatic plants and animals.
primary production	Organic material produced by photosynthetic or chemosynthetic autotroph organisms.

rookery	The nesting or breeding grounds of gregarious (*i e*, social) birds or mammals; also a colony of such birds or mammals.
saltwater intrusion	Phenomenon occurring when a body of saltwater, because of its greater density, invades a body of freshwater; occurs in either surface or ground water sources.
sciaenids	Fishes belonging to the croaker family (Sciaenidae).
seagrass beds	More or less continuous mats of submerged, rooted, marine, flowering vascular plants occurring in shallow tropical and temperate waters. Seagrass beds provide habitat, including breeding and feeding grounds, for adults and/or juveniles of many of the economically important shellfish and finfish.
sediment	Material deposited (as by water, wind, or glacier) or a mass of deposited material.
sensitive coastal habitats	Coastal habitats susceptible to damage from human-related activities.
sensitive offshore area	An area containing species, populations, communities, or assemblages of living resources, to which human-related activities may cause irreparable damage, including interference with established ecological relationships.
spit	Small point of land or a narrow shoal projecting into a body of water from the shore.
subsidence	A sinking of a part of the earth's crust.
taking	To harass, harm, hunt, kill, capture, or attempt to engage in any such conduct (including, actions that induce stress, adversely impact critical habitat, or result in adverse secondary or cumulative impacts).
turbidity	Reduced water clarity resulting from the presence of suspended matter.
vascular plants	Plants containing food- and water-conducting structures; higher plants that reproduce by seeds.

The Living Aquatic Resources Committee

Co-Chairs:

Herb Kumpf	National Marine Fisheries Service
Karen Steidinger	Florida Marine Research Institute

Members:

Philip Bohr	National Marine Fisheries Service
Nora Deyaun Boudreaux	Texas Shrimp Association
Thomas Bright	Texas A&M University
Bradford Brown	National Marine Fisheries Service
Gail Carmody*	U.S. Fish & Wildlife Service
James Cato	Florida Sea Grant College
George Crozier*	Marine Environmental Sciences Consortium
Quenton Dokken	Gulf of Mexico Foundation--CAC
William Evans	Texas A&M University
Bill Fisher*	U.S. Environmental Protection Agency
Douglas Fruge'*	Gulf Coast Fisheries Coordination Office
Joe Gill	Mississippi Bureau of Marine Resources
Al Green*	Texas Parks & Wildlife Department
Gary Hendrix	National Park Service
Joe Herring	Louisiana Department of Wildlife & Fisheries
Rex Herron*	National Marine Fisheries Service
Richard Hoogland*	Gulf of Mexico Fishery Management Council
Robert Jones	Southeast Fisheries Association
H.D. Kelly	Soil Conservation Service
Frederick Kopfler*	U.S. Environmental Protection Agency
John Lambeth	Biloxi Sun Herald
Heidi Lovett*	Center for Marine Conservation
Ronald Lukens*	Gulf States Marine Fisheries Commission
Kumar Mahadevan	Mote Marine Laboratory
Bill Mason	U.S. Fish & Wildlife Service
Thomas McIlwain	Gulf Coast Research Laboratory
R. Vernon Minton	Alabama Department of Conservation
John Ogden	Florida Institute of Oceanography
Steven Plakas	U.S. Food & Drug Administration
Jim Ratterree	U.S. Environmental Protection Agency--Region 6
Ralph Rayburn	Texas Parks & Wildlife Department
Susan Rees	U.S. Army Corps of Engineers
Bruce Rosendahl	Rosenstiel School of Marine & Atmospheric Science
Andrew Sansom	Texas Parks & Wildlife Department
Richard Shaw	Louisiana State University
Robert Shipp	University of South Alabama

Larry Simpson	Gulf States Marine Fisheries
Robert Stewart, Jr.	U.S. Fish & Wildlife Service
Wayne Swingel	Gulf of Mexico Fisheries Management Council
Jack Van Lopik	Louisiana State University
Frederick Werner	U.S. Fish & Wildlife Service
Pace Wilber	U.S. Army Corps of Engineers
Jonathan Wilson	Jackson State University
Alejandro Yanez-Arancibia	Programa Epomex
Bernard Yokel*	Florida Audubon Society

***Steering Committee Member**

Written Comments on Strawman (1.0, 1.1, 1.2 & 1.3) Received From the Following:

Bruce Ackerman	Florida Marine Research Institute
Harry Blanchet	Louisiana Department of Wildlife & Fisheries
Steve Bortone	University of West Florida
Steve Branstetter	Gulf & South Atlantic Fisheries Development Foundation, Inc.
Tom Bright	Texas A&M University
Brad Brown	NOAA/National Marine Fisheries Service
Gail Carmody	U.S. Fish & Wildlife Service
George Crozier	Marine Environmental Sciences Consortium
Doug Fruge'	Gulf Coast Fisheries Coordination Office
Joe Herring	Louisiana Department of Wildlife & Fisheries
Herbert Kale	Florida Audubon Society
Herb Kumpf	NOAA/National Marine Fisheries Service
Ronald Lukens	Gulf States Marine Fisheries Commission
Anne Meylan	Florida Marine Research Institute
Lorna Patrick	U.S. Fish & Wildlife Service
Steven Plakas	U.S. Food & Drug Administration
Jim Ratterree	U.S. Environmental Protection Agency--Region 6
Ron Schmied	National Marine Fisheries Service
Karen Steidinger	Florida Marine Research Institute
Bernard Yokel	Florida Audubon Society